

GENERAL ARTICLE

Barriers to the Administration of Epinephrine in Schools

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ABSTRACT

BACKGROUND: Anaphylaxis is a serious and growing concern in the school setting as the prevalence of food allergies and food-induced severe allergic reactions continues to increase.

METHODS: A cross-sectional, web-based survey was conducted regarding anaphylactic events that occurred during the 2014-2015 school year. Eligible schools were enrolled in the EPIPEN₄SCHOOLS[®] program (Mylan Specialty L.P., Canonsburg, PA), which provides free epinephrine auto-injectors to qualifying US schools. Participating schools completed a 29-item survey on anaphylactic event occurrence and treatment, epinephrine stock, school policies regarding anaphylaxis, school staff training, and school nursing coverage.

RESULTS: Responses were provided by 12,275 schools. Epinephrine was administered on school property for 63.7% of reported anaphylactic events (1272/1998). In 38.5% (235/610) of events for which epinephrine was not used, antihistamines were cited as the reason. Only 59.4% of schools cited epinephrine as their standard first-line therapy for anaphylaxis. School nurses were most likely to be trained in anaphylaxis recognition and permitted to administer epinephrine; however, just 53.6% of schools had a full-time nurse on staff.

CONCLUSIONS: Process-related barriers to the appropriate use of epinephrine go beyond access to medication. Widespread staff training and review of school policies are needed to ensure that anaphylaxis is appropriately managed in schools.

Keywords: anaphylaxis; epinephrine; epinephrine auto-injector; food allergy; school nurse; school staff training.

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Anaphylaxis is a severe allergic reaction that can occur rapidly and may cause death.¹ Risk factors such as a previous anaphylactic episode, a history of asthma, or a known allergy increase the likelihood of experiencing anaphylaxis, yet reactions are not uncommon among individuals without a history of these conditions.² Indeed, as many as one fourth of those who experience an anaphylactic reaction in the school setting have no history of allergy.³⁻⁶ Among school children, food as a trigger for anaphylaxis has become a significant concern as the prevalence of food allergies continues to increase,⁷ as does the frequency of pediatric emergency department visits due to food-induced anaphylaxis.⁸⁻¹⁰ It is now estimated that food

allergies affect 1 in 20 school-aged children, which translates to an average of at least 1 student per classroom.⁷

The strong immune response associated with anaphylaxis is life threatening and requires immediate treatment. Epinephrine, typically administered via an epinephrine auto-injector (EAI), is the only first-line therapy for anaphylactic reactions.^{11,12} Individuals with a known predisposition to anaphylaxis may be prescribed an EAI; however, many children experience their first reaction unexpectedly,¹³ and therefore, would not have a plan in place to manage such events. Even among those who have known risk factors for anaphylaxis and own an EAI, epinephrine is often

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not administered in a timely manner.^{14,15} This delay in treatment increases the risk of hospitalization and death.^{12,15} Reasons that have been cited for deferred administration of epinephrine in schools typically relate to suboptimal awareness regarding anaphylaxis symptoms, shortcomings in emergency management plans and policies, or lack of epinephrine availability.¹⁴ These findings underscore the importance of school preparedness and point to a need to better understand the ways in which schools can improve their response to anaphylactic events.

The EPIPEN4SCHOOLS[®] program (Mylan Specialty L.P., Canonsburg, PA), which launched in 2012, provides anaphylaxis training materials and EAI to participating US schools. An exploratory survey of anaphylactic events that occurred during the 2013 to 2014 school year was previously conducted using schools enrolled in the EPIPEN4SCHOOLS[®] program. This survey exposed potential gaps in schools' anaphylaxis treatment policies that prevented the timely and appropriate management of anaphylaxis.^{5,16,17} Herein, we report the results of an updated survey that covered the 2014 to 2015 school year and more deeply explored school policies and standards, school nursing support, and barriers to epinephrine administration.

METHODS

Participants

All schools registered in the EPIPEN4SCHOOLS[®] program during the 2014 to 2015 school year with available demographic and contact information were eligible to participate in the study. Demographic information was obtained by matching registered schools with the US Department of Education, National Center for Education Statistics Common Core of Data (CCD) (<http://nces.ed.gov/ccd/>) and Private School Universe Survey (PSS) (<http://nces.ed.gov/surveys/pss/pssdata.asp>) databases. Matches to these databases were made for 56,622 of the 60,448 schools registered in the EPIPEN4SCHOOLS[®] program. Duplicates were found for 10,872 school records. The remaining 45,750 schools were combined with 69 additional schools that responded to the survey, but 1 school had an invalid state code and was not invited to participate. In total, 45,818 schools confirmed to be participating in the EPIPEN4SCHOOLS[®] program were invited to respond to the survey.

