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Inter-Association Task Force Recommendations on Emergency Preparedness and Management of Sudden Cardiac Arrest in High School and College Athletic Programs: A Consensus Statement

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Objective: To assist high school and college athletic programs prepare for and respond to a sudden cardiac arrest (SCA). This consensus statement summarizes our current understanding of SCA in young athletes, defines the necessary elements for emergency preparedness, and establishes uniform treatment protocols for the management of SCA.

Background: Sudden cardiac arrest is the leading cause of death in young athletes. The increasing presence of and timely access to automated external defibrillators (AEDs) at sporting events provides a means of early defibrillation and the potential for effective secondary prevention of sudden cardiac death. An Inter-Association Task Force was sponsored by the National Athletic Trainers' Association to develop consensus recommendations on emergency preparedness and management of SCA in athletes.

Recommendations: Comprehensive emergency planning is needed for high school and college athletic programs to ensure an efficient and structured response to SCA. Essential elements of an emergency action plan include establishment of an effective communication system, training of anticipated responders in cardiopulmonary resuscitation and AED use, access to an AED for early defibrillation, acquisition of necessary emergency equipment, coordination and integration of on-site responder and AED programs with the local emergency medical services system, and practice and review of the response plan. Prompt recognition of SCA, early activation of the emergency medical services system, the presence of a trained rescuer to initiate cardiopulmonary resuscitation, and access to early defibrillation are critical in the management of SCA. In any collapsed and unresponsive athlete, SCA should be suspected and an AED applied as soon as possible for rhythm analysis and defibrillation if indicated.

Key Words: sudden cardiac death, athletes, emergency action plan, automated external defibrillators

Sudden cardiac arrest (SCA) is the leading cause of death in young athletes.[1,2] Athletes are considered the healthiest members of our society, and their unexpected death during training or competition is a catastrophic event that stimulates debate regarding both preparticipation screening evaluations and appropriate emergency planning for athletic events. Despite preparticipation screening, healthy-appearing competitive athletes may harbor unsuspected cardiovascular diseases with the potential to cause sudden death.[3] With the increasing availability of automated external defibrillators (AEDs) at athletic events, there is potential for effective secondary prevention of sudden cardiac death (SCD). The presence and timely access of AEDs at sporting venues provide a means of early defibrillation not only for athletes but also for spectators, coaches, officials, event staff, and other attendees on campus in the case of an unexpected SCA.

Many health-related organizations have guidelines for managing SCA during athletic practices and competitions. However, these guidelines have not directly linked emergency planning and SCA management in athletics. The National Athletic Trainers' Association (NATA) convened an Inter-Association Task Force in Atlanta, Georgia, on April 24, 2006, to develop consensus recommendations on emergency preparedness and management of SCA in high school and college athletic programs. The task force included representatives from 15 national organizations with special interest in SCA in young athletes and a multidisciplinary group of health care professionals from athletic training, cardiology, electrophysiology, emergency medicine, emergency medical technicians, family medicine, orthopaedics, paramedics, pediatrics, physical therapy, and sports medicine (Appendix).

The goal of this statement is to assist those in high school and college athletic programs to prepare for and respond to an unexpected SCA by summarizing the essential elements of SCA in young athletes and outlining the necessary elements for emergency preparedness and standardized treatment protocols in the management of SCA. Management guidelines are focused on basic life support measures for SCA that can be provided by both bystanders and health care professionals before the arrival of emergency medical services (EMS) personnel. All recommendations in this statement are in agreement with the 2005 American Heart Association (AHA) guidelines for cardiopulmonary resuscitation (CPR) and emergency cardiovascular care (ECC),[4] the AHA scientific statement on response to cardiac arrest and selected life-threatening medical emergencies and the medical emergency response plan for schools,[5] and the NATA position statement on emergency planning in athletics.[6] Recommendations are directed toward the athletic health care team, including athletic trainers, team physicians, coaches, school administrators, and other potential first responders. This statement is intended for high school and college athletic programs and institutions, although the recommendations may be applicable in other settings.

Purposes of Consensus Statement

1. To summarize essential information regarding SCA in young athletes
2. To define appropriate emergency preparedness for SCA at athletic venues
3. To establish uniform recommendations for the management of SCA in athletes

Organization of Consensus Statement

This statement is organized as follows:

1. Executive Summary, including key points on emergency preparedness and management of SCA (Figure)
2. Background and review of the causes of SCD in young athletes, limitations of cardiovascular screening, resuscitation pathophysiology, survival after SCA, and factors affecting survival in young athletes
3. Recommendations for emergency preparedness, including review of the ''chain of survival,'' establishment of an emergency action plan (EAP), access to early defibrillation, emergency communication, emergency personnel, emergency equipment, emergency transportation, practice and review of the EAP, postevent catastrophic incident guidelines, current state of emergency preparedness, and obstacles to implementing AEDs
4. Recommendations for the management of SCA, including the 2005 AHA guidelines for CPR and ECC,[4] the collapsed athlete, recognition of SCA, and management of SCA for both witnessed and unwitnessed collapses
5. Special circumstances regarding SCA associated with cervical spine injuries; commotio cordis; exertional heat stroke; lightning; mass events; and rainy, wet, ice, and metal surfaces
6. Conclusions

EXECUTIVE SUMMARY

Emergency Preparedness

- Every school or institution that sponsors athletic activities should have a written and structured EAP.
- The EAP should be developed and coordinated in consultation with local EMS personnel, school public safety officials, on-site first responders, and school administrators.
- The EAP should be specific to each individual athletic venue and encompass emergency communication, personnel, equipment, and transportation to appropriate emergency facilities.
- The EAP should be reviewed and practiced at least annually with certified athletic trainers, team and consulting physicians, athletic training students, school and institutional safety personnel, administrators, and coaches.[6]
- Targeted first responders should receive certified training in CPR and AED use.
- Access to early defibrillation is essential, and a target goal of less than 3 to 5 minutes from the time of collapse to the first shock is strongly recommended.[5,7]
- Review of equipment readiness and the EAP by on-site event personnel for each athletic event is desirable.

Management of Sudden Cardiac Arrest

- The initial components of SCA management are early activation of EMS, early CPR, early defibrillation, and rapid transition to advanced cardiac life support (ACLS).
- Sudden cardiac arrest should be suspected in any collapsed and unresponsive athlete.
- An AED should be applied as soon as possible on any collapsed and unresponsive athlete for rhythm analysis and defibrillation if indicated.
- Cardiopulmonary resuscitation should be provided while waiting for an AED.
- Interruptions in chest compressions should be minimized and CPR stopped only for rhythm analysis and shock.
- Cardiopulmonary resuscitation should be resumed immediately after the first shock, beginning with chest compressions, with repeat rhythm analysis after every 2 minutes or 5 cycles of CPR, and continued until advanced life support providers take over or the victim starts to move.[7,8]
- Sudden cardiac arrest in athletes can be mistaken for other causes of collapse, and rescuers should be trained to recognize SCA in athletes with special focus on potential barriers to recognizing SCA, including inaccurate rescuer assessment of pulse or respirations, occasional or agonal gasping, and myoclonic jerking or seizure-like activity.
- Young athletes who collapse shortly after being struck in the chest by a firm projectile or by player contact should be suspected of having SCA from commotio cordis.
- Rapid access to the SCA victim should be facilitated for EMS personnel.

