
Life-threatening asthma and anaphylaxis in schools: a treatment model for school-based programs

Kevin R. Murphy, MD*; Russell J. Hopp, DO†; Eleanor B. Kittelson, MA‡; Geri Hansen, RN, MSN§; Mary L. Windle, PharmD¶; and John N. Walburn, MD||

Background: Pediatric asthma is the No. 1 chronic disease in childhood and is responsible for significant morbidity and mortality. In Nebraska, the number of asthma-related deaths is greater than the national average, and in 1998, 2 students died of acute asthma attacks while attending school in the Omaha public schools (OPSs). In response, we designed and implemented a program to respond to this problem.

Objective: To implement and study a school-based program for the treatment of life-threatening asthma and anaphylaxis in the OPSs.

Methods: The Emergency Response to Life-Threatening Asthma or Systemic Allergic Reactions (Anaphylaxis) Protocol was designed and evaluated in 78 OPSs from 1998 to 2003. Nurses and school staff were trained in the protocol, which required the use of nebulized albuterol and/or intramuscular epinephrine in conjunction with an emergency response procedure. Outcomes were measured by improvement in acute care in schools and survival of students.

Results: In the 5 years of evaluation, 98 students were treated successfully. One student died. Of those treated with the protocol, equal numbers had at school both asthma action plans (AAPs) and metered-dose inhalers (MDIs), MDIs only, or neither AAPs nor MDIs. As a result of the program, there has been an increased awareness from parents, teachers, and physicians about the necessity of an emergency response program. In 2002, an outcome of the OPS program resulted in the formation of Attack on Asthma Nebraska to ensure that Nebraska schools have the education, training, and medications to respond to anyone experiencing a life-threatening asthma or anaphylaxis attack at school. The following year, a revised protocol was approved by the Nebraska State Board of Education for use in all Nebraska schools.

Conclusions: Emergency response protocols provide protection for children while in school. This program should serve as a national model for other school-based programs for children and adolescents with asthma and anaphylaxis.

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INTRODUCTION

Childhood asthma is the No. 1 chronic illness in the United States. Conservative estimates from the Centers for Disease Control and Prevention indicate that of the 20.3 million asthmatic patients in the United States, 24% are children, and among adolescents younger than 18 years, the prevalence of asthma is 7.3%.¹ Asthma is the third ranking cause of hospitalizations among children younger than 15 years and is the fourth most common cause for office visits to a health care professional.² Nationally, the disease is the leading cause of

school absenteeism attributable to chronic illness, accounting for 14 million lost school days annually.³

Since the 1970s, the prevalence, morbidity, and mortality of asthma in the United States and other western countries have increased.^{1,4,5} From 1980 to 1996, asthma prevalence among children increased by an average of 4.3% per year, from 3.6% to 6.2%.² The most rapid increase has occurred in children younger than 5 years, for which rates increased 160% during the past 15 years.¹ Finally, the data from Australia clearly show that asthma mortality can occur in children with mild disease.⁶

Delay in treating worsening asthma and anaphylaxis has been identified as one of the most important aspects in patient outcomes.^{7–9} Most concerning is that children are at greater risk of severe anaphylaxis at school than at home or another setting.^{8,9} Specifically, delay in seeking medical help was a major factor in whether the patient survived.⁹ In addition, regular follow-up, use of inhaled anti-inflammatory agents,¹⁰ and rapid access to a health care practitioner are important to patient survival.¹¹ Unfortunately, many children with symptoms consistent with asthma have not had their conditions diagnosed and remain untreated, substantially increasing the risk of health problems and death.¹² Also, parents often fail to

*Midwest Allergy and Asthma Clinic, Midwest Children's Chest Physicians, and Department of Pediatrics, University of Nebraska Medical Center, Omaha, Nebraska.

†Department of Pediatrics, Creighton University, Creighton University School of Medicine, Omaha, Nebraska.

‡Attack on Asthma Nebraska, Omaha, Nebraska.

§Omaha Public Schools, Omaha, Nebraska.

