

Response to Cardiac Arrest and Selected Life-Threatening Medical Emergencies

The Medical Emergency Response Plan for Schools A Statement for Healthcare Providers, Policymakers, School Administrators, and Community Leaders*

Writing Group

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This document introduces a public health initiative, the Medical Emergency Response Plan for Schools. This initiative will help schools prepare to respond to life-threatening medical emergencies in the first minutes before the arrival of emergency medical services (EMS) personnel.

This statement is for healthcare providers, policymakers, school personnel, and community leaders. It summarizes essential information about life-threatening emergencies, including details about sudden cardiac arrest (SCA). This statement describes the components of an emergency response plan, the training of school personnel and students to respond to a life-threatening emergency, and the equipment required for this emergency response. Detailed information about SCA and cardiopulmonary resuscitation (CPR) and automated external defibrillator (AED) programs is provided to assist schools in prioritizing and preparing for emergencies to maximize the number of lives saved.

Life-threatening emergencies can happen in any school at any time. These emergencies can be the result of preexisting health problems, violence, unintentional injuries, natural disasters, and toxins. In recent years, stories in the lay press have documented tragic premature deaths in schools from SCA, blunt trauma to the chest, firearm injuries, asthma, head injuries, drug overdose, allergic reactions, and heatstroke. School leaders should establish an emergency response plan

to deal with life-threatening medical emergencies in addition to the emergency plan for tornados or fires.

This statement has been endorsed by the following organizations: American Heart Association (AHA) Emergency Cardiovascular Care Committee, American Academy of Pediatrics, American College of Emergency Physicians, American National Red Cross, National Association of School Nurses, National Association of State EMS Directors, National Association of EMS Physicians, National Association of Emergency Medical Technicians, and the Program for School Preparedness and Planning, National Center for Disaster Preparedness, Columbia University Mailman School of Public Health. This statement was also reviewed by the Centers for Disease Control Division of School and Adolescent Health.

This statement includes all of the recommendations made in the 2001 Guidelines for Emergency Medical Care in School published by the American Academy of Pediatrics.¹ It is consistent with the position of the AHA statement on use of AEDs in children,² the National Association of School Nurses' statement on the use of AEDs in schools,³ the statement from the National Association of EMS Physicians about the use of AEDs in children,⁴ the emergency planning in athletics statement of the National Athletic Trainers' Association,⁵ and the American Lung Association Asthma Alert for Teachers.⁶

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Background

Magnitude of the Problem

School nurses, athletic trainers, and teachers are often required to provide emergency care during the school day and for extracurricular activities, including sports. In a survey of elementary and high school teachers in the Midwest, 18% of all teachers surveyed indicated that they personally provided some aspect of emergency care to more than 20 students each academic year, and 17% indicated that they had responded to ≥ 1 life-threatening student emergency during their teaching career.⁷ A survey of school nurses in New Mexico documented that each year, 67% of schools activated the EMS system for a student and 37% of the schools activated the EMS system for an adult.⁸ Unfortunately, data on the type and severity of emergency calls from schools to EMS systems are limited. A review of the medical literature yielded no published reports of the national frequency and causes of life-threatening medical emergencies in schools. Information in the present statement was gathered from the medical literature, regional and statewide surveys, and registries of isolated problems.

School medical emergencies can involve students or adults. All schools have adult faculty and staff, and most schools host large numbers of adults during extracurricular activities (eg, sports events, drama productions, community meetings). As noted above, each year, more than one third of schools may have an emergency that involves an adult and requires activation of the EMS system.⁸ The data on adult life-threatening medical emergencies in schools were derived from the most frequent causes of death in adults reported by the National Center for Health Statistics⁹ and the most common causes of work-related fatalities.^{10,11}

Life-Threatening Emergencies in Children and Adolescents

Noncardiac Causes of Emergencies

In children and young adults, injuries cause more childhood deaths than all other diseases combined.⁹ Unless an injury involves *commotio cordis* (a sudden blow to the chest), injury deaths typically are associated with difficulty breathing or development of shock (low blood pressure) due to blood loss. In such cases, the heart often slows and then stops so that the cardiac arrest is a secondary (rather than a primary or sudden) event.¹² Victims of injuries require early activation of EMS, support of breathing, and control of hemorrhage and are unlikely to need treatment with a defibrillator.

The AHA modified the Adult Chain of Survival to emphasize the prevention of injuries and other causes of death and the need for immediate bystander CPR for children.¹² The links in the AHA Infant and Child Chain of Survival are as follows:

1. Prevention of injury and other causes of cardiac arrest
2. Early CPR
3. Early activation of the EMS system
4. Early advanced care

TABLE 1. Chief Complaints* of School Versus Nonschool EMS Dispatches, State of Utah, 1994–1996

| | School (n=755 of 12 603 Dispatches), % | Nonschool (n=11 848 of 12 603 Dispatches), % |
|------------------------|--|--|
| Falls | 36.2 | ... |
| Motor vehicle crashes | ... | 30.8 |
| Other trauma | 27.3 | 11.4 |
| Medical illness | 24.5 | 30.4 |
| • Breathing difficulty | 18.4 | 13.7 |
| • Other illness | 12.3 | 20 |
| • Seizure | 16 | ... |
| • Abdominal pain | ... | 12.0 |

Data derived from Knight et al.¹³

*Note: Often more than one complaint reported.

The Intermountain Injury Control Research Center at the University of Utah compared statewide reasons for EMS dispatch for children 5 to 18 years of age at schools with reasons for EMS dispatch for children at nonschool locations during a 3-year period (see Table 1).¹³ Injuries accounted for a greater proportion of school-based EMS calls than other EMS calls for children; most school injuries occurred during sports activities, and 11 resulted in permanent paralysis.¹³

During the 3-year study period, the Intermountain Injury Control Research Center documented 3 chief medical complaints for school EMS dispatches for children unrelated to injury: breathing difficulty (18.4%), seizure (16%), and other illness (12.3%).¹³ These complaints are consistent with the causes of school deaths reported in the lay press: severe asthma, anaphylaxis (severe allergic reaction), choking, drug overdose, and heatstroke. These causes of arrest require recognition of the emergency and first aid, which may include administration of medications at the scene (eg, use of the victim's inhaler for severe asthma or use of an epinephrine autoinjector for anaphylaxis), cooling of heatstroke victims, opening of the airway, possible CPR (especially rescue breathing), and rapid transport to an appropriate medical facility. These treatments are time dependent. For the child to survive, the school must have a plan to ensure that trained rescuers identify the emergency and act quickly in a coordinated fashion to provide appropriate treatment within a few minutes.