BACKGROUND

Causes of Sudden Cardiac Death in Young Athletes

The underlying cardiac anomaly in young athletes with SCD is usually a structural cardiac abnormality. Hypertrophic cardiomyopathy and coronary artery anomalies represent approximately 25% and 14% of cases, respectively, in the United States.[1] Commotio cordis is caused by a blunt, nonpenetrating blow to the chest that induces a ventricular arrhythmia in an otherwise structurally normal heart and accounts for approximately 20% of SCD in young athletes.[1] A variety of other structural cardiac anomalies account for most of the remaining causes of SCD in athletes. These include conditions such as myocarditis, arrhythmogenic right ventricular dysplasia, Marfan syndrome, valvular heart disease, dilated cardiomyopathy, and atherosclerotic coronary artery disease. In about 2% of sudden deaths in young athletes, postmortem examination fails to identify a structural cardiac cause of death.[1,9,10] These deaths may be due to inherited arrhythmia syndromes and ion channel disorders such as long QT or short QT syndrome, Brugada syndrome, or familial catecholaminergic polymorphic ventricular tachycardia (VT).[1]

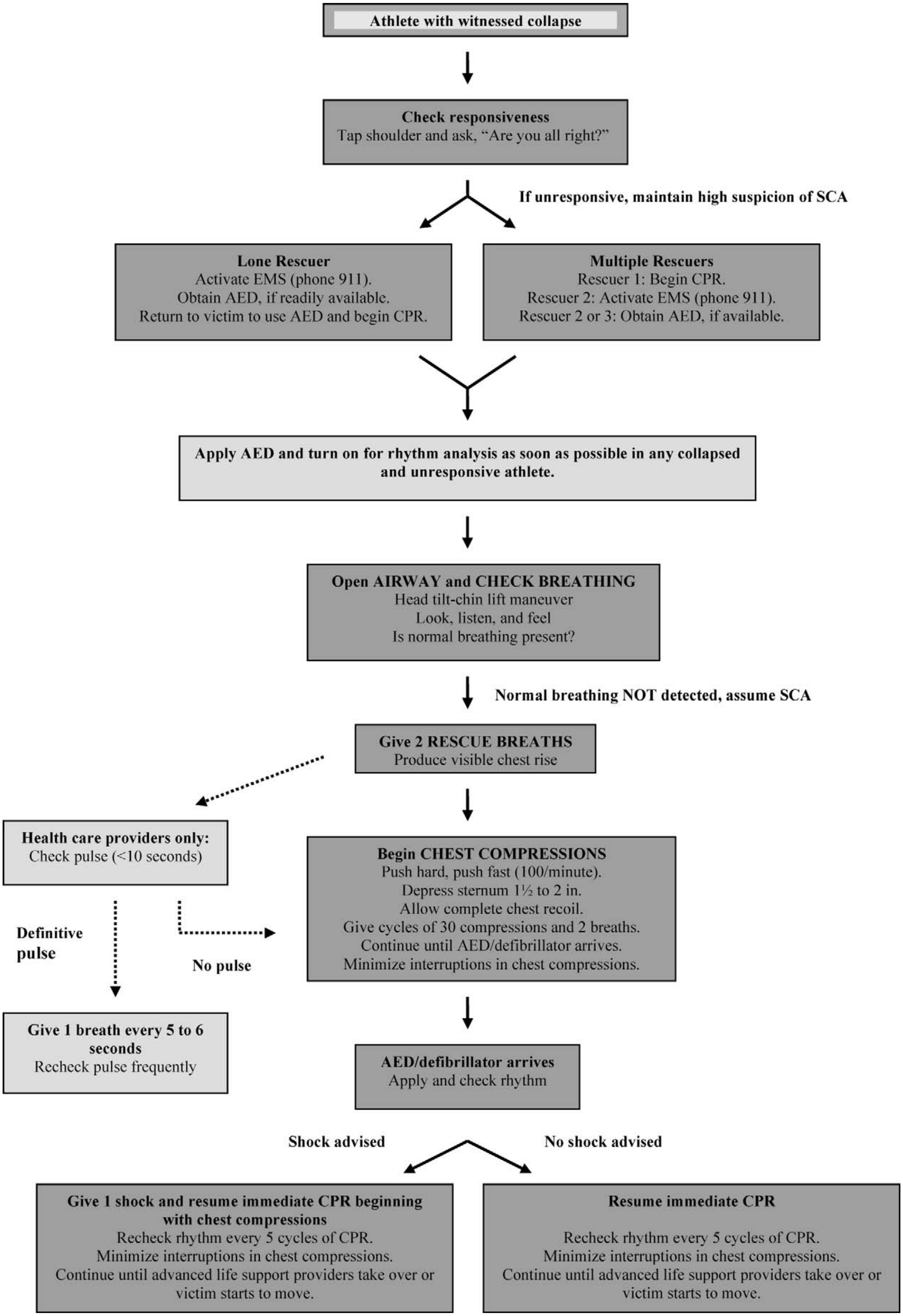

Figure 1. Management of sudden cardiac arrest. SCA indicates sudden cardiac arrest; EMS, emergency medical services; AED, automated external defibrillator; CPR, cardiopulmonary resuscitation.

Vigorous exercise appears to be a trigger for lethal arrhythmias in athletes with occult heart disease.[1] Authors of the best available studies estimate the incidence of SCD in high school athletes to be 1:100 000 to 1:200 000.[2,3] The estimated incidence of SCD in college-aged athletes is slightly higher, ranging from 1:65 000 to 1:69 000.[2,11] However, with no mandatory national reporting or surveillance system, the true incidence of SCA/SCD in athletes is unknown, and prior reports may have underestimated the actual occurrence of SCA/SCD in young athletes. More recently, Maron et al[12] reported on the frequency of sudden death in young competitive athletes and documented approximately 110 deaths per year, or about 1 death every 3 days in the United States.

Limitations of Cardiovascular Screening

A comprehensive discussion of preparticipation cardiovascular screening in athletes is beyond the scope of this task force. However, recognizing the limitations of current preparticipation screening strategies in detecting potentially lethal cardiac abnormalities in young athletes is critical to understanding the need for emergency preparedness and management protocols to prevent SCD. Healthy-appearing athletes may harbor unsuspected cardiovascular disease with the potential to cause SCD.[3] In approximately 55% to 80% of cases of SCD, the athlete is asymptomatic until the cardiac arrest, with death representing the sentinel event of otherwise silent cardiovascular disease.[3,13] The task force supports the AHA recommendations for cardiovascular screening in athletes,[14] as well as the use of a standardized questionnaire to guide examiners, such as the widely accepted monograph *Preparticipation Physical Evaluation,* 3rd edition.[15] At this time, cardiovascular screening of asymptomatic athletes with electrocardiography or echocardiography is not recommended by the AHA in the United States because of the poor sensitivity, high false-positive rate, poor cost-effectiveness, and total cost of implementation.[14,16] Detection of premonitory cardiovascular symptoms such as a history of exertional syncope or chest pain should be improved by the use of standardized history forms and requires a careful and thorough cardiovascular evaluation to exclude underlying heart disease. Improved education for athletes, coaches, and health care professionals is needed regarding symptoms that may precede SCA.

Resuscitation Pathophysiology

About 40% of out-of-hospital cardiac arrest victims demonstrate ventricular fibrillation (VF) on first rhythm analysis.[17] Ventricular fibrillation is characterized by chaotic rapid depolarizations and repolarizations, which cause the heart muscle to quiver and lose its ability to pump blood effectively. It is likely that a larger percentage of victims has VF or rapid VT at the time of collapse, but the rhythm has already deteriorated to asystole before the first rhythm analysis. The probability of successful defibrillation for VF SCA diminishes rapidly over time, with survival rates declining 7% to 10% per minute for every minute that defibrillation is delayed.[18,19] Defibrillation through deployment of electric energy terminates VF and allows the normal cardiac pacemakers to resume firing and produce an effective rhythm if the heart tissue is still viable. Survival after SCA is unlikely once VF has deteriorated to asystole.

Cardiopulmonary resuscitation is important both before and after defibrillation; it provides a small but critical amount of blood flow to the heart and brain and increases the likelihood that defibrillation will restore a normal rhythm in time to prevent neurologic damage. Chest compressions create blood flow by increasing intrathoracic pressure and directly compressing the heart. When bystander CPR is initiated, survival declines only 3% to 4% per minute for every minute defibrillation is delayed.[18,20] Thus, CPR can greatly improve survival from witnessed SCA for any given time interval to defibrillation. Resuming CPR immediately after shock delivery is also critical. Many victims are in pulseless electric activity or asystole for several minutes after defibrillation, and CPR is needed to provide perfusion.[21–23] Unfortunately, bystander CPR is initiated in less than one third of cases of witnessed SCA,[24,25] and, if initiated, more than 40% of chest compressions are of insufficient quality.[26] These deficiencies illustrate the tremendous need for increased public education and training in CPR.