¶eMedicine Inc and Department of Pharmacy Practice, College of Pharmacy, University of Nebraska Medical Center, Omaha, Nebraska.

||Department of Pediatrics, University of Nebraska Medical Center, Omaha, Nebraska.

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recognize the importance of proper asthma education and awareness, and school personnel are alerted to problems only after a child has an asthma attack in school.¹³

Clinicians can ensure that parents of children with asthma receive appropriate education so they can recognize a child's worsening asthma and follow a clear individualized asthma action plan (AAP). In using this approach, some school-based programs have shown effectiveness in preventing deaths in schools. In 8 years of operation, the Red Alert Program has shown success in ensuring aggressive and timely interventions for asthma attacks and has prevented several deaths in Florida schools.¹¹ Another study found that asthma health education designed for delivery to children can significantly increase management skills, reduce symptoms of asthma, and improve school performance.¹⁴

Experiences with asthma-related deaths in the state of Nebraska underscore the national problem of school-aged children with asthma. In 2002, an estimated 8% of students who attended the Omaha public schools (OPSs) had been diagnosed as having asthma.¹⁵ Nebraska asthma mortality was the second highest in the United States during 1990 to 1995,¹ and from 1993–1995 to 1996–1998, Nebraska's asthma mortality rate continued to increase, whereas the US rate decreased.¹⁶ In 1998, the rate of emergency department visits was highest among children 5 to 14 years of age in Nebraska.¹⁶ For residents of the Omaha metropolitan area (ie, Douglas and Sarpy counties), death from asthma was 2 to 4 times higher than the national average.¹⁵

National recommendations have been made to integrate available resources in the United States to improve overall asthma outcomes for children, including establishing school-based asthma initiatives.¹⁷ In 1998, in response to 2 asthma-related deaths in the OPSs, we developed a program for the OPSs that would treat children with life-threatening asthma or anaphylaxis and provide them with rapid access to individuals trained to administer life-saving medications. After reviewing protocols and practices from school districts across the nation and with input from local physicians, pharmacists, school nurses, school administration, and the American Lung Association, this protocol was adopted by the OPS system. In this article, we report our experience from 1998 to 2003 with the Emergency Response to Life-Threatening Asthma or Systemic Allergic Reactions (Anaphylaxis) Protocol, a treatment model for school-based programs.

METHODS

Study Participants and Scope

For the OPS program, all parents were informed of the protocol to be used for the treatment of their child in the event of severe asthma or anaphylaxis. From 1998 to 2003, we established and implemented a protocol at 78 schools within the OPS system for any student who experienced an asthma attack or anaphylaxis while in school. This included 7 high schools, 10 middle schools, and 61 elementary schools.

Definitions

For each student treated, we recorded whether they had an AAP and metered-dose inhaler (MDI), an MDI only, or neither an MDI nor AAP. These 3 categories were defined as follows: AAP and MDI, students had their own medication at school along with an AAP provided by their primary care physician; MDI only, students had only their own medication at school and, while they were under a physician's care, no AAP was provided; and neither MDI nor AAP, students had neither their own medication nor an AAP at school.

The protocol we established (Fig 1) was termed the Emergency Response to Life-Threatening Asthma or Systemic Allergic Reactions (Anaphylaxis) Protocol. In developing this protocol, life-threatening asthma was defined as a disorder characterized by marked chest tightness, wheezing, and shortness of breath, symptoms often associated with a change in mental status, retractions, and cyanosis. A systemic allergic reaction (anaphylaxis) was defined as a severe reaction with the potential to progress to cardiovascular collapse (shock) after exposure to an antigen (eg, bee or other insect sting), ingestion of a food or medication, or exposure to other allergens, such as animal fur, chemical irritants, pollens, or molds, among others. The description and definition of life-threatening asthma and anaphylactic symptoms are outlined in Figure 1.