Because injuries are the most common life-threatening emergencies encountered in children and adolescents in or out of schools, teachers, school nurses and physicians, and athletic trainers should know the general principles of first aid (eg, how to ensure scene safety and assess responsiveness, how to use personal protective equipment when in contact with blood or other body fluids, when and how to phone the EMS system, and when it is acceptable to move a victim). In addition, first aid rescuers must be able to control bleeding, recognize and treat shock, immobilize the spine, warm hypothermia victims, cool heatstroke victims, detect and treat hypoglycemia, support the airway, and provide CPR and use an AED when needed. These skills are taught in 1-day first aid courses that teach first aid, CPR, and AED use.

Children With Special Healthcare Needs

Children with special healthcare needs have chronic physical, developmental, behavioral, or emotional conditions and require health and related services of a type or amount not usually required by typically developing children.^{14–16} These children may need emergency care for acute, life-threatening complications that are unique to their chronic conditions (such as severe asthma or obstruction of a tracheostomy airway), or they may develop progression of underlying respiratory failure or neurological disease. However, approximately half of EMS responses to children with special healthcare needs are unrelated to the child's special needs and include traditional causes of EMS calls, such as injury.

When a child with special healthcare needs or any illness with life-threatening complications attends school, the school nurse should have access to specific medical information about the child's baseline condition, the medical plan of care, the child's current medications, and potential complications or signs of deterioration. The healthcare provider guiding the child's care should provide information to school personnel about emergency actions.

A standardized form, the Emergency Information Form, was developed by the American Academy of Pediatrics and the American College of Emergency Physicians and is available on the World Wide Web.¹⁶ In most instances, the school nurse is responsible for interpreting the Emergency Information Form and developing an individual emergency care plan that is specific to the school environment.^{17,18}

The school should have specific instructions about whom to contact for emergencies and when such contact should be made.¹⁸ If the child has a tracheostomy, everyone responsible for the child's care at school should be taught to assess airway patency, clear the airway, and provide CPR with the artificial airway. If the child has asthma, the school nurse and any teacher responsible for the child's care should be able to recognize wheezing and signs of breathing difficulty and should know to follow the asthma action plan for the child.⁶

If the physician who cares for the child, the child's parents, and the child (as appropriate) have made a decision to limit resuscitation efforts or withhold resuscitation attempts, the physician should write a Do Not Attempt Resuscitation (DNAR) or "no-CPR" order specifically for use in the out-of-hospital setting. The child's primary caretaker, the school, and the EMS systems for the child's home and school should have copies of these orders.

SCA in Children and Adolescents

SCA is the sudden cessation of cardiac activity so that the victim becomes unresponsive, with no normal breathing and no signs of circulation. Unless the victim receives immediate CPR and other treatment to restore normal cardiac activity, he or she will die. Although the precise incidence of SCA in children is unknown, it is not a leading cause of death in children and young adults.

Response to SCA is a major focus of this statement. Although SCA is relatively uncommon in children and young adults, victims are more likely to survive SCA than prehospital traumatic cardiac arrest if they receive prompt support and treatment.

When SCA does occur in children and young adults, it may be precipitated by ventricular fibrillation (VF) or rapid ventricular tachycardia (pulseless VT). These abnormal heart rhythms in children are typically caused by inherited or congenital cardiac conditions or by acute medical problems that cause inflammation of the heart. Examples of conditions that may be familiar to school nurses, physicians, and parents include long-QT syndrome, hypertrophic cardiomyopathy, abnormal development of the coronary arteries, aortic dissection, myocarditis, and congenital aortic stenosis.¹⁹ Many of these conditions will not be detected during routine screening for school physicals or sports activities,^{20,21} so SCA may be the first sign of these problems. Vigorous exercise appears to act as a trigger for lethal arrhythmias.²¹

SCA may also result from *commotio cordis*, a blow to the chest that causes VT or VF. Each year \approx 5 to 10 cases of *commotio cordis* are reported nationwide for victims of all ages.^{21–23}

A statewide survey of SCA in athletes in Minnesota conducted by Maron et al^{24,25} was the basis for estimating the risk of SCA in high school athletes, which is thought to be 0.5 to 1.0 per 100 000 high school athletes (or 1 per 200 000 to 1 per 100 000) per year.^{21,25} This risk is \approx 1/100 to 1/200 of the risk reported in the adult population 35 years of age and older.²⁶ In 1999, an estimated 5 000 000 athletes competed in varsity athletics in 34 486 public and private high schools throughout the United States. Extrapolation from the Maron Minnesota data predicted \approx 25 to 50 episodes of SCA nationwide among all high school athletes per year.

The National Center for Catastrophic Sports Injury Research (NCCSIR) tracks voluntary reports of serious injuries and deaths that occur during training or competition in male and female high school and college sports.²⁷ The NCCSIR reports deaths attributable to an injury (direct injury death) and those not attributable to an injury (indirect nontraumatic death). In 2000, the NCCSIR reported 15 deaths of high school athletes nationwide: Twelve deaths were caused by SCA (indirect nontraumatic death), 2 deaths resulted from direct injury with *commotio cordis* (blow to the chest), and 1 death resulted from a brain injury.²⁸ The 14 reported cardiac deaths among 5 000 000 high school athletes are lower than the 25 to 50 fatalities predicted by the Maron Minnesota data and yield an incidence of 0.28 cardiac deaths per 100 000 high school athletes, or 1 death per 357 000 high school athletes.

Over a 10-year period from July 1983 to June 1993, the NCCSIR reported 126 nontraumatic sports deaths in high school athletes and 34 deaths in college athletes, or an average of 16 reported deaths per year nationwide.²⁹ Most of these deaths were caused by cardiovascular conditions, especially hypertrophic cardiomyopathy and congenital anomalous coronary arteries. Estimated death rates in male athletes were 5-fold higher than those in female athletes (0.747 versus 0.133 per 100 000 athletes per year; $P < 0.0001$) and 2-fold higher in male college athletes than in male high school athletes (1.45 versus 0.66 per 100 000 athletes per year; $P < 0.0001$).²⁹

The NCCSIR database includes only voluntary reports of deaths or injuries at athletic activities sanctioned and spon-

sored by high schools and colleges. It does not include deaths or injuries that occur during routine class hours, physical education classes, or pickup sporting activities. Despite these limitations, the NCCSIR represents the best ongoing source of data on high school athletic injuries and death.

There is little information about SCA among high school students who do not compete in athletics or about SCA among elementary school students. Although SCA has been reported in nonathletic adolescents during sedentary activities, the risk of SCA appears to be lower in high school students who do not play competitive sports than in athletes.^{21,24,30} When the limited data from EMS systems are examined,³¹ the risk of SCA in elementary school-age children appears to be much lower than that reported in high school-age students who are not athletes and substantially lower than that reported in high school athletes.