Instrumentation

A 29-item survey was administered to gather information on anaphylactic events that occurred during the 2014 to 2015 school year. The survey expanded on the core questions from the previous study by including additional questions relating to policies and standards at the school such as standard

first-line therapy for anaphylaxis, maintenance of records regarding anaphylactic events, availability of school nursing support (full-time, part-time, or visiting), type of epinephrine stocked and administered other than EAIs (eg, vials, nebulizer solutions), and reasons why epinephrine was not used for a reported anaphylactic event. Eighteen of the 29 questions were repeated for each anaphylactic event reported by the responding school.

Procedure

Survey administration, school contact, and sample preparation were performed in accordance with the methodology established for the 2013 to 2014 survey.⁵ Briefly, schools were contacted via letter or e-mail and invited to participate in the survey. Schools were provided a web address for the survey and given 14 weeks to complete the questionnaire. Technical assistance was available through a toll-free telephone number manned by trained project staff. Weekly reminders were sent through July 15, 2015, to schools that had not yet completed the survey. Schools were advised to have the survey completed by the individual best able to provide the necessary information; for example, the school nurse, other health staff, or school administrator. Respondents received no compensation for their participation. Data were collected between May 8, 2015, and August 14, 2015.

The survey and study methodology were submitted to the RTI institutional review board for approval. A waiver was granted because, in the institutional review board's determination, the investigation did not constitute research involving human subjects as defined by the US Code of Federal Regulations (45 CFR 46.102).

Data Analysis

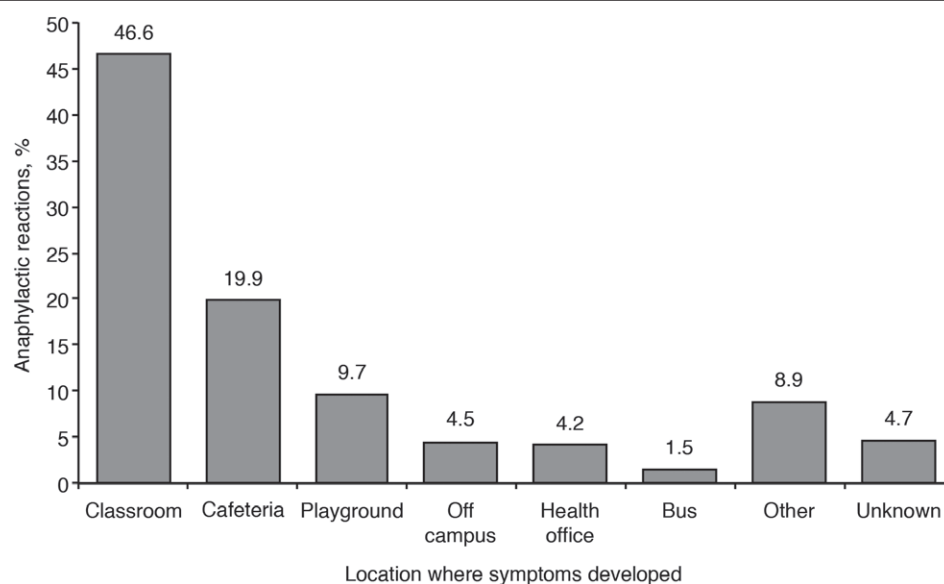
Survey responses were analyzed using descriptive statistics. A survey was considered "completed" even if all of the individual questions were not answered. Hence, the percentages of responses per question were calculated based on the number of responses available for that question. "Unknown" was a response option for several questions. Therefore, "unknown" was included in the number of responses per question, but missing responses were excluded.

RESULTS

Survey Participation and EAI Stock

Data were collected from 26.8% (12,275/45,818) of the schools invited to participate in the survey. Most schools (94.7%; 11,493/12,141) indicated that they stocked 2 or more EAIs during the 2014 to 2015 school year. Approximately 10% (1174/11,994) of schools reported stocking EAIs from both the

Figure 1. Reported Anaphylactic Events Stratified by Location of Where the Symptoms Developed.