Automated external defibrillators are computerized devices that analyze a victim's rhythm, determine if a shock is needed, charge to an appropriate shock dose, and use audio and visual instructions to guide the rescuer. These devices are easy to use and extremely accurate in recommending a shock only when VF or rapid VT is present.[27] In one study, AEDs were safely and successfully operated by untrained sixth graders almost as quickly as trained paramedics in a simulated resuscitation, with only a 23-second difference in mean time to defibrillation.[28]

Weisfeldt and Becker[29] described a 3-phase model of resuscitation to account for the changes in cardiac arrest pathophysiology that occur with time. The model emphasizes phase-specific treatments based on the time interval from collapse and includes the following: (1) the electric phase, which extends from the time of cardiac arrest to approximately 4 minutes after cardiac arrest; (2) the circulatory phase, from approximately 4 minutes to 10 minutes after cardiac arrest; and (3) the metabolic phase, extending beyond 10 minutes from cardiac arrest.[29] The most critical intervention during the electric phase is early defibrillation, and CPR should be provided until an AED or a manual defibrillator is available.

After 4 to 5 minutes of untreated VF (circulatory phase), some authors suggest that outcomes may be better if shock delivery is preceded by a brief period of CPR to deliver blood to the heart and brain. In animals, outcomes improved for prolonged untreated VF when CPR was initiated before defibrillation compared with immediate defibrillation.[30,31] In some clinical studies,[32,33] survival was improved when CPR was initiated before defibrillation in cases of untreated VF lasting longer than 3 to 5 minutes. Thus, as the duration of cardiac arrest increases, initial chest compressions and oxygen delivery to vital tissues may take priority over defibrillation in some patients, with delay of shock delivery until 1 to 2 minutes of CPR has been completed.[29,32,33]

After approximately 10 minutes of cardiac arrest (metabolic phase), additional tissue injury can occur from global ischemia and with resumption of blood flow from reperfusion injury. Cellular protection from reperfusion injury may be augmented by hypothermia-mediated therapies to attenuate the rapid oxidant burst caused by restoring oxygen and substrates to ischemic tissues, although these therapies are not widely available.[34]

Survival after Sudden Cardiac Arrest

The single greatest factor affecting survival after out-of-hospital cardiac arrest is the time interval from arrest to defibrillation.[19] Survival after out-of-hospital cardiac arrest has been greatly improved by lay rescuer and public access defibrillation programs designed to shorten the time interval from SCA to shock delivery. These programs train lay rescuers and first responders in CPR and AED use and place AEDs in high-risk public locations for SCA. Studies of rapid defibrillation using AEDs with nontraditional first responders and trained or untrained laypersons in high-risk locations such as casinos, airlines, and airports have demonstrated survival rates from 41% to 74% if bystander CPR is provided and defibrillation occurs within 3 to 5 minutes of collapse.[11,35–43] Key elements to the success of these programs include training of motivated responders in CPR and AED use, a structured and practiced response, and short response times.

Although SCA is a rare but catastrophic event in young athletes, it is more common in an older population, with an estimated annual frequency of 1 in 1000 persons aged 35 years or older in the United States.[19] The presence of AEDs in schools and institutions provides a means of early defibrillation, not only for young athletes but also for other individuals on campus who may experience an unexpected cardiac arrest. Jones et al[44] found a 2.1% annual probability of SCA on high school campuses, mainly due to SCA among older school employees, spectators, and visitors on campus. At National Collegiate Athletic Association Division I universities, Drezner et al[11] found that older nonstudents, such as spectators, coaches, and officials, accounted for 77% of SCA cases at collegiate sporting venues and that placement of AEDs at these venues provided a significant survival benefit for older nonstudents, with a 54% overall immediate resuscitation rate.

Limited research is available regarding the survival rate in young athletes after SCA. Initially, authors[11,45] investigating AED use in the college athletic setting did not identify a survival benefit in a small number of collegiate athletes with SCA. Drezner and Rogers[46] later investigated the timing and details of resuscitation in 9 collegiate athletes with SCA. All 9 athletes had a witnessed arrest, and most received immediate assessment by an athletic trainer skilled in basic life support and CPR. Seven athletes received defibrillation, with an average time from cardiac arrest to defibrillation of 3.1 minutes. Despite a witnessed collapse, timely CPR, and prompt defibrillation in most cases, only 1 of 9 (11%) athletes in this cohort survived—an unexpected finding given the young age, otherwise good health and physical conditioning of the athletes, and early reported defibrillation.[46] Other groups[47,48] have also found the survival rate after SCA in young athletes to be lower than expected. Maron et al[47] analyzed 128 cases from the United States Commotio Cordis Registry and found an overall survival rate of 16%. Cardiopulmonary resuscitation was performed in 106 cases and defibrillation in 41 cases, with 19 of 41 (46%) of the individuals who received defibrillation surviving.[47] Successful resuscitations using AEDs have been reported in the public media and in case reports[49,50] and demonstrate the lifesaving potential of public access defibrillation on the athletic field. Overall, the available studies on SCA in young athletes raise concern regarding the low survival rate and highlight the need for improved and more uniform resuscitation strategies for SCA in young athletes.

Factors Affecting Survival in Young Athletes

Several factors may contribute to a lower resuscitation rate in young athletes. Structural heart disease is consistently found in most cases of SCD in young athletes. Ventricular arrhythmias in the presence of structural heart disease, especially cardiomyopathies, may be more resistant to even short delays in defibrillation than SCA in the setting of a structurally normal heart. Berger et al[51] documented 18 episodes of unexpected SCA in previously asymptomatic children and adolescents aged 12 to 25 years in Wisconsin from 1999 to 2003. Survival was poor in cases of structural heart disease: 1 of 9 survived with hypertrophic cardiomyopathy, 1 of 3 survived with an anomalous origin of the left coronary artery, and 0 of 1 survived with arrhythmogenic right ventricular dysplasia. In contrast, 5 of 6 patients with long QT syndrome and no structural heart disease survived.[51]

In patients with hypertrophic cardiomyopathy, immediate defibrillation within 10 seconds using implantable cardioverter defibrillators is almost always effective in terminating potentially lethal ventricular arrhythmias.[52,53] However, in athletes with hypertrophic cardiomyopathy, even a brief delay in defibrillation may cause a steep decline in survival.[46] In commotio cordis or primary electric disturbances, survival rates more closely follow the traditional decline of 7% to 10% per minute for every minute defibrillation is delayed.[54] In an animal model using juvenile swine, Link et al[54] demonstrated that successful resuscitation after commotio cordis was possible and highly dependent on the time interval to defibrillation. After induction of VF via blunt chest impact using a baseball, defibrillation was performed after 1, 2, 4, and 6 minutes, with survival rates of 100%, 92%, 46%, and 25%, respectively.[54]

Other factors may also contribute to the apparently lower survival rate in young athletes after SCA. The overall incidence of SCA in athletes is relatively rare, and delayed recognition of cardiac arrest by first responders may lead to delay in initiating CPR and defibrillation. Rescuers may mistake agonal or occasional gasping for normal breathing or falsely identify the presence of a pulse. Sudden cardiac arrest may also be misdiagnosed as a seizure because of the presence of myoclonic activity after collapse. Thus, a high suspicion of SCA must be maintained for any collapsed and unresponsive athlete. Other potential factors affecting survival in young athletes include the duration and intensity of exercise before arrest, higher catecholamine levels produced during exercise, potential for oxygen debt and ischemia from exercise, metabolic and physiologic adaptations during exercise, and vascular changes such as decreased systemic vascular resistance.