Because the Maron and NCCSIR registries provide the most concrete data available, the risk of SCA of 0.5 to 1.0 per 100 000 (or 1 per 200 000 to 1 per 100 000) children and young adults is used for calculations in the present statement. This figure will likely *overestimate* the incidence of SCA, particularly in elementary school children and adolescents who do not participate in athletics.²¹

As in an adult, if a child develops SCA caused by VF or pulseless (rapid) VT, immediate bystander CPR and early defibrillation are needed. AEDs are computerized defibrillators designed for use by lay rescuers to treat SCA. The AED provides voice and visual prompts to guide the rescuer. When attached with adhesive pads to an unresponsive victim in cardiac arrest, the AED analyzes the victim's heart rhythm, determines if a shock is needed, charges to an appropriate shock dose, and prompts the rescuer to deliver a shock. The AED delivers a shock only if VF or rapid VT is present.

The US Food and Drug Administration has now cleared several AEDs for use in children younger than 8 years of age. Two of these devices have been shown to accurately identify VF and rapid VT in young children and are also accurate in identifying pediatric rhythms that do not require defibrillation.^{32,33} When used with a designated pediatric pad-cable system, these AEDs deliver an energy dose that is smaller than that delivered with adult pads. The AHA² and the National Association of EMS Physicians⁴ state that AEDs may be used with CPR for treatment of prehospital cardiac arrest (victims who are unresponsive, with no breathing and no signs of circulation) in children 1 to 8 years of age. The AHA continues to recommend the use of CPR with AEDs for treatment of cardiac arrest in children 8 years of age and older and in adults.³⁴

Life-Threatening Emergencies in Adults

Noncardiac Life-Threatening Emergencies in Adults

In developing the 2000 international guidelines for CPR and emergency cardiovascular care,¹¹ the AHA and the International Liaison Committee on Resuscitation (ILCOR) identified the leading causes of death in persons 25 to 64 years of age. The 10 leading causes of death are malignancy, heart disease, unintentional injury, suicide, stroke, diabetes, liver disease, human immunodeficiency virus (HIV), respiratory disease (bronchitis, emphysema, and asthma), and homicide.

The leading causes of work-related fatalities are transportation incidents (41%); assaults and violence (20%); contacts with objects and equipment, including poisons (16%); environmental exposure (12%); falls (10%); and fires and explosions (3%).^{10,11}

Adult workplace emergencies are likely to be representative of life-threatening emergencies among adults who work in schools. Rescuers responding to these emergencies must recognize the condition, notify the EMS system when appropriate, and provide basic first aid until EMS providers arrive. First aid rescuers must know the general principles for all emergencies, such as how to ensure scene safety, how to assess responsiveness, how to use personal protective equipment when in contact with blood or other body fluids, when and how to phone the EMS system, and when it is acceptable to move a victim. In addition, as noted above, first aid rescuers must be able to control bleeding, recognize and treat shock, immobilize the spine, warm hypothermia victims, cool heatstroke victims, detect and treat hypoglycemia, support the airway, and provide CPR and use an AED when needed.

SCA in Adults

SCA is a leading cause of death for adults ≥ 35 to 40 years of age and is the most common cause of death for those >45 years of age. In the United States each year, SCA occurs with an estimated frequency of ≈ 1 per 1000 persons ≥ 35 years of age per year.³⁴⁻³⁷ These statistics can be used to estimate the risk of adult SCA for any location on the basis of the number of adults aged 35 and older typically present at that location and the number of hours they are present at that location per year (see Appendix 1). Note that the risk of SCA in adults is ≈ 100 to 200 times the estimated risk in children and adolescents and those under 35.^{21,24-26}

VF and, much less frequently, pulseless VT are the most common abnormal heart rhythms that cause SCA in adults, although they are not the only rhythms that cause cardiac arrest.³¹ VF and pulseless VT are treated with a defibrillator that delivers a shock to the heart. This shock briefly "stuns" the heart, eliminating the abnormal rhythm and allowing the heart's normal rhythm to resume.

Victims of SCA due to VF/VT can survive if bystanders and EMS providers act quickly. Bystanders must be able to recognize cardiac arrest, phone the EMS system, perform CPR, and use the AED. The AHA has depicted these rescue steps of early recognition, early access to the EMS system, early CPR, and early defibrillation as links in the Adult Chain of Survival³⁸:

1. Early recognition of the emergency and early activation of the EMS system
2. Early CPR
3. Early defibrillation
4. Early advanced life support

Studies have shown that immediate bystander CPR and defibrillation within minutes provide the best chance of survival from sudden VF cardiac arrest in adults. Survival rates of 50% to 74% have been reported when adult victims of VF SCA collapse in front of witnesses and receive immediate bystander CPR plus defibrillation within 3 to 5

minutes of collapse. These adult survival rates have been documented in settings such as airports,³⁹ commercial airlines,^{40,41} casinos,⁴² and communities with police who are trained and equipped to respond to SCA.^{43–46}

Current Level of School Preparation for Medical Emergencies

School nurses, teachers, athletic trainers, coaches, and staff are responsible for the physical well-being of a large portion of the nation's children for many hours each day. Schools now employ fewer nurses, and school nurses often rotate between schools, so some schools are without professional medical coverage for hours or days every week.⁷ Much of the responsibility for the physical care of students during a typical school day now rests with teachers, athletic trainers, coaches, and staff. In a random survey of elementary and high school parents and teachers in the Midwest, 80% of parents indicated that they assumed that teachers were adequately trained in first aid and CPR, but one third of the teachers surveyed had no training in first aid, and 40% had never completed a course in CPR.⁷ A survey in New Mexico confirmed that few school nurses and staff had any emergency training.⁸

In a survey of all high schools in Washington State, 80% of teachers thought that CPR training was important, yet 35% of schools provide no CPR training for students.⁴⁷ When the schools were asked to identify factors that would be most likely to encourage schools to offer CPR training for students, 24% indicated that funding would be helpful, and 17% indicated that a requirement or credit for CPR training would encourage CPR training.⁴⁷

School Medical Emergency Response Plan: Recommended Elements

The goal of the Medical Emergency Response Plan for Schools initiative is to encourage every school to develop a program that reduces the incidence of life-threatening emergencies and maximizes the chances of intact survival from an emergency. Such a program will have the potential to save the greatest number of lives with the most efficient use of school equipment and personnel.

The authors and endorsing organizations of the present statement recommend the following core elements of a school medical emergency response plan:

1. *Effective and efficient communication throughout the school campus:* Establish a rapid communication system linking all parts of the school campus, including outdoor facilities and practice fields, to the EMS system. Establish protocols to clarify when the EMS system and other emergency contact people should be called. Determine the time required for EMS response to any location on campus and establish a method to efficiently direct EMS personnel to any location on campus. Create a list of important contact people and phone numbers with a protocol to indicate when each person should be called. Include names of experts to help with postevent support.
2. *Coordinated and practiced response plan:* Develop a response plan for all medical emergencies in consulta-

tion with the school nurse, the school or school athletic team physicians, athletic trainers, and the local EMS agency, as appropriate. EMS and emergency dispatchers (9-1-1 centers) should be made aware of the type of rescue equipment available at the school and its location. Practice the response sequence at the beginning of each school year and periodically throughout the year, and evaluate and modify it as needed.