Note. Includes data from 1992 anaphylactic events; responses were missing for 199 of the 2191 reported events.

EPIPEN4SCHOOLS[®] program and from other sources. Despite participation in the EPIPEN4SCHOOLS[®] program, 1.2% (147/12,141) of schools had no stock EAI during the 2014 to 2015 school year. Schools were asked to further quantify the number of EAI stocked from the EPIPEN4SCHOOLS[®] program by dose (ie, EpiPen 2-Pak[®] 0.3-mg auto-injector or EpiPen Jr 2-Pak[®] 0.15-mg auto-injector, Mylan Specialty, L.P., Canonsburg, PA). Of the schools that provided information on the number of stock EpiPen 2-Pak[®] 0.3-mg auto-injectors, 54.4% (6566/12,060) stocked 1, 42.4% (5114/12,060) stocked 2 or more, and 3.2% (380/12,060) stocked none. Of the schools that provided information on number of stock EpiPen Jr 2-Pak[®] 0.15-mg auto-injectors, 54.7% (6437/11,762) stocked 1, 30.8% (3622/11,762) stocked 2 or more, and 14.5% (1703/11,762) stocked none.

Of the schools that provided information on epinephrine kept at the schools that was prescribed to individuals, 7.9% (960/12,167) kept epinephrine in forms other than an EAI (eg, vials or nebulizer solution). Stock of 1 or more EAI prescribed to an individual was reported by 83.2% of schools (8920/10,720).

Treatment of Anaphylactic Events

A total of 12,181 responding schools reported 2191 anaphylactic reactions during the 2014-2015 school year, with data regarding events missing for 94 schools. Anaphylaxis symptoms were most likely to develop in the classroom (46.6%; 928/1992), followed by

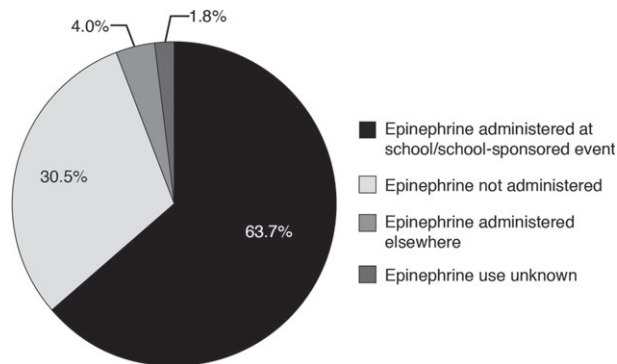
the cafeteria (19.9%; 396/1992) and the playground (9.7%; 194/1992) (Figure 1).

Of the anaphylactic events with data on use of epinephrine on school property, administration at the school or at a school-sponsored event was reported in 63.7% of cases (1272/1998) (Figure 2). In 49.8% (631/1267) of cases, epinephrine administered was from the school's stock of EAI provided by the EPIPEN4SCHOOLS[®] program. A total of 45.9% (582/1267) of cases were treated with the individual's prescribed supply of epinephrine. A second epinephrine injection was administered to 6.3% (80/1271) of individuals. Of the individuals who received multiple injections of epinephrine, 15.0% (12/80) received more than 2 injections. Epinephrine was most commonly administered by the school nurse (Figure 3). Self-administration occurred in only 8.0% (101/1263) of events. Arrangements were made to restock epinephrine after administration for 83.8% (1063/1268) of events.

Epinephrine was not administered on school property but was administered elsewhere in 4.0% (80/1998) of events and was not administered at all in 30.5% (610/1998) of events (Figure 2). If no epinephrine was given, respondents were asked to indicate the reason. Use of antihistamines was the most commonly cited reason for lack of epinephrine administration (38.5%; 235/610) (Figure 4). Students' individual protocols and school protocols were cited as reasons for not administering epinephrine in 28.9% (176/610) and 4.3% (26/610) of cases, respectively.

A treatment other than epinephrine was given as an alternative or in addition to epinephrine for 1058 events. The alternative/adjunct treatment most often

Figure 2. Epinephrine Use for the Treatment of Reported Anaphylactic Reactions.