Key changes from the 2005 AHA guidelines for CPR and ECC may positively affect survival in young athletes.[4] The new guidelines recommend that one attempted defibrillation be followed by immediate CPR, beginning with chest compressions.[7] The initiation of immediate CPR after defibrillation creates blood flow until the heart can generate adequate contractions for perfusion. This is particularly important when defibrillation is followed by pulseless electric activity or recurrent VF requiring multiple shocks. Of 9 cases reported in collegiate athletes, pulseless electric activity followed defibrillation in 2 patients and multiple shocks were deployed in 4.[46] Thus, incorporating changes in CPR protocol and assisting perfusion in the early moments after defibrillation may have a significant effect on survival by limiting interruptions in blood flow and the need for repeat defibrillation.

EMERGENCY PREPAREDNESS

The "Chain of Survival"

Public access to defibrillators and first-responder AED programs improve survival from SCA by increasing the likelihood that SCA victims will receive bystander CPR and early defibrillation. These programs require an organized and practiced response with rescuers trained and equipped to recognize SCA, activate the EMS system, provide CPR, and use an AED.[36] The AHA describes 4 links in a ''chain of survival'' to emphasize the time-sensitive interventions for victims of SCA[19]:

- Early recognition of the emergency and activation of the EMS or local emergency response system: ''phone 911''
- Early bystander CPR: immediate CPR can double or triple the victim's chance of survival from VF SCA[18,20]
- Early delivery of a shock with a defibrillator: CPR plus defibrillation within 3 to 5 minutes of collapse can produce survival rates as high as 49% to 75%[35,37–39,42,55]
- Early advanced life support followed by postresuscitation care delivered by health care providers

Establishing an Emergency Action Plan

Every institution or organization that sponsors athletic activities should have a written EAP.[6] The EAP should be specific to each athletic venue and encompass emergency communication, personnel, equipment, and transportation. Core elements to an effective EAP include the following: (1) establishing an efficient communication system, (2) training of likely first responders in CPR and AED use, (3) acquiring the necessary emergency equipment, (4) providing a coordinated and practiced response plan, and (5) ensuring access to early defibrillation (see Table for an EAP checklist). The plan should identify the person and/or group responsible for documentation of personnel training, equipment maintenance, actions taken during the emergency, and evaluation of the emergency response.[6]

The EAP should be developed by school or institutional personnel in consultation with local EMS personnel, school public safety officials, on-site first responders, and school administrators. It is important to designate an EAP coordinator, usually an athletic trainer, team physician, nurse, or sports administrator. The EAP should be reviewed at least annually with athletic trainers, team and consulting physicians, athletic training students, school and institutional safety personnel, administrators, and coaches.[6] The EAP should be coordinated with the local EMS agency and integrated into the local EMS system. The local EMS agency is encouraged to conduct a ''preincident'' survey to identify any problems or poorly accessible areas for EMS personnel.[5]

The National Collegiate Athletic Association recommends that all institution-sponsored collegiate practices or competitions, as well as out-of-season practices and skills sessions, have an EAP. These plans should include the presence of a person qualified to deliver emergency care; planned access to early defibrillation; and planned access, communication, and transport to a medical facility.[56]

Access to Early Defibrillation

Access to early defibrillation is critical in the management of SCA. In developing an EAP, several time-sensitive intervals must be considered to increase the probability of a successful resuscitation for an SCA victim: the time from collapse to EMS activation, the time from collapse to initiation of CPR, the time from collapse to delivery of the first shock, and the time from collapse to arrival of EMS personnel at the victim's side. The EAP should target a collapse-to-EMS call time and CPR initiation of less than 1 minute.[5,19] A second target goal of less than 3 to 5 minutes from time of collapse to first shock is strongly recommended.

The AHA recommends implementation of an AED program in any school that meets one of the following criteria: (1) the frequency of cardiac arrest is such that there is a reasonable probability of AED use within 5 years of rescuer training and AED placement; (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 congenital heart disease); or (3) an EMS call-to-shock interval of less than 5 minutes cannot be reliably achieved with a conventional EMS system, and a collapse-to-shock interval of less than 5 minutes can be reliably achieved (in more than 90% of cases) by training and equipping laypersons to function as first responders by recognizing SCA, activating the EMS system, starting CPR, and using an AED.[5,19]

Schools and institutions sponsoring athletic programs must determine if this target time interval of less than 5 minutes from collapse to defibrillation can be reliably achieved with the conventional EMS system or if an AED program is required to achieve early defibrillation. Studies suggest that, for most EMS systems, the time interval between activating the EMS and arrival of EMS personnel at the victim's side is usually more than 5 minutes (mean = 6.1 minutes).[57] In some communities, the time interval from EMS call to EMS arrival may be 7 to 8 minutes or longer.[43,58] Thus, achieving early defibrillation after SCA in athletes is largely dependent on the prompt availability of AEDs for responders. In high school and college athletic programs, coaches, officials, athletic trainers, and other sports medicine professionals are in a unique position to act as first responders to SCA during organized training and competition. Training in CPR and on-site AED programs are likely to be the only means of achieving early defibrillation and improving survival from SCA in athletes.

Emergency Communication

A rapid system for communication must be in place linking all athletic facilities, practice fields, and other parts of the campus to the EMS system. When bystanders recognize an emergency and activate the EMS system, they ensure that basic and advanced life support providers are dispatched to the site of the emergency. The time required for EMS response to each sporting venue should be estimated, and a plan must be in place to efficiently direct EMS personnel to the location.[5] The communication network can be developed through existing telephones, cellular telephones, walkie-talkies, alarms, or an intercom system that links a rescuer directly to the EMS or to a central location responsible for contacting the EMS and activating on-site responders. Establishing an accessible communication system will prevent critical delays caused by a rescuer running from a distant athletic facility or practice field

Emergency Action Plan Checklist*

The following elements are recommended in the development of a comprehensive emergency action plan (EAP) for sudden cardiac arrest (SCA) in athletics. Actual requirements and implementation may vary depending on the location, school, or institution.

I. **Development of an Emergency Action Plan**

- ☐ Establish a written EAP for each individual athletic venue.
- ☐ Coordinate the EAP with the local EMS agency, campus public safety officials, on-site first responders, administrators, athletic trainers, school nurses, and team and consulting physicians.
- ☐ Integrate the EAP into the local EMS response.
- ☐ Determine the venue-specific access to early defibrillation (<3 to 5 minutes from collapse to first shock recommended).

II. **Emergency Communication**

- ☐ Establish an efficient communication system to activate EMS at each athletic venue.
- ☐ Establish a communication system to alert on-site responders to the emergency and its location.
- ☐ Post the EAP at every venue and near telephones, including the role of the first responder, a listing of emergency numbers, and street address and directions to guide the EMS personnel.

III. **Emergency Personnel**

- ☐ Designate an EAP coordinator.
- ☐ Identify who will be responsible and trained to respond to a SCA (likely first responders include athletic trainers, coaches, school nurses, and team physicians).
- ☐ Train targeted responders in CPR and AED use.
- ☐ Determine who is responsible for personnel training and establish a means of documentation.
- ☐ Identify the medical coordinator for on-site AED programs.

IV. **Emergency Equipment**

- ☐ Use on-site or centrally located AED(s) if the collapse-to-shock time interval for conventional EMS is estimated to be >5 minutes.
- ☐ Notify EMS dispatch centers and agencies of the specific type of AED and the exact location of the AED on school grounds.
- ☐ Acquire pocket mask or barrier-shield device for rescue breathing.
- ☐ Acquire AED supplies (scissors, razor, and towel), and consider an extra set of AED pads.
- ☐ Consider bag-valve masks, oxygen delivery systems, oral and nasopharyngeal airways, and advanced airways (eg, endotracheal tube, Combitube, or laryngeal mask airway).
- ☐ Consider emergency cardiac medications (eg, aspirin, nitroglycerin).
- ☐ Determine who is responsible for checking equipment readiness and how often and establish a means of documentation.