The Emergency Protocol

The Emergency Response to Life-Threatening Asthma or Systemic Allergic Reactions (Anaphylaxis) Protocol required school-trained personnel to do the following:

1. Call 911.
2. Summon school nurse if available. If not, summon designated trained nonmedical staff to implement the emergency protocol.
3. Check airway patency, breathing, respiratory rate, and pulse.
4. Administer medications (epinephrine [EpiPen] and/or albuterol) per standing order:
 - a. Administer an intramuscular EpiPen Jr. for a child who weighs less than 50 lb or an adult EpiPen for any individual who weighs more than 50 lb AND/OR
 - b. Nebulized albuterol (premixed) and, if not better, may repeat 2 times back to back.
 - c. Administer cardiopulmonary resuscitation if indicated.
5. Determine cause as quickly as possible.
6. Monitor vital signs (pulse, respiration).
7. Contact parents immediately and physician as soon as possible.
8. Transfer any individual treated for symptoms with epinephrine and/or emergency albuterol at school to a medical facility.

Medication

Epinephrine (EpiPen and EpiPen Jr., Dey Laboratories, Napa, CA) was selected for use, because it is easy to use, admin-

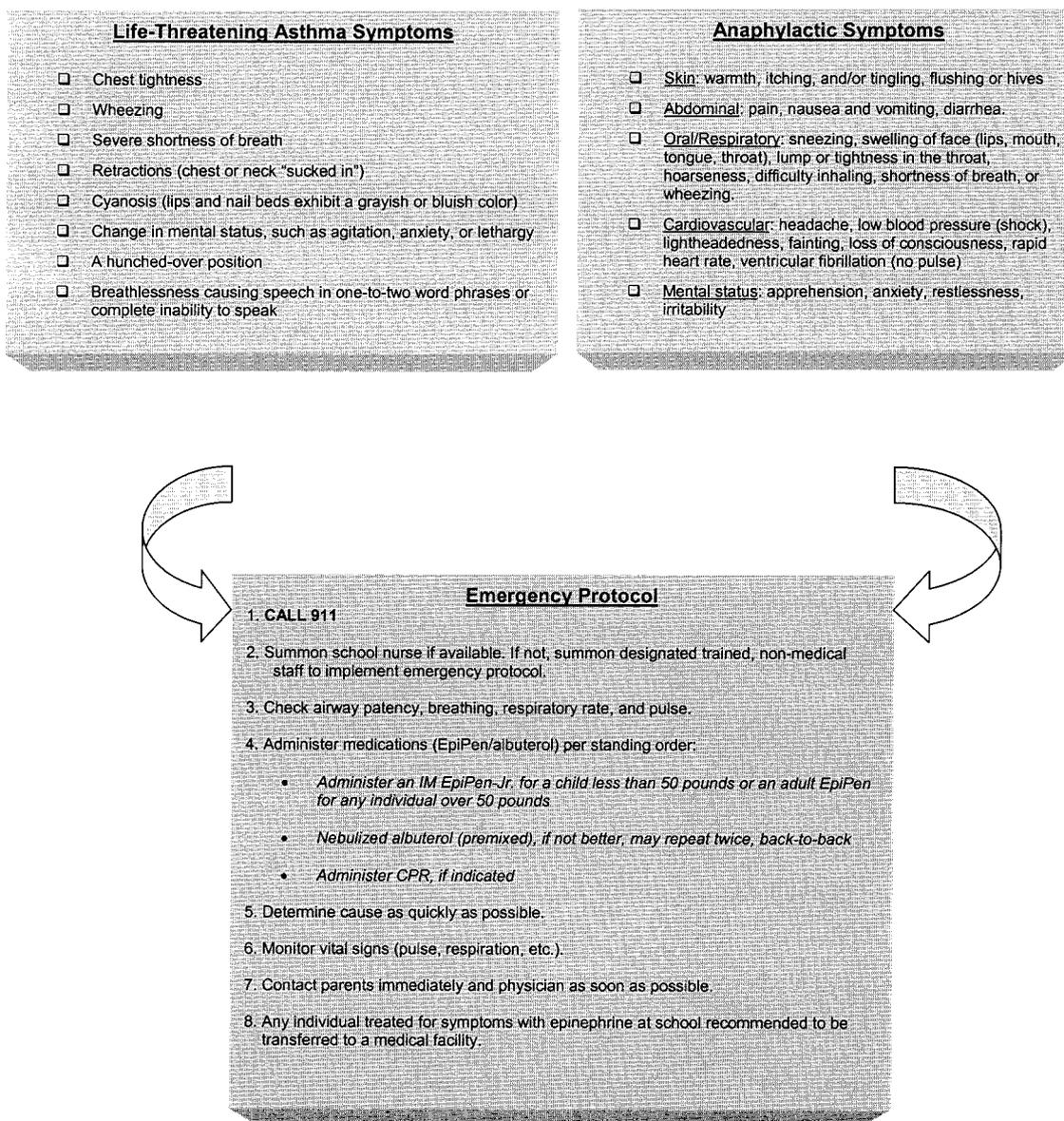


Figure 1. The Emergency Response to Life-Threatening Asthma or Systemic Allergic Reactions (Anaphylaxis).

ister, and store and available in 2 strengths to support weight-based dosing.

Program Training

In each school, a school nurse was responsible for educating the staff on signs and symptoms of severe asthma and anaphylaxis and the procedures for implementing the protocol. The nurse also collaborated with the building principal to identify a minimum of 3 staff members to be trained in implementing the protocol. Each selected staff member was trained in cardiopulmonary resuscitation and also received a minimum of 2 hours of instruction in performing the protocol. This instruction included reviewing severe asthma and

anaphylaxis, administering nebulized albuterol treatments, and injecting epinephrine.

At the conclusion of the training, a written examination was completed by each trainee. The school nurse also tested competency for administration of nebulized albuterol and epinephrine. During each training session, competency was recorded and filed. Before the start of the second semester, the nurse again reviewed the protocol with the school staff.

Data Collection

From August 1998 to June 2003, we recorded data on each child treated with the protocol. Whenever emergency albuterol and/or epinephrine was administered, the school nurse