Note. Includes data from 1998 anaphylactic events; responses were missing for 193 of the 2191 reported events.

given was an antihistamine (86.3%; 913/1058). Other treatments included albuterol (12.4%; 131/1058), corticosteroids (5.3%; 56/1058), unknown (7.0%; 74/1058), and other (0.2%; 2/1058).

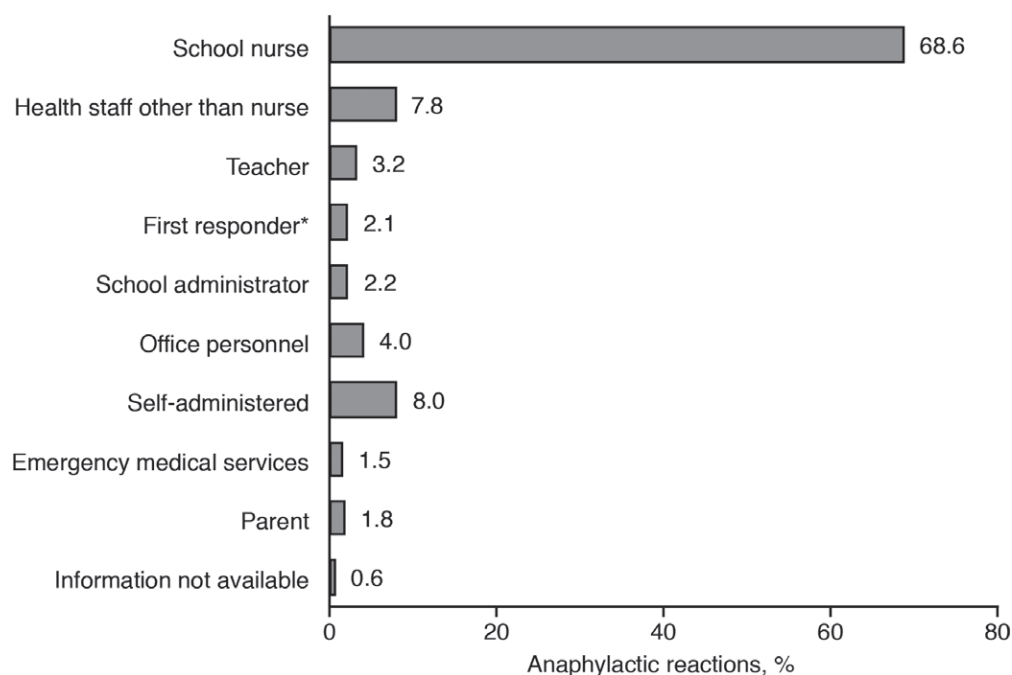
School Policies Regarding Anaphylaxis Management

Survey respondents were asked to identify which of a series of elements were included in their school's or school district's policy on the management of life-threatening allergies; 12,197 schools provided responses. The most frequently cited components of these policies were education and training for

school personnel on the management of students with life-threatening allergies (90.6%; 11,050/12,197), training and protocols for epinephrine use and storage (90.0%; 10,979/12,197), and an Individualized Health Care Plan (IHCP) and Allergy Action Plan for every student with a life-threatening allergy (85.5%; 10,427/12,197). Most schools also had protocols in place for managing allergic reactions outside of school (eg, field trips, school bus) (80.8%; 9857/12,197), protocols to reduce exposure to allergens in school (72.5%; 8837/12,197), and protocols or standing orders for licensed school personnel to administer epinephrine to individuals with undiagnosed allergies (78.1%; 9527/12,197). Student education (eg, food sharing, personal hygiene) was part of the policy for 69.8% (8517/12,197) of schools, and 67.6% (8241/12,197) of schools cited a system-wide plan for addressing life-threatening allergic reactions.