V. **Emergency Transportation**

- ☐ Determine transportation route for ambulances to enter and exit each venue.
- ☐ Facilitate access to SCA victim for arriving EMS personnel.
- ☐ Consider on-site ambulance coverage for high-risk events.
- ☐ Identify the receiving medical facility equipped in advanced cardiac care.
- ☐ Ensure that medical coverage is still provided at the athletic event if on-site medical staff accompany the athlete to the hospital.

VI. **Practice and Review of Emergency Action Plan**

- ☐ Rehearse the EAP at least annually with athletic trainers, athletic training students, team and consulting physicians, school nurses, coaches, campus public safety officials, and other targeted responders.
- ☐ Consider mock SCA scenarios.
- ☐ Establish an evaluation system for the EAP rehearsal, and modify the EAP if needed.

VII. **Postevent Catastrophic Incident Guidelines**

- ☐ Establish a contact list of individuals to be notified in case of a catastrophic event.
- ☐ Determine the procedures for release of information, aftercare services, and the postevent evaluation process.
- ☐ Identify local crisis services and counselors.
- ☐ Consider pre-established incident report forms to be completed by all responders and the method for system improvement.

*EMS indicates emergency medical services; CPR, cardiopulmonary resuscitation; and AED, automated external defibrillator.

to activate the EMS system. The communications system should be checked before each practice or competition to ensure proper working order, and a back-up communication plan should be in effect in case the primary communication system fails.

The EAP should be posted at every sporting venue and near appropriate telephones, with the role of the first responder clearly demarcated. A listing of emergency numbers should be available, as well as the street address of the venue and specific directions (eg, cross streets, landmarks) to guide EMS personnel. When activating the EMS system (calling 911), the caller should alert the EMS to the number and condition of persons injured, if an SCA is suspected, and the first aid treatment rendered. Involving representatives of the EMS system in the initial communications planning before any incidents will improve the onsite transfer of care once EMS personnel arrive on the scene.

Emergency Personnel

The first person to respond to a medical emergency on the field of play will vary widely and may be a coach, official, student, teammate, teacher, school nurse, athletic trainer, physician, or emergency medical technician. All potential rescuers should be familiar and, ideally, trained with the EAP to ensure an effective and coordinated response to an emergency situation. Each institution or organization with a formal athletic program needs to identify who will be responsible and trained to respond to an SCA. The National Collegiate Athletic Association recommends that all athletics personnel associated with practices, competitions, skills instruction, and strength and conditioning be certified in CPR, first aid, and the prevention of disease transmision.[56] For secondary schools, the AHA recommends training of the school nurse and physician, athletic trainer, and several faculty members in the provision of first aid and CPR and that a sufficient number of faculty, staff, and/or students be trained to ensure that a trained rescuer can respond to an SCA within 90 seconds.[5] Because an athletic trainer, physician, or school nurse is not universally present at all extracurricular sporting activities, coaches for every team should receive certified training in CPR and AED use to ensure the presence of a trained rescuer.

Emergency Equipment

All necessary emergency equipment should be at the site or quickly accessible, and personnel must be trained in advance to use it properly. Resuscitation equipment should be placed in a central location that is highly visible and near a telephone or other means of activating the EMS system. All school staff should be instructed on the location of emergency equipment. For large schools or those with distant or multiple athletic facilities, duplicate equipment may be needed. Emergency equipment should not be placed in a locked box, cabinet, or room, which could delay emergency care. Mounted cabinets with audible alarms that sound when the cabinet door is opened may decrease the theft or vandalism risk.[5]

Basic resuscitation equipment for management of SCA should include a pocket mask or barrier-shield device for rescue breathing, an AED for early defibrillation, and AED application supplies (heavy-duty scissors to remove clothing and expose the chest, a towel to dry the chest, and a razor to shave chest hair). Aluminum chlorhydrate (antiperspirant) spray may help the AED leads stick to sweaty skin, and an extra set of AED pads should be considered in case of misapplication or inadvertent damage.

For high schools and colleges that have physicians and ACLS-certified responders on-site, the acquisition of advanced resuscitation equipment for the management of SCA should be considered based on the skills of the designated responders. Advanced resuscitation equipment may include bag-valve masks, oxygen delivery systems, oral and nasopharyngeal airways, advanced airways (eg, endotracheal tube, Combitube [Tyco Healthcare Nellcor, Pleasanton, CA], or laryngeal mask airway), and emergency cardiac medications. The ACLS-certified personnel should have nitroglycerin and aspirin available on-site to use for chest pain without cardiac arrest. The equipment and medications should be assembled in a code bag and stored in an easily accessible central location or at each athletic venue.

If an AED program is implemented, it should be part of the written EAP. The EMS centers should be notified of the specific type of AED and the exact location of the AED on school grounds. If a rescuer is unfamiliar with the school or where an AED is located, he or she can receive instructions from the EMS dispatcher to find and use the AED.[5] All AED programs should include medical or health care provider oversight, appropriate training of anticipated rescuers in CPR and AED use, coordination with the EMS system, appropriate device maintenance, and an ongoing quality improvement program.[5]

If possible, emergency information about the student-athletes, including relevant medical history and contact information, should be accessible to medical personnel at home sporting events and while traveling in case of an emergency.

Emergency Transportation

The EAP should delineate the life support transportation an athlete with SCA will access. In life-threatening emergencies, an athlete should be transported by the EMS personnel to the most appropriate receiving facility that is staffed and equipped to deliver optimal emergency care. Emphasis should be placed on having an ambulance on-site at high-risk events. The EMS response time should be factored in when determining on-site ambulance coverage. Consideration should be given to the level of transportation service available (eg, basic life support, advanced life support) and the equipment and training level of the personnel who staff the ambulance.[6] If an ambulance is on-site, a location should be designated that allows rapid access to enter and exit the venue. A dedicated staff person should be assigned to each event and be familiar with the directions and access points for arriving EMS personnel to specific athletic facilities on campus. Each site should post written directions to read to the EMS response dispatcher. If air-medical transport may be needed, the global positioning satellite coordinates should also be listed.

Practice and Review of the Emergency Action Plan

The EAP should be reviewed and practiced at least annually with athletic trainers, team and consulting physicians, athletic training students, school and institutional safety personnel, administrators, coaches, and other designated first responders.[6] More frequent practice sessions will improve the effectiveness, efficiency, and organization of the response team, and any modifications to the EAP based on practice trials should be documented.[59] A mock SCA scenario can be organized using actors or manikins to simulate SCA victims. Evaluation of each emergency response rehearsal should document the time from collapse to EMS activation, the time from collapse to initiation of CPR, the time from collapse to delivery of first shock if an AED is available, and the time from collapse to arrival of EMS personnel at the victim's side.[5]

Postevent Catastrophic Incident Guidelines

The EAP should include a postevent plan outlining the procedures for release of information; aftercare services for responders, teammates, coaches, and families; and the postevent evaluation process. A list of administrative and legal personnel from the school or institution to be contacted after a catastrophic event should be readily accessible in the EAP, and the methods for data collection, reporting, and incident assessment and review should be defined in the plan. Local crisis services and counselors to assist students, teammates, families, and rescuers after a catastrophic event should be defined and available. The postevent evaluation process is critical both to document the details of the event and to allow system improvement. Pre-established incident report forms to be completed by all responders should be considered to facilitate a summary report with recommendations for site management and modifications to the existing EAP if needed. Feedback, particularly of a positive nature, should also be provided to responders.

Emergency Preparedness: Where Are We Now?