was responsible for documenting each case. A written, postincident report was completed in duplicate, with the original submitted to the supervisor of health services and the duplicate kept on file at the incident site.

For all students, the nurse recorded data, answering the following questions: (1) Did they have an AAP from their physician before receiving treatment with the protocol? (2) Did they have an MDI at school? (3) After being treated, did they return to school with an AAP, medications, and physician release?

The supervisor of health services reviewed and compiled the data. Generated reports were reviewed quarterly by the Asthma/Anaphylaxis Protocol Committee (AAPC), which is composed of 4 physicians, the supervisor of health services, 2 OPS nurse representatives, a pharmacist, a representative from the American Lung Association, and the director of student and community services for the OPS system. In addition, the AAPC was responsible for evaluating how the protocol was being implemented. Each year, a final report of the AAPC was submitted to the OPS Board of Education. Physician members of the AAPC were immediately notified following use of the protocol if the child received epinephrine.

RESULTS

Demographics

The protocol was established and implemented in 78 schools of the OPS system, which in 2003 served approximately 45,000 students. The demographics for 99 of the children treated with this protocol are given in Table 1, divided by school level and treatment type. Of the 99 students, there were 59 boys and 40 girls. Of the 99 students treated, 5 were for anaphylaxis and 3 were female. Included in the analysis are numbers of treated students segregated by those who had an AAP and MDI, those who had an MDI only, and those with neither an AAP nor an MDI (see the "Methods" section for definition). In addition to evaluation for MDI and AAP, individuals with anaphylaxis were evaluated for the presence of an emergency action plan and the availability of epinephrine at school. In all 5 cases, no epinephrine was available at school.

From 1998 to 2003, a total of 99 students were treated with the protocol (Table 1). Children and adolescents were treated with epinephrine alone (5%), epinephrine and albuterol (5%), and albuterol only (90%). Of all 99 children treated with the protocol, 30.3% had AAPs and MDIs, 33.3% had MDIs only, and 36.4% had neither MDIs nor AAPs. The racial breakdown of the protocol recipients is shown in Figure 2. In 2004 the OPS student racial statistics (all students) were as follows: white, 46%; African American, 31%; Hispanic, 20%; Asian, 1.5%; and Native American, 1.5%. Of those children treated with the protocol, more than 50% were African American.