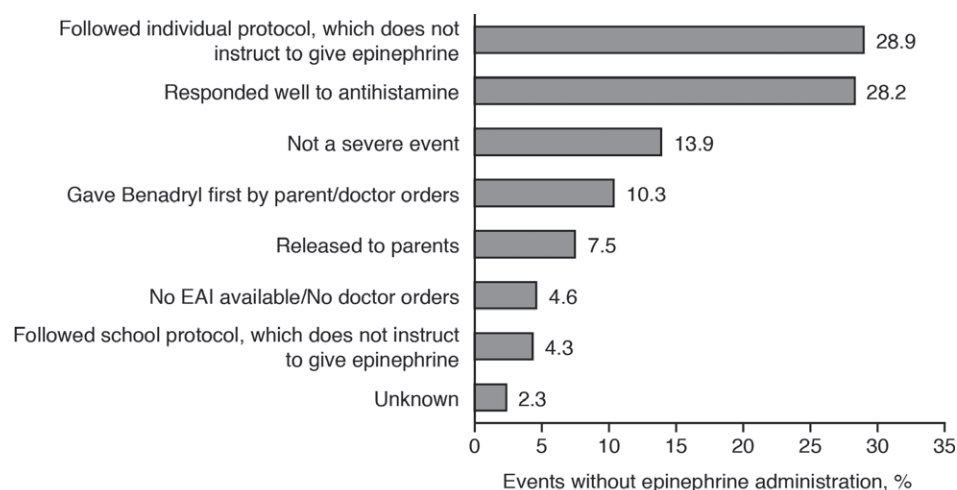
A total of 12,196 schools provided information on their school's policy for standard first-line treatment of anaphylactic events. Epinephrine was cited as the standard initial therapy for anaphylaxis by 59.4% (7243/12,196) of schools. Additional first-line procedures included administration of an antihistamine (21.4%; 2606/12,196), albuterol (0.7%; 84/12,196), or corticosteroids (<0.1%; 2/12,196); 18.5% (2261/12,196) of respondents indicated use of "other" standard first-line treatment.

Figure 3. Individual Who Administered Epinephrine on School Property or at a School-Sponsored Event.



Note. Includes data from 1263 anaphylactic events; responses were missing for 9 of the 1272 events in which epinephrine use was reported. *First responders include school-associated personnel, such as coaches, athletic trainers, and bus drivers.

Figure 4. Reasons Why Epinephrine Was Not Administered for the Treatment of an Anaphylactic Event.



Note. Includes data from 610 anaphylactic events.

Anaphylaxis Training and Permission to Administer Epinephrine

Responses from 12,222 schools revealed that school nurses were the most likely to be trained in recognizing anaphylaxis (89.4%; 10,921/12,222) (Figure 5). Only 33.7% (4117/12,222) of schools indicated that all teachers were trained to recognize anaphylaxis, and just 14.8% (1812/12,222) of schools reported training students. Various methods of training included staff in-services provided by the school (87.5%; 10,642/12,156), use of the training video on the EPIPEN4SCHOOLS[®] program website (29.8%; 3625/12,156), and reading the package insert included with the EAI (11.9%; 1443/12,156). Other methods were reported by 24.2% (2939/12,156) of schools. In general, more school personnel were trained to identify signs and symptoms of anaphylaxis than were permitted to administer epinephrine. School nurses were also the most likely to be permitted to administer epinephrine (89.8%; 10,968/12,213) (Figure 5).

School Nurse Coverage

Among the 12,183 schools with data on school nurse availability, 53.6% (6530/12,183) indicated that they have a full-time school nurse. Part-time nurses were available to 32.0% (3899/12,183) of schools; 6.8% (824/12,183) of schools had no nurse but did have access to a visiting nurse, and 7.6% (930/12,183) of schools had no nursing support, either in a full-time, part-time, or visiting capacity. Schools that reported 1 or more anaphylactic events were less likely to have no nursing support compared with the overall study population (4.1% [56/1351] vs 7.6% [930/12,183], respectively). Among schools with part-time nursing