Studies demonstrating that AEDs placed at public locations can substantially improve survival from SCA have accelerated a growing national trend to broadly implement AED programs at public sporting venues and selected athletic facilities. In 2003, 91% of National Collegiate Athletic Association Division I institutions already had AEDs, with a median of 4 (range = 1 to 30) at each of these institutions.[11] The most common location for the AEDs was the athletic training room (82%), followed by the basketball arena (43%), campus police station (40%), football stadium (27%), baseball or softball field (21%), and recreation or fitness facility (21%).[11] A range of 25% to 54% of high schools had at least one AED on school grounds.[44,60,61] Common locations for AEDs in high schools include the school athletic training room, basketball facility or gymnasium, nurse's office, and main lobby.[61,62]

In the university setting, resources to purchase AEDs have largely come from the athletic department budget. In contrast, financial resources at high schools are more limited, and AED acquisition has been primarily funded through donations. In Washington State, 60% of high schools with AEDs acquired them through donated funds, and only 38% were purchased by the school, school district, or athletic department.[61] In the greater Boston area, after a single AED was donated to 35 schools, 25 schools purchased additional AEDs using a combination of donated funds (21), grants (11), and school budget funds (8).[62]

School nurses, athletic trainers, teachers, and coaches may be called on to provide emergency care during school hours and extracurricular sporting activities. However, emergency training for many of these potential first responders varies widely. A survey of school nurses in New Mexico documented that few school nurses and staff had any emergency training.[63] In 3 midwestern states, one third of teachers surveyed had no first aid training, and 40% had never completed a course in CPR.[64] In Washington State high schools with AEDs, 78% of coaches, 72% of administrators, 70% of school nurses, and 48% of teachers received formal AED training.[61]

Although more schools are placing AEDs on campus grounds, significant deficiencies in emergency planning and coordination still exist. In Washington State, only 25% of high schools coordinated the implementation of AEDs with any outside medical agency, and only 6% of schools coordinated with the local EMS system.[61] In contrast, studies involving AED implementation as part of a more comprehensive emergency plan have demonstrated more success. In the greater Boston area, 35 high schools were given a single donated AED and educated to develop a training protocol for appropriate staff and to assess the need for purchase of additional AEDs.[62] In this study, 90% of schools trained their faculty, 76% trained their staff and custodial workers, 71% trained their athletic trainers, and 48% trained some or all of their student body in AED use.[62] Over a 2-year study period, an AED was successfully used twice for SCA in a football referee and a teacher. Every school participating in the study considered participation in the AED program to be worthwhile.[62] Similarly, in Wisconsin, Project ADAM has assisted 143 of 400 public high schools in implementing an AED program as part of a comprehensive EAP. The goals of Project ADAM include educating faculty, staff, parents, students, and health care professionals about SCA in children and adolescents and advocating for teaching CPR with AED instruction to all high school students before graduation.[51]

Legislation to require AEDs in schools is also growing but is not uniformly funded. New York and Illinois have already passed legislative mandates for AEDs in public schools, and California, Delaware, Florida, Georgia, Maine, Massachusetts, New Jersey, Nevada, Pennsylvania, Rhode Island, and Virginia have pending legislation.[65] However, unfunded mandates to establish AED programs in schools often lack the necessary emergency planning, coordination, and training that are essential to a successful program.

Obstacles to Implementing Automated External Defibrillators

Although the prevalence of AEDs in schools and at public athletic venues is increasing, budgetary constraints remain an obstacle to initiating public access defibrillation programs. Policymakers must determine which sites warrant an AED and which must go without. Although uncertainty on where to place the AED (57%) and medical-legal concerns (48%) were also reported as common obstacles, National Collegiate Athletic Association Division I head athletic trainers at institutions without AEDs cited financial resources (70%) as the primary obstacle to acquiring AEDs.[11] In the high school setting, financial resources are the critical barrier to implementing an AED program. In Washington State, 65% of high schools without AEDs identified monetary resources as the main obstacle to acquiring AEDs.[61] In the greater Boston area, 93% of schools given a single AED reported lack of funding as the reason for not purchasing additional AEDs.[62]

The task force recognizes that budgets for many schools are already challenged, and more research is needed to explore the development of funding programs to assist schools with limited resources. Until the cost of AEDs further declines or government funding is allocated toward emergency preparedness in schools, administrators and those responsible for emergency planning must work within their school districts to elicit financial support from the local community, parenting and fundraising groups, and applicable state and federal grants to fund AED programs. However, the goal is not just to acquire the AED but to do so as part of a comprehensive educational and emergency action plan. As demonstrated by Project ADAM and the greater Boston area program, donations can fund both the equipment and educational materials for school administrators and lead to the development of a successful program in participating schools.[51,62]

The current cost (in 2006) of purchasing a single AED is approximately $1500, and in many communities, local EMS personnel will provide emergency planning consultation at no cost. The additional cost of CPR and AED training for targeted responders must also be considered. However, with the commitment and dedication of school administrators, parents, local businesses, and health care leaders, implementation of an AED program in schools is an obtainable goal.

MANAGEMENT OF SUDDEN CARDIAC ARREST

2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

In December 2005, the AHA released updated guidelines on CPR and ECC.[4] The guidelines are based on the evidence evaluation from the 2005 International Consensus Conference on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations.[66] The AHA adult CPR guidelines apply to any child older than 8 years.[67] Thus, for the purposes of this statement, the protocols discussed are intended for youth and adult athletes greater than 8 years old. The most significant change in these guidelines is a stronger emphasis on chest compressions, increasing the number of chest compressions per minute and reducing the interruptions in chest compressions during CPR. Key changes to the guidelines are listed in the following:

- Elimination of lay rescuer assessment of circulation
- Recommendation of a universal compression-to-ventilation ratio of 30:2 for single rescuers and for all SCA victims in this age group
- Chest compressions (‘‘push hard, push fast’’) should be at a rate of 100 compressions per minute, allowing complete chest recoil and minimizing interruptions in chest compressions
- CPR should resume immediately after initial shock delivery, beginning with chest compressions
- Rescuers should not check the rhythm or pulse after shock delivery until 5 cycles (or about 2 minutes) of CPR have been performed
- Recommendations that EMS providers consider 5 cycles (or about 2 minutes) of CPR before defibrillation for unwitnessed arrest, particularly if the suspected time from collapse to arrival at the scene is more than 4 to 5 minutes

The new recommendations call for only one shock, followed immediately by chest compressions, and represent a major change from traditional treatment protocols involving a sequence of 3 stacked shocks in the treatment of VF and rapid VT. This change is based on the high success rate of a single defibrillation, with first-shock efficacy for VF by current biphasic defibrillators reportedly higher than 90%.[8] In addition, if the first shock fails, CPR may improve oxygen and substrate delivery to the myocardium, making subsequent shocks more likely to be successful. Interruptions in chest compressions for rhythm analysis are associated with lower survival rates and a decreased probability of conversion of VF to another rhythm.[68,69]

Rhythm analysis for a 3-shock sequence in older AEDs results in delays up to 37 seconds between delivery of the first shock and delivery of the first postshock chest compression.[70] The new AHA guidelines necessitate reprogramming of all previously purchased AEDs, as they are programmed with older ‘‘stacked shocks’’ protocols. Institutions that have AEDs with older protocols should contact their vendors to reprogram the AED. If possible, AED units should also comply with the new AHA recommendations for first shock energy levels, either 360 J for monophasic waveforms or the individual manufacturer’s recommendations for biphasic waveforms.[8]

The Collapsed Athlete

Fortunately, most athletes who collapse during or after exercise will not be in SCA. The differential diagnosis of nontraumatic exercise-related syncope includes but is not limited to SCA, exertional heat stroke, heat exhaustion, hyponatremia, hypoglycemia, exercise-associated collapse, neurocardiogenic syncope, seizures, pulmonary embolus, cardiac arrhythmias, valvular disorders, coronary artery disease, cardiomyopathies, ion channel disorders, and other structural cardiac diseases. A collapsed athlete who is also unresponsive should be treated as a potential cardiac arrest until either spontaneous breathing and a pulse are documented or the cardiac rhythm is analyzed. If SCA is ruled out but the athlete remains unresponsive, further immediate evaluation to determine the cause of collapse is needed, as other emergent medical interventions may still be required.

Exercise-related syncope involves a transient loss of consciousness and postural tone during or immediately after exercise. Exercise-associated collapse describes athletes who are unable to stand or walk unaided as a result of lightheadedness, dizziness, or syncope immediately after exercise.[71] Exertional syncope without SCA in young adults is usually benign but always requires investigation because it can be an indication of a more serious cardiac disorder and the only symptom that precedes SCD.[3,13] Syncope that occurs during exercise tends to be more ominous than syncope occurring after exercise.[72] Young and otherwise healthy adults who collapse while exercising have a greater probability of an organic cardiac abnormality, such as hypertrophic cardiomyopathy or anomalous coronary artery origin, than do athletes with postexertional or nonexertional syncope.[3,13] The investigation of exercise-related syncope should specifically exclude known pathologic diagnoses before a complete return to activity is permitted.