3. *Risk reduction:* Prevent injuries through safety precautions in classrooms and on the playground. Identify students, faculty, and staff with medical conditions that place them at risk for development of life-threatening conditions, and train and equip personnel to provide the appropriate response for those conditions.
4. *Training and equipment for first aid and CPR:* Ensure that many teachers are trained as CPR and first aid instructors. Train school staff and graduating high school students in CPR. Teachers and staff trained in first aid should, at a minimum, be equipped and able to give first aid for the following life-threatening emergencies until EMS rescuers arrive:
 - a. Severe breathing problems, including asthma, choking, and anaphylaxis (severe allergic reaction)
 - b. Chest pain and heart attack
 - c. Diabetes and low blood sugar
 - d. Stroke
 - e. Seizure
 - f. Shock
 - g. Bleeding
 - h. Head and spine injury
 - i. Broken bones
 - j. Burns
 - k. SCA
 - l. Temperature-related emergencies (heatstroke and hypothermia)
 - m. Poisoning
5. *Implementation of a lay rescuer AED program in schools with an established need:* If the school determines that a lay rescuer AED program is needed, school administrators and medical personnel should include the AED program in the school medical emergency response plan and practice and evaluate response to SCA using the AED. EMS and 9-1-1 centers should be notified of the specific type of AED and the exact location of the AED on the schoolgrounds. Rescuers who are unfamiliar with the school can call 9-1-1 and receive instructions from 9-1-1 dispatchers to find and use the AED. AED programs should have the following elements:
 - a. Medical/healthcare provider oversight
 - b. Appropriate training of anticipated rescuers in CPR and use of the AED
 - c. Coordination with the EMS system
 - d. Appropriate device maintenance
 - e. Ongoing quality improvement program

A medical emergency response plan must start with development of a good system of communication. It also requires development and coordination of a planned and practiced response, risk reduction, and training and equipment.

Effective and Efficient Communication

An effective emergency response plan begins with establishment of rapid, effective communication to and from every location on the school campus. This network can be built with cellular telephones, walkie-talkies, alarms, or intercom systems to establish contact with a central location that is responsible for the EMS call. Several such systems may work, as long as the EMS system can be contacted immediately and directed to the site of any emergency without delay. Critical delays will result if teachers or coaches must send a runner from a distant practice field or track to the school office, so this method of communication is not recommended. The local EMS system may be able to provide valuable input in development of the plan.

Every school district and each school should identify persons who will be authorized and trained to make decisions when health emergencies occur. The names, telephone numbers, and locations of these persons should be provided to all staff members, with a protocol indicating when each authority should be called.

All school staff should be taught when to telephone the EMS service (phone 9-1-1), when to phone other school or medical personnel, where to find the emergency equipment, how to clear crowds, and how to direct arriving EMS personnel to all sites on campus. These efforts will ensure that the entire staff is engaged in the response plan.

The lay press has reported unfortunate delays in emergency response when student calls for help are dismissed as pranks. The school must sensitize teachers, staff, and students to the gravity of reports of emergencies. Student reports of emergencies must be taken seriously, and disciplinary consequences must follow any false claims.

Coordinated and Practiced Response Plan

Plan Development

The school nurse and school or team physicians and athletic trainers should be involved in development of the medical emergency response plan. The plan should specify their participation in the emergency response and in documentation, evaluation, and postevent support of students, teachers, and staff.

The school should coordinate the plan with the local EMS agency and integrate it with the local EMS system. School administrators should invite input from both the emergency medical dispatch system and the EMS system that provides responding units to the school. The local EMS agency should be encouraged to conduct an on-site "preincident" visit to identify problems, such as restrictive passages through the school parking lot or buildings or any areas that are inaccessible to a crew in an ambulance.

Written notification protocols should list the appropriate contact people and their contact telephone numbers and should specify when parents, school district personnel, and the EMS system should be contacted. Forms should be available to document the details of an emergency event. A complete Emergency Information Form should be available for reference during emergencies involving children with special healthcare needs.

The school should give a copy of the final emergency response plan to the local EMS system and local EMS dispatcher. This plan should include the location and type of emergency equipment. The school should notify the local fire/emergency rescue agency if any faculty, staff, or students at the school are dependent on mechanical ventilation or other electrical equipment so the agency is prepared to provide support in the event of a power failure or other emergency. National crisis plans now require schools to keep detailed floor plans and maps of the school property for use in emergencies. Much of this information can be entered into computer-aided dispatch systems at the 9-1-1 dispatch center and linked to the school's address and telephone numbers. Entering this information will permit 9-1-1 dispatchers to have immediate access to this information during the emergency call.

Plan Practice and Evaluation

Each school should practice and evaluate the response plan with participation of the school nurse, school or team physicians, athletic trainers, and the local EMS system. This plan should target a collapse-to-EMS call time of ≤ 1 minute, provision of first aid and CPR when appropriate, and a collapse-to-first shock time of < 3 minutes for SCA if an AED program is on site.³⁴

Designated rescuers should participate in unannounced practice drills on a regular basis (eg, at the beginning of every school year and repeated during the school year) to promote an efficient, organized, and timely response to life-threatening medical emergencies anywhere on the schoolgrounds. These practice drills should include real-time participation by students, staff, and faculty who feign emergency conditions or participate as members of the response or communication team. The drill should use manikins to simulate victims in cardiac arrest. The AHA has created scenario cards that may be used for these practice drills. The scenario cards are available in the AHA instructor materials.⁴⁸ Scenarios are also in the ARC first aid/CPR/AED program instructor materials.

During each practice drill, an observer should record the following:

1. *Critical time intervals:* time from development of the emergency to 9-1-1 call; time from development of the emergency to administration of first aid; time from collapse to bystander initiation of CPR (if indicated); time from collapse in cardiac arrest to delivery of first shock (if an AED program is in place); and time to arrival of EMS personnel at the victim's side.
2. *Availability and function of emergency equipment at the school.*

After each drill, review performance of each component of the plan, and revise the school emergency response plan as needed to improve performance and efficiency.

When a life-threatening medical emergency does occur at the school, administrators should hold a postevent meeting of all involved personnel. This meeting should be scheduled within a few days of the emergency and should provide the opportunity for a frank discussion of what worked, what

didn't work, and how to improve the response plan. This will enable revision of the response plan to better serve the next emergency.

Postincident counseling should be available to staff and students whenever a fatal or near-fatal event occurs at the school. Most school districts have designated counseling staff to handle such needs. The school supervisor should identify resource personnel before an emergency arises and should have contact numbers for use in the event of an emergency. The local children's hospital, medical center, community mental health agency, or local EMS agency may be able to provide names of experts.