Outcomes

Of the 99 students treated with the protocol, all improved except 1, who died. This child had experienced a severe

Table 1. Demographics for Omaha Public School Program, 1998–2003

Treatment	No. (%) of students (N = 99)
Total treated in 1998–2003	
Epinephrine only	5 (5)
Epinephrine and albuterol	5 (5)
Albuterol only	89 (90)
Total	99
No. treated by grade level	
Elementary school	
Epinephrine only	3 (3)
Epinephrine and albuterol	2 (2)
Albuterol only	49 (50)
Middle school	
Epinephrine only	0
Epinephrine and albuterol	0
Albuterol only	17 (17)
High school	
Epinephrine only	2 (2)
Epinephrine and albuterol	3 (3)
Albuterol only	23 (23)
No. treated by AAP/MDI*	
AAP and MDI	30 (30)
MDI only	33 (33)
No APP or MDI	36 (36)

Abbreviations: AAP, asthma action plan; MDI, metered-dose inhaler. *Number (percent) of students treated with an AAP and/or albuterol MDI.

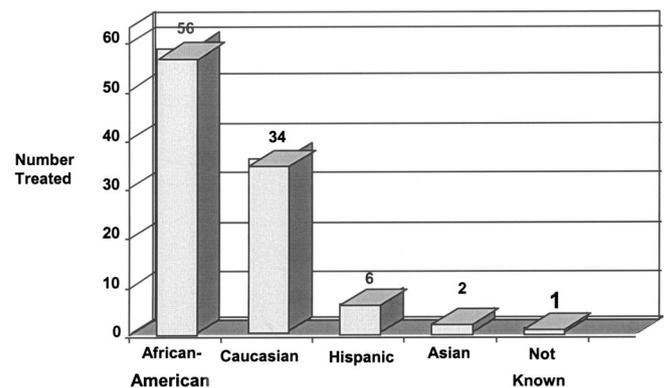


Figure 2. Ethnicity of students treated in Omaha public schools, 1998–2003.

asthma attack while in school and was immediately treated with the protocol but was nonresponsive. The child was immediately taken to the hospital and despite emergency treatment subsequently died several days later. Of the students treated and released to class or home, 7 children returned with AAPs and/or MDIs (Table 2). Of the 98 students who responded favorably, no adverse effects were reported during or following treatment.

As of 2003 all emergency medical staff from Omaha have been adequately trained to administer nebulized albuterol and

Table 2. Breakdown of Student Use of Medications and/or AAP at School Before and After Protocol Treatment

School year	Total No. of students treated	Before treatment with protocol, No.		After treatment with protocol, No.	
		No medications	No AAP	Return with medications	Return with AAP
1998–1999	24	6	13	1	1
1999–2000	23	9	15	2	0
2000–2001	15	7	9	2	0
2001–2002	14	8	11	0	0
2002–2003	23	13	16	0	1
Total	99	43	64	5	2

Abbreviation: AAP, asthma action plan.

epinephrine. Before implementation of this protocol by the OPSs, only certified paramedics could administer epinephrine. As a result of interest and awareness in the protocol, other initiatives were implemented. The State of Nebraska Department of Health and Human Services later updated their emergency medical services regulations to allow all emergency medical personnel (first responders, emergency medical technicians, and paramedics) to administer epinephrine on completion of approved training. This regulation change became effective in October 2003. In addition, both teachers and certified staff were provided a general overview of asthma and anaphylaxis treatment and how to respond to emergency situations. In the first year of the program, many local physicians were updated with regard to requirements of the protocol, in particular with the importance of individualized AAPs.

Parent Response

Parents often commented that the school program had decreased their anxiety about accessing care and helped them to feel more secure and prepared in their ability to treat asthma. Some parents expressed that the school-based program had helped them to return to work and many believed it had positively affected the family's day-to-day life. No parents expressed dissatisfaction with the program. A number of parents requested to testify to the life-saving result for their child to the Nebraska Department of Education (NDE) to implement the protocol in all schools within the state.