Recognition of Sudden Cardiac Arrest

Prompt identification of SCA is critical in the management of this life-threatening emergency. Any collapsed athlete who is unresponsive requires an immediate assessment for SCA. Although SCA is relatively uncommon in the athletic setting, on-site responders must maintain a high index of suspicion, as unrecognized SCA in a collapsed athlete causes critical delays in CPR and defibrillation. Resuscitation is often delayed because the victim is reported to have signs of life.[73] Sudden cardiac arrest can be misdiagnosed as a seizure in the form of involuntary myoclonic jerks; seizure-like activity is present in approximately 20% of patients with cardiogenic collapse.[74] Seizure-like activity has also been reported in 3 of 10 athletes with SCA.[75] To avoid life-threatening delays in resuscitation, brief seizure-like activity should be assumed to be due to SCA and initial management steps for SCA taken immediately until a noncardiac cause of the collapse is clearly determined.

Other barriers to recognizing SCA in athletes include inaccurate rescuer assessment of pulse or respirations. Occasional or agonal gasping can occur in the first minutes after SCA and is often misinterpreted as normal breathing, especially by lay responders.[76] Occasional gasping does not represent adequate breathing and, if present, should not prevent rescuers from initiating CPR. Assessment of signs of circulation and the presence of a pulse by lay rescuers and health care professionals can also be inaccurate. Lay rescuers fail to recognize the absence of a pulse in 10% of pulseless victims and fail to detect a pulse in 40% of victims with a pulse.[7,77] The updated AHA CPR guidelines eliminate lay rescuer assessment of pulse and recommend that cardiac arrest be assumed if the unresponsive victim does not demonstrate normal breathing.[4] Health care providers may also have difficulty accurately determining if a pulse is present or take too long in their assessment. Health care providers should take no longer than 10 seconds to check for a pulse and should proceed with chest compressions if a pulse is not definitively detected.[7] Sports medicine professionals and other potential first responders to an SCA in athletes must understand these potential obstacles to recognizing SCA, as inaccurate initial assessment of SCA results in critical delays or even failure to activate the EMS system, initiate CPR, and provide early defibrillation.

Management of Sudden Cardiac Arrest: Witnessed Collapse

Sudden cardiac arrest in the athletic setting is likely to be witnessed by a bystander, coach, official, teammate, or athletic trainer. When more than one person is present at the scene, several management steps can be taken simultaneously (Figure). Management of a collapsed athlete begins with an initial assessment of responsiveness. The rescuer should check the victim for a response by tapping the victim on the shoulder and asking, ''Are you all right?''[7] If the athlete is unresponsive, one or more trained rescuers should begin CPR while another bystander activates the EMS system by calling 911 or the local emergency number and retrieves the AED if available. When contacting the EMS system, the rescuer should be prepared to provide the exact location of the emergency and a brief account of what happened and the initial care given. In the case of a lone rescuer and a witnessed arrest, the rescuer should first activate the EMS system by calling 911 or the local emergency number, obtain an AED if readily available, and return to the victim to initiate CPR and AED use. If an on-site response system is activated, the central communication center is responsible for contacting the EMS and activating on-site responders to facilitate transport of an AED to the victim.

An AED should be applied to the victim as soon as possible and turned on for rhythm analysis and defibrillation if indicated. If an AED is not immediately available, the rescuer should open the airway by using the head tilt–chin lift maneuver and then ''look, listen, and feel'' for breathing. If a cervical spine injury is suspected, the modified jaw thrust maneuver is recommended to open the airway. The presence of normal breathing should distinguish the victim who has collapsed but does not require CPR. Agonal or occasional gasping should not be mistaken for normal breathing and should be recognized as a sign of SCA.[67] If a collapsed athlete is determined not to be in SCA and does not become normally responsive, the athlete should be continually reassessed for signs of, or progression to, SCA. The athlete may require other medical interventions depending on the specific cause of collapse.

If normal breathing is not detected within 10 seconds, 2 rescue breaths should be given, followed by chest compressions.[7] Lay rescuers (coaches, officials, and other bystanders) should not assess the athlete for a pulse or signs of circulation. Health care providers (athletic trainers, school nurses, emergency medical technicians, and physicians) should deliver 2 rescue breaths and may consider checking for a pulse. If the health care provider does not definitively feel a pulse within 10 seconds, CPR should be initiated. Rescue breaths are provided by pinching the victim's nose, creating an airtight mouth-to-mouth seal, and giving one breath over 1 second that produces a visible chest rise. If the victim's chest does not rise with the first rescue breath, the head tilt–chin lift maneuver should be repeated before the second breath in an attempt to open the airway. If the rescuer is unable or unwilling to give rescue breaths, then chest compressions should be initiated.

Effective chest compressions in adults are performed by compressing the lower half of the sternum, using the heels of the hands, and should depress the chest a depth of 3.8 to 5.1 cm; complete chest recoil permits venous return between compressions. Rescuers should ''push hard and push fast.''[67] The CPR should be performed using the universal compression-to-ventilation ratio of 30:2 at a rate of 100 compressions per minute. When multiple rescuers are present, they should rotate the compressor role about every 2 minutes or earlier if fatigue develops.

An AED or a manual defibrillator should be applied for rhythm analysis as soon as it arrives. All interruptions in chest compressions for analyzing the rhythm or delivering a shock should be minimized. With 2 or more rescuers, CPR can be continued while attaching the AED leads. Defibrillation is more likely to be successful with a shorter time between chest compressions and delivery of a shock.[78,79] If VF or rapid VT is detected, the AED will instruct the rescuer to deploy a shock. The rescuer should deliver 1 shock and then immediately resume CPR, beginning with chest compressions. When 2 rescuers are present, the rescuer operating the AED should be prepared to deliver a shock as soon as the compressor removes his or her hands from the chest and all rescuers are clear of contact with the victim. The rescuer should not delay resuming chest compressions to allow for repeat rhythm analysis, and CPR should be continued for 5 cycles or about 2 minutes before rechecking the rhythm or until the victim becomes responsive. If no shock is advised after rhythm analysis, CPR should be immediately resumed and continued for 5 cycles before rechecking the rhythm or until advanced life support measures are available.

Some advanced airway devices such as an endotracheal tube, esophageal-tracheal Combitube, or laryngeal mask airway can be used by health care professionals with sufficient training and experience. Once an advanced airway is in place, pauses or interruptions in chest compressions for ventilation are no longer necessary. Rescuers should deliver 100 compressions per minute and 8 to 10 breaths per minute continuously.[67] If available, bag-mask ventilation can also be performed by health care providers with the use of supplementary oxygen at a minimum flow rate of 10 to 12 L/min.[7]

Management of Sudden Cardiac Arrest: Unwitnessed Collapse

If an athlete is found collapsed and unresponsive and the time lapse from onset of SCA is unknown, rescuers may consider 5 cycles or 2 minutes of CPR before checking the rhythm and attempting defibrillation.[7,8] After a prolonged cardiac arrest, a brief period of CPR can deliver oxygen and energy substrates, perhaps increasing the likelihood that a perfusing rhythm will return if defibrillation is possible.