Risk Reduction

The Medical Emergency Response Plan for Schools should strengthen each link in the Chain of Survival. The first link in the AHA Infant and Child Chain of Survival is prevention of life-threatening events through education about injury prevention and identification, evaluation, and support of children at risk. Some injuries that occur on school grounds result from high-risk behavior that begins at home. Schools should provide injury prevention information to children and families about the importance of age-appropriate restraint devices in automobiles, use of bicycle helmets, use of smoke detectors, and use of trigger locks and lock boxes for firearms stored at home.

Injury prevention in schools requires proper equipment maintenance and supervision of students during shop and laboratory classes, playground time, physical education classes, and team sports. Students and teachers should wear proper safety gear during shop, laboratory, and physical education classes. All class equipment should be kept in good working order and any dangerous or flammable chemicals stored in locked cabinets.

The ground surface under swing sets, climbing bars and slides, and gymnastic equipment should be sufficiently cushioned to reduce impact and prevent injuries. All playground equipment should be constructed without sharp edges and should be properly maintained.

As noted above, the school should be aware of any children with medical conditions that may have life-threatening complications. If a student has a health problem that could be life threatening, the school nurse should develop an emergency care plan for that child. The child's teachers and the school nurse should be prepared to activate that plan when needed. The school should ask the parents to consult the child's physician to determine if the school should maintain an extra supply of medications (eg, bronchodilator administered by metered-dose inhalers with spacers for children with severe asthma) for use during emergencies or exacerbations. The school must be in compliance with state laws and regulations and school board policies for use of these medications. If appropriate, information about the child's condition should also be conveyed to the local EMS agency.

Routine medical care of many conditions, such as asthma, can modify the course of the disease and make acute exacerbations less likely. Teachers should consult the child's parents and physician to identify and eliminate factors in the

classroom or school environment that may act as triggers for asthma or severe allergic reactions.⁶

Training and Equipment for First Aid and CPR

As part of the Medical Emergency Response Plan, the school nurse and physician, the athletic trainer, and several faculty members should be trained in and equipped to provide first aid and CPR. Ideally, the school should establish a goal to train every teacher in CPR and first aid and train all students in CPR. All students, faculty, and staff should know how to access the EMS system. The school should maintain a first aid kit, and school staff must know where emergency equipment is stored.

The authors and endorsing organizations of this statement have not specified the number of teachers and staff to be trained in first aid and CPR at each school. There should be a sufficient number of trained faculty, staff, and students, however, to ensure that a trained rescuer can get the appropriate equipment and reach any area of the campus within 90 seconds of the onset of the emergency. Persons trained in CPR and first aid should therefore be carefully selected on the basis of their likely location on the school campus each day, their typical responsibilities, and their likely response interval in the event of an emergency. An office assistant may be able to respond more quickly to an emergency than a teacher who is often off campus for meetings. In a typical school, at least 2 teachers and 2 alternate rescuers will likely be required to ensure coverage for every location and every school day. The school should also evaluate the number of students and adults present on school grounds during afterschool activities, and the plan should cover these time periods if needed.

Training in First Aid and Universal Precautions

All school nurses, physicians, athletic trainers, and several faculty and staff should be trained and equipped to provide first aid because immediate first aid can prevent a life-threatening problem from becoming a fatal one. Potential rescuers must be able to recognize and provide initial treatment for breathing emergencies such as choking, severe asthma, or severe allergic reaction; injury emergencies such as burns, shock, head or spinal cord injury, or bleeding; neurological emergencies such as seizures and stroke; temperature-related emergencies such as heatstroke and hypothermia; and poisoning. Certified athletic trainers are educated to care for student athletes with sports-related injuries and emergencies.⁵ Coaches should be trained to provide CPR (with an AED if indicated) and first aid for common and life-threatening sports-related emergencies.⁴⁹

Every school should comply with precautions to minimize the risk of blood-borne pathogens. In some states, public schools must comply with the Occupational Safety and Health Administration (OSHA) standards with regard to blood-borne pathogens.

Several courses have been developed in recent years to provide training in first aid, including precautions to minimize risk of blood-borne pathogens. The AHA and ARC have developed first aid courses to teach these essential assessment, knowledge, and first aid skills to workplace rescuers.⁵⁰ The University of Connecticut College of Continuing Studies

developed the School Nurse Emergency Medical Services for Children (SNEMS-C) Program.⁵¹ The National Standards for Athletic Coaches provide information needed by coaches to deal with sports-related injuries.⁴⁹ Visual aids such as first aid posters can be displayed in conspicuous places to remind faculty, staff, and students of critical first aid and CPR skills.

Training in CPR

CPR training is important for several reasons. First, rapid bystander CPR, particularly provision of rescue breathing, may prevent breathing problems and other emergencies from progressing to cardiac arrest. Second, CPR has been shown to improve the chance of survival in adults and children with cardiac arrest. In one recent study of children who required CPR in the out-of-hospital setting, ≈ 1 child was resuscitated by bystander CPR alone for every 7 children who required CPR by EMS personnel.^{52,53} Immediate bystander CPR for adults with SCA can double survival.⁴⁰

Because bystander CPR is so critical in improving survival from SCA, the AHA recommends that all high school students be trained in CPR. To facilitate this training, the AHA and ARC developed school CPR courses with course materials tailored for teaching children in a classroom setting.⁵⁴ The Maternal and Child Health Bureau has also developed a course to teach CPR in schools.⁵⁵ Such training should increase the likelihood of immediate initiation of bystander CPR for victims of SCA and should contribute to improved survival rates. CPR training may also have less quantifiable benefits. For example, CPR training implies an underlying commitment to fellow citizens and may encourage and model a willingness to provide assistance to victims of medical emergencies.

Equipment

Equipment is an important part of any medical emergency response plan, beginning with a first aid kit and CPR barrier devices and may include an AED. First aid and CPR-AED equipment should be carefully selected on the basis of the types of emergencies likely to develop at the school. For example, if football, gymnastics, or diving events take place on campus, a backboard with restraints should be available to immobilize an athlete with suspected spine injury.

Epinephrine can be lifesaving for victims with anaphylaxis (severe allergic reaction), such as that resulting from a bee sting, a severe food allergy, or latex allergy. Some states and EMS systems encourage the use of epinephrine autoinjectors for emergency treatment of severe allergic reactions. If state and EMS regulations allow, these autoinjectors can be included in the school's emergency equipment, and staff should be trained in their use. A physician's prescription is required to purchase autoinjectors. To check state regulations about epinephrine autoinjectors, contact the AHA at 1-888-277-5463.