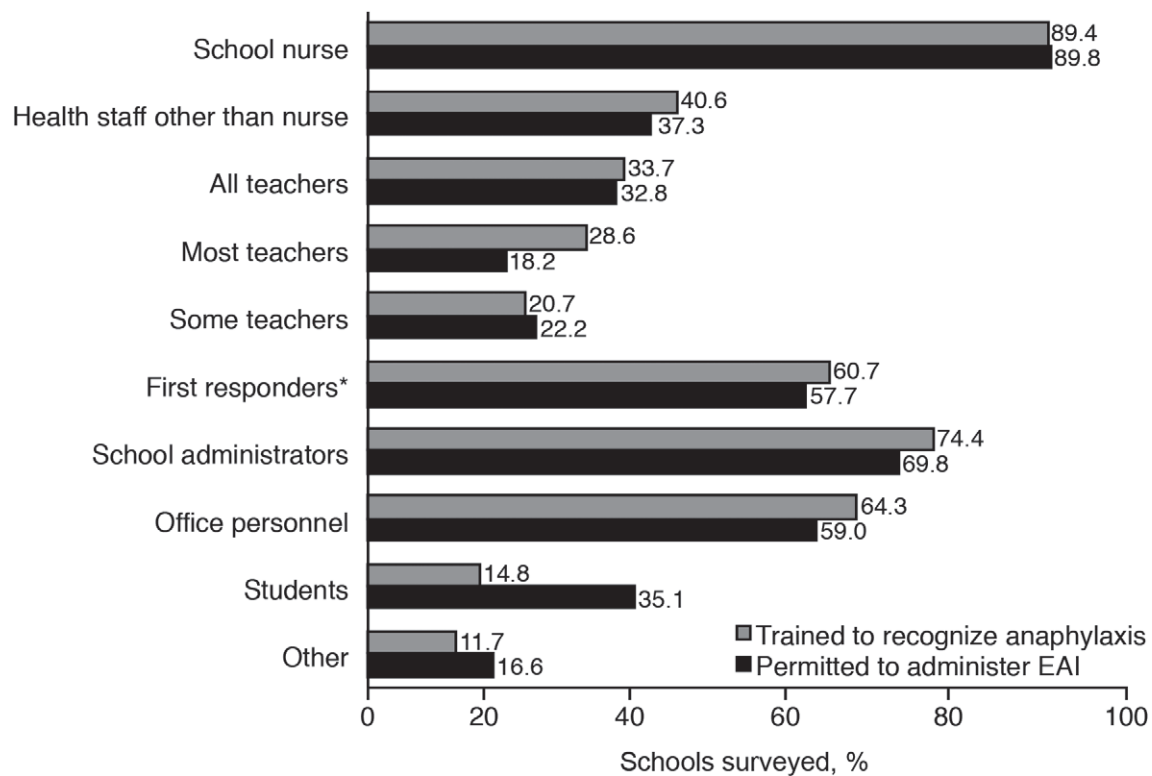
support, 68.8% (2669/3880) indicated that a nurse was available 3 days or less per week.

DISCUSSION

Data from the 2014 to 2015 EPIPEN4SCHOOLS[®] program survey demonstrate that epinephrine administration for the treatment of anaphylaxis in the school setting remains suboptimal. According to survey responses, epinephrine was administered for two thirds of reported anaphylactic reactions. This represents a decrease from the 2013 to 2014 survey, in which 74.7% of anaphylactic events were treated with an EAI.⁵

Consistent with the 2013 to 2014 survey findings, antihistamines were frequently used as the first-line agent for management of anaphylaxis in cases where epinephrine was not administered. According to US anaphylaxis management guidelines, efficacy has not been established for antihistamines in the treatment of anaphylaxis, and they should not be given as first-line therapy as they do not treat the most severe symptoms of anaphylaxis.^{11,18} Interestingly, the use of antihistamines was cited as the reason for why epinephrine was not used in 38.5% of cases. Only 4.6% of cases cited a lack of EAI availability or no doctor orders as the reason for not administering epinephrine. This figure compares favorably with the observation from a recent, cross-sectional survey of schools in Illinois, wherein lack of availability of epinephrine was cited in 42.9% of cases in which epinephrine was not administered.⁶ These data suggest that participation in the EPIPEN4SCHOOLS[®] program successfully ameliorated lack of epinephrine availability as a barrier to appropriate use of

Figure 5. Individuals Who Are Trained to Recognize Anaphylaxis and/or Permitted to Administer Epinephrine.



Note. Includes data on training from 12,222 schools and on administration from 12,213 schools; responses were missing for 53 and 62, respectively, of the 12,275 schools that completed the survey. *First responders include school-associated personnel, such as coaches, athletic trainers, and bus drivers.

epinephrine for anaphylaxis treatment in the school setting.