SPECIAL CIRCUMSTANCES

Cervical Spine Injury

Any athlete suspected of having a cervical spine injury should not be moved, and the cervical spine should be immobilized. Unconscious athletes in collision sports are presumed to have unstable spine injuries until proved otherwise. High cervical spine injuries can cause apnea, ineffective breathing patterns, and paralysis of the phrenic nerve. Although rare, prolonged hypoxemia can lead to cardiac arrest. Protective equipment used in collision sports such as football and hockey makes the management of SCA in a spine-injured athlete difficult. The facemask should be removed (leaving the helmet in place) as soon as possible before transportation, regardless of respiratory status and even if the athlete is conscious.[80] Shoulder pads should also be opened (but not removed) before transportation to provide access to the chest if CPR or defibrillation is required. A designated rescuer must be responsible for manually stabilizing the head and neck during CPR and any transfer of the victim. The rescuer responsible for neck stabilization should disengage if defibrillation is necessary. For more information on the care of the spine-injured athlete, refer to ‘‘Prehospital Care of the Spine-Injured Athlete,’’ available at http://www.nata.org/statements/consensus/NATAPreHospital.pdf.[81]

Commotio Cordis

Commotio cordis, also called cardiac concussion, involves a blunt, nonpenetrating blow to the chest during a vulnerable phase of ventricular repolarization, leading to a ventricular arrhythmia with no structural damage or cardiac contusion present. Commotio cordis occurs most commonly in young male adolescents (mean age = 13.6 years) with compliant chest walls.[47] Approximately 80% of cases involve blunt chest impact by a firm projectile, such as a baseball, softball, hockey puck, or lacrosse ball, and 20% of cases are due to chest contact with another person.[47] To date, commercially available chest protectors have not been shown to prevent commotio cordis.[82] Survival after commotio cordis closely depends on the time to defibrillation.[54] Overall survival as reported from the United States Commotio Cordis Registry was only 16%, but for those victims still in VF who were reached in time to receive defibrillation, the survival rate was 46%.[47] Young athletes who collapse shortly after being struck in the chest should be suspected of having commotio cordis until the athlete is clearly responsive. Rescuers can improve survival by promptly recognizing SCA due to commotio cordis, activating the EMS system, immediately initiating CPR, and using an AED as soon as possible.

Exertional Heat Stroke

Heat stroke is a life-threatening emergency, and treatment of concurrent cardiac arrest requires simultaneously cooling the athlete and performing CPR. The presence of exertional heat stroke in a collapsed athlete must be suspected in hot, humid environments, especially if the athlete is wearing athletic clothing and equipment that limits heat loss, and the EMS system must be activated. Both heat exhaustion and heat stroke can cause syncope in the athlete. Heat stroke is differentiated by the presence of mental status changes and a core temperature of greater than 40°C (104°F). Untreated exertional heat stroke can progress to end-organ damage, adult respiratory distress syndrome, disseminated intravascular coagulation, neurologic injury, cardiac arrest, and death. The diagnosis of heat stroke can be confirmed on-site with a rectal temperature measurement. If the athlete is unresponsive but has normal breathing and circulation, rapid cooling by ice water bath immersion is recommended.[83] If an ice water tub is not available or if concurrent SCA is suspected, rotating ice water towels applied to the head, trunk, and extremities and ice packs applied to the neck, axilla, and groin represent an alternative method for cooling while performing CPR and using an AED. Because prompt temperature reduction is critical, transport to the emergency department for heat stroke victims without SCA should be delayed if sideline cooling measures, such as ice water bath immersion, are available.[83] Cooling should also be continued during transport if needed.

Lightning

Lightning presents an environmental hazard with the potential for multiple victims. If the lightning storm is ongoing, rescuers must ensure their personal safety by moving an SCA victim indoors if possible. Spine immobilization should be considered. Cardiac arrest from lightning strike is associated with significant mortality and requires modification of standard ACLS measures to achieve successful resuscitation. Most lightning strike victims have associated multisystem involvement, including neurologic complications, cutaneous burns, soft tissue injury such as rhabdomyolysis, and associated blunt trauma.[84] When managing several lightning strike victims, the normal multiple casualty triage priorities are reversed. Casualties who appear unresponsive require prompt, aggressive resuscitation using standard CPR and ACLS protocols, including defibrillation and cardiac pharmacotherapy.[84] The chance for a successful outcome is greater for lightning-related cardiac arrest, even with initial rhythms that are traditionally unresponsive to therapy.

Mass Events

Emergency preparation and management of SCA at mass athletic events require additional planning. Schools and institutions may have their own athletic staffs with them, and advanced communication with the host organization is helpful to ensure that visiting athletic staffs are familiar with the EAP and central medical area or equipment. Distance events such as cross-country meets, triathlons, and marathons present an additional challenge because running or biking courses are often spread out over long distances, sometimes in remote areas. Among marathoners, SCA occurs in approximately 1 in 40 000 runners across the age spectrum.[85] Distributing medical staff and AEDs along the course or field of play and using bicycle or "golf-cart" rescue teams will improve response times should an emergency arise.

Rainy, Wet, Ice, and Metal Surfaces

Defibrillators used in a wet environment or on an ice playing surface are considered safe and do not pose a shock hazard for rescuers or bystanders. If a collapsed victim with suspected SCA is lying on a wet surface or in a puddle, the patient should not be moved to avoid delays in initiating CPR. Simulation of a patient and a rescuer in a wet environment does not show a significant risk of electric shock.[86] Responders to an SCA on an ice playing surface should consider foot traction devices and helmets for their own safety.[87,88] In contrast, SCA victims found immersed in a pool or contained body of water should be removed from the water before defibrillation. Any SCA victims lying on metal conducting surfaces (eg, bleachers) should be moved to a nonmetal surfaces or placed onto spine boards before defibrillation if that can be done quickly and without significant delays.

CONCLUSIONS

The most important factor in SCA survival is the presence of a trained rescuer who can initiate CPR and has access to early defibrillation. The athletic community is in a unique position to have trained coaches, officials, and other targeted responders, and, in some circumstances, on-site athletic trainers, school nurses, and team physicians respond immediately to SCA at organized athletic events and practices. Comprehensive emergency planning is needed for high school and college athletic programs to ensure an efficient and structured response to SCA. Essential elements to an EAP include establishing an effective communication system, training of anticipated responders in CPR and AED use, access to an AED for early defibrillation, acquisition of necessary emergency equipment, coordination and integration of on-site responder and AED programs with the local EMS system, and practice and review of the response plan. High suspicion of SCA should be maintained in any collapsed and unresponsive athlete, with application of an AED as soon as possible for rhythm analysis and defibrillation if indicated. Interruptions in chest compressions for rhythm analysis and shock delivery should be minimized, and rescuers should be prepared to resume CPR, beginning with chest compressions, as soon as a shock is delivered. Improved education in the recognition of SCA, enhanced emergency preparedness, training in current CPR protocols, and increased access to AEDs for early defibrillation are needed to improve survival from SCA in athletics.

DISCLAIMER

The National Athletic Trainers' Association and the Inter-Association Task Force advise individuals, schools, and institutions to carefully and independently consider each of the recommendations. The information contained in the statement is neither exhaustive nor exclusive to all circumstances or individuals. Variables such as institutional human resource guidelines, state or federal statutes, rules, or regulations, as well as regional environmental conditions, may impact the relevance and implementation of these recommendations. The NATA and the Inter-Association Task Force advise their members and others to carefully and independently consider each of the recommendations (including the applicability of same to any particular circumstance or individual). The foregoing statement should not be relied on as an independent basis for care but rather as a resource available to NATA members or others. Moreover, no opinion is expressed herein regarding the quality of care that adheres to or differs from any of NATA's position statements. The NATA and the Inter-Association Task Force reserve the right to rescind or modify their statements at any time.

REFERENCES

1. Maron BJ. Sudden death in young athletes. *N Engl J Med.* 2003;349: 1064–1075.
2. Van Camp SP, Bloor CM, Mueller FO, Cantu RC, Olson HG. Nontraumatic sports death in high school and college athletes. *Med Sci Sports Exerc.* 1995;27:641–647.
3. Maron BJ, Shirani J, Poliac LC, Mathenge R, Roberts WC, Mueller FO. Sudden death in young competitive athletes: clinical, demographic, and pathological profiles. *JAMA.* 1996;276:199–204.
4. ECC Committee, Subcommittees and Task Forces of the American Heart Association. 2005 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation.* 2005;112(suppl 24):IV1–203.
5. