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Anaphylaxis and Epinephrine in North Carolina Public Schools

Benjamin L. Wright, M.D.

Fellow in Allergy and Clinical Immunology, Duke University, Durham NC

Between 1 and 2 students in every classroom is at risk for anaphylaxis from food ingestion or insect stings.^{1, 2} The prevalence of pediatric food allergy, in particular, has risen significantly.¹ While most reactions in children occur at home, harrowing accounts of fatalities in schools^{3, 4} highlight the need for advance preparation. Early studies demonstrated that a significant number of school-related anaphylactic reactions occur in individuals without a history of allergy^{5, 6}; consequently, school districts across the country have begun to supply stock epinephrine. Stock epinephrine is a term used to refer to an unassigned supply of epinephrine that may be used to treat anyone experiencing a life threatening reaction.

Public awareness of the need for stock epinephrine has attracted legislative attention at both federal and state levels. On November 13, 2013 the federal School Access to Emergency Epinephrine Act was signed into law. This law amends the Public Health Service Act, with respect to asthma-related grants for child health services, to give an additional preference to a state that allows self-administration of asthma/anaphylaxis medications and makes a certification concerning Good Samaritan protections. Additionally the act requires schools in these states to do the following:

1. Maintain an emergency supply of epinephrine;
2. Permit trained personnel of the school to administer epinephrine;
3. Develop a plan for ensuring trained personnel are available to administer epinephrine during all hours of the school day.

Currently 45 states have guidelines or laws governing the availability and use of stock epinephrine.⁷ North Carolina recently passed mandatory legislation joining 7 other states that require all schools provide an emergency supply of epinephrine.

Ten years ago, the school health community in North Carolina began tracking parameters relevant to severe allergies and anaphylaxis as part of the North Carolina Annual School Health Services Report (see Table 1).⁸ Consistent with epidemiologic studies, the number of students with self-reported severe allergies has risen dramatically, from 1.3% of all students

Correspondence to: Benjamin L. Wright.

Current address: Department of Pediatrics, University of North Carolina, 2242 Genome Sciences CB# 7231, 250 Bell Tower Drive, Chapel Hill, NC 27599, Telephone: (919) 962-5136, Telefax: (919) 962-4421, benjamin.wright@duke.edu

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in 2004 to 3% in 2014. This upsurge has most profoundly affected elementary school-aged children, for whom the prevalence has more than doubled (147% increase). This trend, at least in part, can be attributed to increases in food allergy. Evidence for this assumption is demonstrated by rises in the number of orders for epinephrine, as severe food allergy is the most common indication for epinephrine prescription.

In addition school health officials have also reported data on cases of anaphylaxis. Since the fall of 2004, 2,285 episodes of anaphylaxis have been reported. A majority of reactions occurred in the classroom (43.15%), playground (17.55%), and lunchroom (14.4%), though, the proportion of reactions occurring in classrooms is not as high as the 79% of reactions reported by McIntyre et al.⁵ While episodes of anaphylaxis occurring on the playground may also include students with venom allergy, this supports previous findings that accidental exposures to foods most commonly occur outside of the cafeteria. Importantly, schools officials have seen a 3.4 fold increase in the numbers of students with physician orders for epinephrine over the past 10 years; currently 1 in 76 school children. The incidence of anaphylaxis has also increased dramatically; from 1 in 9,381 students (2004) to 1 in 4,333 students (2014) representing a 2.2 fold increase.

These data have broad implications for school officials, policy makers and prescribing physicians as the demand for stock epinephrine increases. Because of industry discounts programs and the promise of federal funding, most state legislation has been passed without appropriation of state government funds. While each school can be equipped with an emergency supply of epinephrine, this stock must be replaced in the event that it is used. Limited epidemiologic data regarding school-related anaphylaxis are available to provide policy makers with real cost estimates of maintaining an emergency supply of epinephrine. This is particularly important in states where schools are mandated to provide unassigned epinephrine. Data from schools in Massachusetts⁵ suggest that roughly ¼ of students receiving epinephrine have no history of allergy. Using the incidence of school-related anaphylaxis in North Carolina, we can estimate a utilization rate of at least 0.58 doses/10,000 students per year.

Unfortunately, this estimate does not account for all instances when an epinephrine auto-injector is needed. Ideally, stock epinephrine would be reserved for individuals without a prior history of allergy experiencing a life threatening reaction. However, studies examining utilization have shown that stock epinephrine may be used for individuals with a history of allergy but no epinephrine auto-injector available.^{5,9} A recent study in Chicago Public Schools found that 45% of individuals receiving stock epinephrine had a prior history of severe allergy or anaphylaxis.¹⁰ This finding emphasizes the importance of allergists and primary care physicians in identifying patients at risk for school-related anaphylaxis and providing a comprehensive management strategy that includes prescription of epinephrine. Differences among state training standards and the availability of school nurses may also affect the likelihood that epinephrine will be delivered appropriately.

In summary, stock epinephrine legislation has become widespread throughout the United States. These data regarding anaphylaxis and epinephrine utilization in North Carolina Public Schools were influential in persuading state legislators to pass mandatory stock

epinephrine legislation; moreover, they provide a compelling argument for the five remaining states in the U.S. without such legislation to adopt similar statutes. As state and local officials appropriate limited resources, cost is an important consideration. Cost, however, can only be estimated through epidemiologic study of epinephrine utilization patterns as presented here. Prospective studies are needed to further characterize school-related anaphylaxis and justify funding sources to maintain emergency epinephrine supplies.

Delayed administration of epinephrine during anaphylaxis is associated with increased mortality.^{3, 4} Schools are responsible for the immediate care of students and staff experiencing life-threatening events. In order to respond effectively to such events, schools must have adequate planning and resources. Allergists must partner with advocacy groups and school health officials to promote legislation, develop education standards, and implement training programs. In addition, they should volunteer to prescribe unassigned epinephrine and advise school health officials regarding its proper storage and use.,

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TABLE 1
Severe allergies, epinephrine orders and anaphylaxis in North Carolina public schools

School Year	Total NC students [*]	Children reporting severe allergies			Students with epi orders [†]	Incidence of anaphylaxis [‡]
		Elementary	Middle School	High School		
2004-2005	1332009	10249	4098	3487	3.88	1.07
2005-2006	1363695	10447	4195	3724	4.94	1.20
2006-2007	1386363	10749	4001	3584	5.57	1.75
2007-2008	1404957	12773	4830	4633	6.31	1.74
2008-2009	1410497	11237	3421	3781	6.80	1.64
2009-2010	1402269	13446	4142	4771	8.01	1.75
2010-2011	1409895	15018	5005	4783	9.24	1.45
2011-2012	1417657	18117	5965	5926	9.58	1.45
2012-2013	1427480	24262	8855	7946	10.95	1.91
2013-2014	1434180	25283	8760	8619	13.21	2.31

^{*} total students in all North Carolina public schools, not including public charter and state residential schools

[†] epinephrine orders per 1,000 students

[‡] episodes of anaphylaxis per 10,000 students