Establishment of Attack on Asthma Nebraska

As an outgrowth of the OPS protocol, the Attack on Asthma Nebraska (AOAN) program was established in 2002 to ensure that all Nebraska schools would receive education, training, and medications to respond to anyone experiencing a life-threatening asthma or anaphylactic reaction at school. The AOAN is a nonprofit organization partnered with the NDE to mandate the protocol for every school in the state. The goals of AOAN are to (1) prevent deaths at school from life-threatening asthma attacks or severe allergic reactions (anaphylaxis); (2) support collaborative partnerships among medical and allied health professionals, school district administration and staff, parents, state and local agencies, and

community health organizations; and (3) emphasize comprehensive asthma and allergy awareness, education, and medical treatment.

NDE Rule 59

The NDE Rule 59 (Title 92, NAC, Chapter 59) is a state regulation that defines school responsibilities for administering medications and is entitled "Regulations for School Health and Safety." Now mandated in NDE Rule 59, the protocol was approved by the Nebraska State Board of Education in May 2003 and became effective on October 1, 2003, by signature of Nebraska Governor Mike Johanns. The NDE Rule 59 (Section 006) states that all accredited schools, approved schools, and approved early childhood education programs will adopt and implement the protocol no later than the end of the 2003–2004 academic school year and procure and maintain the equipment and medication necessary to implement the protocol in each school building while school is in session in the case of any student and/or school staff emergency.

The AOAN agreed to develop and distribute all education and training materials for schools, conduct or arrange for staff and emergency response team trainings, and assist schools with their procurement of medications and supplies. School emergency response teams are taught to recognize the signs and symptoms of life-threatening asthma and anaphylaxis, follow a student's own AAP first and then call 911, administer epinephrine, and follow with nebulized albuterol. Following input from the OPS AAPC and many individuals across the state, the AOAN recommended a modified version of the protocol to NDE, requiring that epinephrine always be administered first followed by nebulized albuterol while awaiting arrival of emergency medical services. This change removes the need for responding school staff, many of whom have no medical background, to make a determination about which medication to administer first.

Outcomes From 2003–2004

By June 2004, selected staff members from all Nebraska schools had been fully trained to recognize the onset of symptoms and respond quickly to use the protocol. The first school year Rule 59 became effective, the protocol was used

successfully in several rural Nebraska schools. This includes 2 communities in western Nebraska (North Platte, Chadron), one in eastern Nebraska (Ashland), and one in Northeast Nebraska (Newman Grove).

From the continued use of this program, several important trends have emerged. One is that students, parents, and school staff have become increasingly aware and therefore educated about the serious consequences of untreated asthma. Through experience and training, school staff and teachers now have significantly more knowledge about asthma and severe allergies and are more aware and educated about prevention and treatment of anaphylaxis. Second, in 2004–2005, OPS students treated with the protocol must have medications and a current AAP on their return to school. Those without medications and an AAP must have a signed waiver from their physician or parents. Third, currently in the protocol definition, *student* has been expanded to include *all* individuals. Specifically, the term *student* in the original OPS protocol has been replaced with *individual* in the protocol mandated for all schools in Rule 59. Thus, the regulation covers “any student and/or school staff emergency.” Finally, since 2003, no child in school who has been treated with this protocol has died in Nebraska.

DISCUSSION

Few publications exist that describe school-based programs directed to children and adolescents with asthma, despite a consensus that implementing National Institutes of Health guidelines on asthma education and prevention would decrease fatalities.¹⁸ Many educational-only programs have been described.^{19–22} Overall, however, the effectiveness of such educational programs on reducing school absences and health care use has been found to be small.²³ A nurse-managed program to prevent death in children at risk of death from asthma was found successful by providing early, aggressive medical attention and rapid access to care for selected children.²⁴ The establishment of elementary school-based programs to identify children with asthma and to provide education, family support, and clinical care was found effective in improving asthma outcomes for children.^{25–27} However, because so many schools do not have a full-time nurse or established emergency response programs, asthmatic children in schools continue to be at risk of serious health outcomes and death.²⁸ To our knowledge, the AOAN program described in this report is the first comprehensive multischool-based program designed to prevent asthma-related fatalities in children spanning from the elementary to high school level.

From 1998 to 2003, 99 students were treated with the school-based protocol. All but 1 student described in this report responded favorably to treatment without serious adverse events. Approximately equal numbers of children treated with this protocol presented with both AAPs and MDIs (30.3%), MDIs only (33.3%), or neither AAPs nor MDIs (36.4%). The protocol was effective even for 75% of

the students who had no AAPs. Of the 10 students with severe asthma reactions who were given epinephrine, only 2 had AAPs. Although the school protocol was not intended to replace student AAPs, the results underscore the need for increased awareness and education surrounding the importance of AAPs. Dating back to 1991, the National Heart, Lung, and Blood Institute continues to recommend that a written asthma management (action) plan be established for students attending schools, including plans to ensure prompt, reliable access to medications.¹⁸

Our experience and that of others have shown that even children with mild asthma are at risk. In one study, one third of child deaths were due to mild asthma.⁶ A survey of 122,882 children in 499 North Carolina public middle schools found 17% reported asthma symptoms with no previous diagnosis, at least a quarter of whom had missed school, limited their activities, and had sleep disturbances.¹² In addition, it has been shown that although symptoms of atopic asthma often disappear at puberty, asthmatic patients in clinical remission frequently have relapses later in life, and even during clinical remission in which no outward signs of asthma may be obvious, airway inflammation is nevertheless present.²⁹ The rapidly growing lungs of younger children are particularly susceptible to the effects of inflammation associated with persistent asthma,³⁰ and more than 70% of children with asthma experience symptoms by the age of 3 years.³¹ Accordingly, schools and parents must be educated, aware, and prepared for any unexpected asthma event especially in elementary school children. This is made even more urgent by the finding that more children succumb to a fatal anaphylactic reaction at school than at home or another setting.³²

The 2 goals of our program were met. First, we enabled schools to implement this protocol effectively, and second, the subsequent establishment of AOAN has improved public awareness and understanding of childhood asthma through education and training. Since 1998, when we established and began evaluating this program, parents of children in OPSs have been consistently positive and supportive of the program. Many of them have expressed a feeling of safety generated by the knowledge that a rapid response emergency response network exists. The protocol has been effective in increasing awareness, education, proper diagnosis, and early management. Feedback from the school administrators indicates that the staff now has significantly more knowledge about asthma and severe allergies. This has led to many instances of early intervention for severe asthma attacks, anaphylactic events, and allergic reactions. Rapid access to emergency medical care, patient education, and caregiver education are the key components that continue to make this program successful.

In 2001, a national blueprint for policy action for improving childhood asthma outcomes in the United States identified several goals to meet its objective for improving health care performance measures for childhood asthma care by promoting “asthma-friendly schools” and school-

based asthma programs.¹⁷ Their recommendations called for implementing a protocol that would provide a safety net for all schoolchildren and establishing an asthma surveillance system in our schools. In 1991, the National Heart, Lung, and Blood Institute established guidelines for schoolchildren, suggesting that “reliable, prompt access to medications [in schools] is essential.”¹⁸ By 2004, the program described in this article has successfully achieved these recommendations.

In conclusion, in providing this program, our overarching goal has continued to be that no child should die of asthma or an allergic reaction in our schools. By establishing the AOAN and a state-mandated emergency response protocol, we have begun to significantly protect the children in Nebraska schools. Ultimately, by establishing similar school-based programs, providing more education, and creating a better understanding of asthma, the burden of childhood asthma will steadily decrease in the United States. We believe this program should serve as a national model for other school-based programs for children and adolescents with asthma and anaphylaxis.

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Requests for reprints should be addressed to:

Kevin R. Murphy, MD

Midwest Allergy and Asthma Clinic

16945 Frances St

Omaha, NE 68130

E-mail: murphknc@aol.com.