Stock EAI provide potentially lifesaving medication in a number of scenarios, such as in the treatment of individuals who have not previously been prescribed an EAI, for events where the individually prescribed EAI is not easily accessible, in case of malfunction of a prescribed EAI, or when a second epinephrine dose is needed but only 1 prescribed EAI is available.¹⁹ During the 2012 to 2013 school year, the Chicago Public Schools district provided EAIs to all of its schools; 55% of the events that were treated with stock EAIs were first-time anaphylactic events.¹³ Schools that participated in the 2014 to 2015 EPIPEN4SCHOOLS[®] survey generally reported having both stock and individually prescribed EAIs on hand. An EAI from the EPIPEN4SCHOOLS[®] program was used more often in the treatment of anaphylaxis on school property than an individually prescribed EAI (49.8% and 45.9%, respectively). This distribution was relatively unchanged from the previous survey.⁵ The proportion of schools that maintained a stock of 2 or more EAIs increased appreciably from the previous survey (56.7% in 2013 to 2014 to 94.7% in 2014 to 2015).⁵ It is generally recommended that individuals at risk of anaphylaxis have 2 EAIs available in the event that a second injection is required to control

their anaphylaxis symptoms.¹¹ In this survey, 80 individuals (6.3% of those for whom epinephrine was administered on school property or at a school-sponsored event) required a second dose.

An element that was not assessed in the current study was accessibility of EAIs in various locations throughout the school. Ideally, EAIs should be easily accessible in locations where students are most likely to experience an anaphylactic reaction. According to this survey, anaphylactic events occurred most often in the classroom. Prior studies have also found the classroom to be a common location for anaphylactic events.^{3,20} The frequent occurrence of anaphylaxis in classrooms and cafeterias is likely related to the fact that food consumption occurs more often in these locations than in other parts of the school. However, a survey of school-aged children at risk of anaphylaxis found that they often do not have their EAI available when eating lunch or snacks,²¹ demonstrating the importance of having stock EAIs.

One of the additions to the 2014 to 2015 survey was an exploration of school policies related to anaphylaxis management. Schools generally cited multiple components to their policies, including elements of education and training of school staff and establishment of protocols for managing events. However, 67.6% of schools affirmed that they had

a system-wide plan in place for addressing life-threatening allergic reactions. Moreover, 78.1% of schools surveyed had protocols or standing orders for licensed school personnel to administer epinephrine to individuals with undiagnosed allergies. The ability to provide timely treatment with epinephrine for this population is critical, as it has been found that as many as one-quarter of anaphylactic events in the school setting occur among those without a history of allergy.⁴⁻⁶ Postponing treatment could have dire, even fatal, consequences for these individuals.

As part of the policy assessment, schools were asked to identify their standard initial therapy for an anaphylactic event. Epinephrine was identified by only 59.4% of schools. One of the challenges to making early administration of epinephrine standard protocol in schools is the misperception that epinephrine is a dangerous medication. Indeed, when surveyed, 49% of school nurses from an urban public school district agreed with the statement that “epinephrine is an extremely dangerous drug with many potentially harmful side effects.”²² Moreover, 63% of school nurses surveyed believed that an antihistamine should always be the first medication given when a student is having a food-induced allergic reaction. In reality, intramuscular injection of epinephrine via an EAI is considered safe and carries a low risk of side effects.¹² Antihistamines may be administered as a second-line or adjunct therapy but have not demonstrated sufficient efficacy to be considered a first-line therapy for anaphylaxis as they do not treat the most severe symptoms of anaphylaxis such as airway obstruction and shock.^{11,12,18}

Among surveyed schools, school nurses were found to be the most likely to have training in recognizing anaphylaxis and to be permitted to administer epinephrine. However, 68.6% of events were treated by a school nurse, and only 53.6% of schools reported having a full-time school nurse, suggesting that many anaphylactic events may be missed or not treated because of the absence of trained staff. Only 33.7% of schools reported that all of their teachers are trained to recognize anaphylaxis. Training of staff members other than the school nurse is important because a school nurse may not be available at the time an anaphylactic reaction occurs. Part-time, intermittent nursing support is increasingly common in public schools.^{6,23} In our survey, 53.6% of schools reported having a full-time school nurse. In addition, nurses do not necessarily attend after-school activities or off-campus school-sponsored events and are not regular riders on school buses. Therefore, it is advisable that all staff and others who routinely supervise children (eg, playground monitors, field trip chaperones, athletic coaches) be trained in recognizing anaphylaxis and initiating appropriate emergency response protocols. Ancillary staff such as those

involved in school transportation should be included in this training. In a recent survey of US school bus drivers and monitors, more than one third reported having no training for dealing with severe allergic reactions.²⁴ Notably, only 2% of school bus drivers and monitors indicated that they had immediate access to an EAI. These results demonstrate that many staff members who supervise children may be underprepared and unable to recognize or manage an anaphylactic event.