A physician may determine that other medications, such as bronchodilators (medicines that open narrowed airways) administered by metered-dose inhalers with spacers, oxygen, and glucose or glucagon (a rapid-acting hormone for treatment of severe low blood sugar), should be kept at the school for at-risk students or staff. In this case, the student's family or a member of the school staff is responsible for providing

the medication. A school nurse must be regularly available to give medications or delegate administration of medications if allowed by local law and school district policy.

School personnel first aid training includes recognition of low blood sugar (hypoglycemia) and administration of a source of rapid-acting sugar. The parent of the diabetic child is responsible for providing the school with such foods as fruit juice, packets of sugar, or a (nondiet) soft drink to be administered by trained staff if the child shows signs of hypoglycemia.

Any equipment is useless unless it is readily accessible in an emergency and rescuers are appropriately trained to use it. First aid and resuscitation equipment should be placed in a central, highly visible, and accessible location near a telephone, and all school faculty, staff, and students should know where the equipment is stored. If the school is large, it may be necessary to keep duplicate equipment in several areas. Because injuries are most likely to occur during athletic activities, the athletic facilities should be considered high-priority areas for placement of equipment such as the first aid kit and spine backboards.

General emergency equipment should not be placed in a locked office or cabinet because this might delay emergency care. Unfortunately, accessibility will provide opportunities for theft or vandalism of equipment. This problem has been solved in many schools and public places such as airports by the use of mounted cabinets with audible alarms that sound when the cabinet door is opened. These cabinets cost \approx \$250 to \$500.

If medications such as epinephrine autoinjectors, bronchodilators, and glucagon are included in the school medical emergency response plan or a child's emergency care plan, these items should be kept in a location that is readily available to trained rescuers and the school nurse but not accessible by students and the general public. If a student has a healthcare problem that may require the use of emergency medications, the school nurse must develop a plan to make the medication available to the child when needed.

EMS and 9-1-1 centers must know in advance where emergency equipment is kept on school property. This can prevent failure to use available equipment (such as an AED) because responders are unaware of the existence or location of the equipment. If the 9-1-1 center knows where emergency equipment is located on the school grounds, the dispatcher can tell the rescuer where to find the equipment and can instruct rescuers in the use of the equipment before the arrival of EMS personnel.

Implementation of a Lay Rescuer AED Program in Schools With a Documented Need

To determine the need for an AED program at any location, the ECC Guidelines 2000³⁴ recommend consideration of lay rescuer AED program implementation in locations with at least one of the following characteristics:

1. The frequency of cardiac arrest events is such that there is a reasonable probability of AED use within 5 years of rescuer training and AED placement. This probability is calculated on the basis of 1 cardiac arrest known to have

- occurred at the site within the last 5 years, or the probability can be estimated on the basis of population demographics (see Appendix 1); **or**
2. There are children attending school or adults working at the school who are thought to be at high risk for SCA (eg, children with conditions such as congenital heart disease and a history of abnormal heart rhythms, children with long-QT syndrome, children with cardiomyopathy, adults or children who have had heart transplants, adults with a history of heart disease; etc); **or**
 3. An EMS call-to-shock interval of <5 minutes *cannot* be reliably achieved with conventional EMS services **and** a collapse-to-shock interval of <5 minutes *can* be reliably achieved (in >90% of cases) by training and equipping laypersons to function as first responders by recognizing cardiac arrest, phoning 9-1-1 (or other appropriate emergency response number), starting CPR, and attaching/operating an AED.

When funds are limited, but there is a desire to establish some AED school programs, priority should be given to establishing programs in large schools, schools used for community gatherings, schools at the greatest distance from EMS response, and schools attended by the largest number of adolescents and adults (eg, high schools and trade schools).

The 5 components of an AED program are

1. Medical/healthcare provider oversight
2. Appropriate training of anticipated rescuers in CPR and use of the AED
3. Coordination with the EMS system
4. Appropriate device maintenance
5. An ongoing quality improvement program to monitor training and evaluate response with each use of the device

If an AED program is established at the school, the AED should be placed in a central location that is accessible at all times and ideally no more than a 1- to 1½-minute walk from any location. The device should be secure and located near a telephone (eg, near the school office, library, or gymnasium) so that a rescuer can activate the EMS system and get the AED at the same time. The EMS system should be notified of the establishment of the AED program, and the emergency medical dispatcher should know the specific type of AED at the school and where it is located. Several staff members should be trained in both CPR and use of the AED.

Recent federal legislation provides guidance for AED programs in schools. HR 389-PL 108-41 enabled the creation of an information clearinghouse with funds from the AED program in the Public Health Security and Bioterrorism Response Act (PL 107-188). The new law allows creation of a national resource center to provide schools with information and technical guidance to set up AED programs, giving schools access to the appropriate training, fundraising techniques, and other logistics required to make such programs successful. The national resource center is modeled after Project ADAM (Automatic Defibrillators in Adam's Memory), a joint venture between the Children's Hospital of Wisconsin and David Ellis, a friend of the project's namesake, Adam Lemel, who collapsed and died during a high school basketball game. Senate Bill 231 is a companion measure.

For information about the clearinghouse, visit <http://healthlink.mcw.edu/article/962141848.html>. For information about establishing an AED program, call the AHA (1-877-242-4277), or visit the AHA website at <http://www.americanheart.org/cpr>.

Potential Costs of Proposed School Emergency Response Plans

The goal of a school emergency response plan is to ensure an organized, efficient, and effective response to life-threatening emergencies. Although the response plan is designed for all life-threatening emergencies, an estimation of program cost per life saved can be made by using the example of the cost per survival of a high school victim of SCA in a school with a medical emergency response plan that includes a lay rescuer AED program. This example will enable calculation using the costs of all potential elements described in this statement: the costs of training 4 teachers to serve as first aid, CPR, and AED rescuers and instructors every 2 years; training half of the student body in CPR and use of an AED every year; establishment of a lay rescuer AED program; and all first aid, CPR, and AED equipment needed.

Estimation of Costs per School

In 1999 there were 13 369 163 high school students in the United States. These students were enrolled in 23 825 public schools and 10 661 private schools, or a total of 34 486 high schools, with an average of 390 students per school. For this example, an estimated annual incidence of SCA of 0.5 to 1.0 in 100 000 high school students was used.²⁵ This predicts that there may be ≈133 to 266 SCAs in high school students nationwide per year, or 1 event per 259 to 547 schools. Note that this number of cardiac arrests has not been reported, but it is used as a starting number that likely overestimates the number of cardiac arrests in high school students.

The program costs per life saved are estimated by calculating the cost of all equipment plus the cost of training at each school and then multiplying the result by the number of schools required to save 1 life annually. Costs are depreciated over the anticipated lifespan at an annual rate of 3%.⁵⁶

The following assumptions are made to estimate the annual costs of the program (Table 2).

- If students in the high school receive formal CPR training during their freshman and junior years, ≈200 students per school (freshman class size tends to be larger than subsequent years) will be trained each year in an average high school.
- At each school, 2 teachers and 2 alternate teachers are trained as first aid plus CPR and AED rescuers and instructors (total of 4 instructors). The provider plus instructor training requires 2 days. The calculated costs include funds for hiring 4 substitute teachers during training. If the teachers are trained on professional development days, substitute teachers will not be required, and the money allocated for substitute teachers is not needed.
- The school medical emergency response plan is developed as part of school faculty (salaried) responsibilities, so no additional costs are incurred for development of the plan, practice drills, and evaluation.

TABLE 2. Approximate Annual Costs* per School for School Medical Emergency Response Plan With Student CPR and AED Education and a Lay Rescuer AED Program

| Implementation Item | Cost | Quantity | Lifespan, y | First Year Cost* per School | Annual Cost* per School |
|--|--------|----------|-------------|-----------------------------|-------------------------|
| Instructor training | | | | | |
| Training for 2 teachers and 2 alternates† | \$300 | 4 | 2 | \$1200 | \$ 627 |
| Substitute teachers to fulfill classroom responsibilities‡ | \$250† | 4† | 2 | \$1000† | \$ 523† |
| Training equipment | | | | | |
| AED with defibrillation pads and case | \$2500 | 1 | 8 | \$2500 | \$ 356 |
| Manikins (\$175 each) and AED trainers (\$100 each) | \$275 | 8 | 6 | \$2100 | \$ 388 |
| Miscellaneous accessories | \$2.50 | 200 | 1 | \$ 500 | \$ 515 |
| First aid kit | \$300 | 1 | 10 | \$ 300 | \$ 185‡ |
| Training materials | | | | | |
| Instructor toolkits | \$100 | 2 | 5 | \$ 200 | \$ 44 |
| Student manuals | \$1 | 200 | 1 | \$ 200 | \$ 206 |
| CPR cards | \$1 | 200 | 1 | \$ 200 | \$ 206 |
| Reference CPR texts for class | \$7.50 | 2 | 5 | \$ 15 | \$ 15 |
| Total | | | | \$7965† | \$3065† |

*The estimated costs have been amortized, and costs are depreciated over their anticipated lifespan at an annual rate of 3%.

†If teachers are trained as CPR and first aid instructors on professional development days, substitute teachers will not be required, and the money allocated for substitute teachers is saved.

‡Includes annual cost for replacement of materials of \$120 + depreciation of kit.

- The healthcare provider who coordinates the medical emergency response plan does so on a voluntary basis.
- The school establishes an AED program and purchases an AED that has been cleared by the US Food and Drug Administration for use in children and documented to be accurate in children. In addition, the school purchases several adhesive AED pads for adults and children plus an equipment pack, at a total cost of ≈\$2500 amortized over 8 years. Note that if the school does not establish an AED program, the \$2500 cost may be subtracted from the costs listed in Table 2.
- The average school purchases 8 manikins, 8 AED trainers, and 2 CPR instructor toolkits. The manikins and trainers are replaced every 6 years, and the instructor toolkits are replaced every 5 years when the AHA revises its resuscitation guidelines and training materials.
- The school purchases and equips a first aid kit (see Appendix 2) with a Mylar blanket, dressings, 2 epinephrine autoinjectors, and bronchodilator inhalers with spacers. The \$300 estimated total cost of the kit is amortized over 10 years (\$30 per year). The medications and some supplies are replaced annually at an estimated annual cost of \$120 (total of \$150 per year). The parents are responsible for the purchase of prescription medications that are routinely used by students at the school.
- The school provides CPR student manuals, CPR cards (credentials), and barrier devices for each student trained and will train half of all students (average of 200 manuals and cards per school) every year.
- The school purchases 2 copies of a CPR reference text for the students each year.

- All training materials are available for use in practice drills. As a result, the practice drills are conducted without additional costs.



Estimation of Costs per Life Saved

To determine the potential cost per life saved (premature death prevented), an incidence of SCA of 0.5 to 1.0 in 100 000 high school students per year was used, or 1 episode of SCA annually for every 259 to 547 schools. A successful program should have a goal of saving at least half of the potential victims of SCA (50% survival to hospital discharge),^{57,58} or 1 life saved every year for every 518 to 1094 schools. Because each school must invest ≈\$3065 per year, this would result in a cost per life saved of \$1 587 670 to \$3 353 110 (\$3065 annual cost per school × 518 to 1094 schools per life saved). Note that the actual cost per life saved is probably higher than this number because the predicted risk of SCA reported was for athletes, and that number is probably higher than the actual risk of SCA for all high school students. If fewer students experience cardiac arrest than the number predicted, there will be fewer potential lives saved and a higher cost per life saved. These figures should be reevaluated when more data are available.

These numbers provide only the cost of life saved at the school and do not include the EMS costs or costs of hospital care, implantable defibrillator insertion, or rehabilitative care for the victim. They do not include subsequent lost wages for parents of the victim, the victim, and other family members. These calculations do not consider life-years saved or potential contributions to society by a surviving victim. A child survivor of SCA may live a long life. If the victim of SCA

survives neurologically intact and lives for 50 years after the event, then the cost per life-year saved may be very low.⁵⁹

These calculations do not account for the effect on overall public health that would result from training all high school students in the United States to perform CPR. Benefits to society from training a large number of adolescents in CPR cannot be accurately quantified. These calculations also neglect the potential benefit of a school AED program that results in resuscitation of an adult coach or spectator. School insurance pools have recognized the benefits and risk reduction of having trained personnel and equipment available for life-threatening situations.⁶⁰

A challenge to estimating the cost-effectiveness of this program is the lack of published data on the effectiveness of first aid and CPR training and the use of AEDs in schools. This analysis predicts a 50% survival rate from SCA using published models from adult victims.^{57,58} When school emergency response plans are enacted, it will be important to collect data about activation of the plans and outcomes and revise these cost estimates as needed.

An international multicenter trial of lay rescuer AED programs, funded by the AHA, AED manufacturers, and the National Heart, Lung and Blood Institute (NHLBI), is evaluating the effectiveness and cost of lay rescuer AED programs. The trial is a prospective, multicenter, randomized clinical study testing whether volunteer, nonmedical responders can improve survival from out-of-hospital cardiac arrest by using AEDs. The study has just concluded data collection at 24 field centers in \approx 1000 community units (eg, apartment or office buildings, gated communities, sports facilities, senior centers, shopping malls, etc) in the United States and Canada. The primary end point is the number of out-of-hospital cardiac arrest victims who survive to hospital discharge. Secondary end points include neurological status, health-related quality of life, cost, and cost-effectiveness. Data collection for this trial was completed in September 2003, and the results should be published shortly.⁶¹

School Data Collection

More information is needed about the frequency of life-threatening emergencies, including SCA in schools. Schools must collect or provide reports of emergencies. These reports will have maximum impact if collected and verified using the model of Maron and colleagues.^{25,26} Only through the gathering of reliable data can we begin to accurately determine the frequency of life-threatening emergencies and plan the best interventions to save lives.

Legislative Mandates and Funding for School Medical Emergency Response Plan

Legislative efforts to save the lives of children who develop life-threatening emergencies at schools should support an approach that is most likely to save the greatest number of lives. A planned program should be required, as should appropriate training and equipment.

Unfunded legislative mandates, particularly those that address the purchase of equipment rather than programs of

planned response, will limit effectiveness and place a substantial burden on school budgets. Many school budgets are already stretched to provide basic education, achieve student test score goals, and meet the needs of a wide range of students, including those with special healthcare and learning needs. Unfunded mandates for emergency care in schools are likely to be met with minimal effort that does not include the development of planned and practiced responses and the training and retraining that are most likely to save lives. Policymakers must work with schools to ensure that long-term solutions are enacted to be sure that programs are sustained indefinitely.

Local and state policymakers should support an immediate response to life-threatening medical emergencies with the following priorities for policy and appropriations:

1. Establishing an efficient and effective campus-wide communication system for each school
2. Developing a coordinated and practiced medical emergency response plan with the school nurses, physicians, athletic trainers, and the EMS system, with appropriate evaluation and quality improvement
3. Reducing the risk of life-threatening emergencies by identifying students at risk and ensuring that each has an individual emergency care plan and by reducing the risk of injury and disease triggers at the school
4. Training and equipping teachers, staff, and students to provide CPR and first aid
5. Establishing an AED program in those schools with a documented need

Note that some schools throughout the United States have implemented some components of the medical emergency response plans without the use of public funds. Fundraising for such activities can take many different approaches, including sponsorship by local organizations (eg, Rotary Club, Parent-Teacher Association) and student activities (eg, car washes, bake sales). Such programs do not ensure predictable coverage for the greatest number of students, however.

Conclusions

On any given day, as much as 20% of the combined US adult and child population can be found in schools. Life-threatening emergencies in schools are relatively uncommon, but when they do occur, they require a planned, practiced, and efficient response with provision of first aid and possible CPR and use of an AED. To maximize survival from a life-threatening emergency, schools must develop a medical emergency response plan designed to provide appropriate therapy within the first minutes of the emergency. The medical emergency response plan includes (1) creation of an effective and efficient campus-wide communication system; (2) coordination, practice, and evaluation of a response plan with the school nurse and physician, athletic trainer, and local EMS agency; (3) risk reduction; (4) training in and equipment for CPR and first aid for the school nurse, athletic trainers, and teachers and CPR training for students; and (5) in schools with a documented need, establishment of an AED program.

Appendix 1

Sample Calculations to Estimate Risk of SCA in Adult and Young Populations

Use of Person-Hours to Estimate Risk of SCA

Calculating Risk in a School

Person-hours are calculated by multiplying the number of persons gathered in one place by the number of hours they will spend at the same site in a given year. On the basis of limited epidemiological data, the incidence of SCA in high school athletes has been estimated at 0.5 to 1.0 SCA per 100 000 athletes per year, and that figure has been extrapolated to apply to the young population under 35 years of age per year. That translates to 0.5 to 1.0 possible episode of SCA per 876 million young person-hours (100 000 young persons × 24 h/d × 365 d/y = 876 million young person-hours), compared with 1 SCA per 8.76 million adult person-hours based on adult risk.

To provide a rough estimate of the risk of a child’s SCA in a school, calculate the number of hours that students spend in a given school per year, including all sports events and conferences. In a school of 4000 students who attend school 10 hours per day, 5 days per week, 40 weeks per year, the result is 8 million young person-hours at that school per year (4000 young persons × 10 h/d × 5 d/wk × 40 wk/y = 8 million young person-hours per year). If no other students or adults gather at that school, 1 SCA is predicted in a child or adolescent attending that school every 100 to 200 years. This calculation is likely to overestimate the number of cardiac arrests per year because it is based on risk in high school athletes; risk will likely be lower in nonathletes and elementary school children. Note that the number of hours that adults spend at the school should also be calculated to consider the risk of an adult SCA (see calculation formulas in Table 3, below).

TABLE 3. Calculation Formulas

| Population Studied | Prediction of SCA |
|--|---|
| No. of adults (≥35 y of age) living in a community all year = A | $A \div 1000 =$ estimated No. of SCA/y in adults ≥35 y of age. |
| No. of adults (A) present in a location for predictable times each year | $A \times \text{h/d at location} \times \text{d/y at location} =$ adult person-hours at location per year. Total adult person-hours at location per year \div 8.76 million = risk of adult SCA/y. |
| No. of children and young adults (<35 y of age) living in a community all year = C | $C \div 100\ 000 =$ Highest range of estimated risk of SCA/y in children and young adults <35 y of age. Note: To calculate lower estimate of risk (0.5 per 100 000 or 1 per 200 000), divide C by 200 000. |
| No. of children and young adults (<35 y of age) = C, present in a location for predictable times each year | $C \times \text{h/d at location} \times \text{d/y at location} =$ child person-hours at location per year. Total child person-hours at location per year \div 876 million = risk of child SCA/y. |

Appendix 2



TABLE 4. Sample First Aid Kit

| Description | Quantity | Description | Quantity |
|---|----------------------|---|----------------|
| List of important local emergency telephone numbers, including police, fire department, EMS, poison control center, school district emergency numbers | | Elastic roller bandage, 4" and 6" wide | 1 roll of each |
| Flashlight and extra batteries | 1 | Sealed moist towelettes (hand wipes) | 12 |
| Multipurpose scissors | 1 | Emergency Mylar blanket | 1 |
| Tweezers | 1 | Face mask or face shield | 1 |
| Disposable gloves (small, medium, large, and extra large) | 2 pairs in each size | Triangular bandages | 2 to 4 |
| Protective eye shield | 1 | Disposable instant-activating cold packs | 2 |
| Adhesive bandage strips | 1 | Resealable plastic bags (quart size) | 2 |
| Sterile eye pads | 2 | Biohazard waste bag (3.5-gallon capacity) | 1 |
| Sterile gauze pads (4×4") | 6 | Potential medications that may be part of the school emergency response plan (consult school nurse and physician—prescription required and must meet state regulations and school board policy) | |
| Sterile trauma pads (5×9") | 2 | • Epinephrine autoinjector (replaced annually) | 2 |
| Sterile trauma pads (8×10") | 1 | • Bronchodilator metered-dose inhaler with spacer | 1 to 2 |
| Roll of gauze (2" wide) | 3 rolls | • Oxygen | 1 tank |
| Roll of gauze (4.5" wide) | 3 rolls | • Source of rapid glucose administration: sugar packet or glucagon | 2 |
| Adhesive tape (1" to 2" wide) | 1 roll | | |

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