Limitations

Interpretation of the study results is subject to the inherent limitations of a survey-based instrument, such as systematic and random variance that stems from respondents and questionnaire design. In addition, the survey responses were limited by the level of detail recorded by the school for individual anaphylactic events. As the anaphylactic events were based on self-report and not independently adjudicated, it is possible that some reactions did not constitute true anaphylaxis. Descriptions of the events as “not severe” or “responded well to antihistamine” suggest that some cases in which epinephrine was not administered may have been allergic reactions but not anaphylaxis. The sampling itself may have been skewed because of the voluntary nature of both the survey and the EIPEN4SCHOOLS[®] program. By virtue of their participation in the EIPEN4SCHOOLS[®] program, schools surveyed herein may be more proactive in anaphylaxis management than US schools in general. The consistency of the current results with the previous survey and with data in the literature, however, does support the validity of the overall findings.

Conclusions

Results from the 2014 to 2015 EIPEN4SCHOOLS[®] program survey indicate that barriers other than the supply of EAI are limiting the use of epinephrine for the treatment of anaphylaxis in schools. Areas for improvement include the widespread training of primary and secondary staff members in the recognition of anaphylaxis, establishing protocols that guide appropriate treatment of anaphylactic reactions, and correcting misperceptions regarding appropriate first-line therapy for anaphylaxis. These challenges can be overcome by ensuring that school staff are properly educated in anaphylaxis recognition and management and that school-wide or district-wide policies that follow best practice recommendations are enacted.

IMPLICATIONS FOR SCHOOL HEALTH

Prevention and management of anaphylaxis in the school setting is the shared responsibility of all school personnel.¹⁹ Although the school nurse functions as the leader to coordinate preparation for and response

to severe allergic reactions, the US Centers for Disease Control and Prevention (CDC) recommend that all school staff be trained to recognize signs and symptoms of anaphylaxis and to respond appropriately by initiating emergency protocols.²⁵ Multiple types of educational interventions, including workshops, didactic presentations, and hands-on demonstrations, have proven to be effective in improving participant knowledge and/or self-efficacy regarding anaphylaxis identification and management.²⁶⁻²⁸ Achieving self-efficacy is important because it reflects not only knowledge of the topic, but an individual's belief that he or she is capable of performing the necessary actions—in this case, identifying and appropriately responding to an anaphylactic event. Ideally, training is repeated on a regular basis to maintain competence and confidence.

Schools should review their policies regarding the management of anaphylaxis to ensure that they follow both state and local guidelines as well as best practice standards. For example, a protocol in which an antihistamine is recommended as the first-line therapy warrants reexamination. Schools should also evaluate their policies on stocking EAI's and permitting appropriate staff members to administer epinephrine. The National Association of School Nurses (NASN) recommends that all schools permitted by state laws and regulations maintain a stock of undesignated epinephrine and obtain standing orders from a physician that allow the school nurse to administer epinephrine in the appropriate circumstances.²⁹ Currently, all states except Hawaii have laws/guidelines that either allow or require schools to stock epinephrine.³⁰ Guidance on establishing anaphylaxis policies and protocols is available from the CDC (<http://www.cdc.gov/healthyschools/foodallergies/index.htm>), NASN (<http://www.nasn.org/toolsresources/foodallergyandanaphylaxis>), and Food Allergy Research & Education, Inc (FARE, <http://www.foodallergy.org/resources/schools>).

According to survey responses, many schools do not train all staff to recognize the signs and symptoms of anaphylaxis. Students having an anaphylactic reaction may encounter staff members who are unprepared to recognize and treat anaphylaxis, including bus drivers, cafeteria staff, volunteers, after-school personnel, and some teachers. To minimize student vulnerabilities, schools should ensure that the entire school team, including regular volunteers and all staff members, understand the school's policies, know the protocol in the event of anaphylaxis, and are capable of responding to emergencies in a timely manner.

Human Subjects Approval Statement

This study was granted an exemption from approval by the RTI institutional review board because the research activity did not involve human participants

as defined by the US Code of Federal Regulations (45 CFR 46.102).

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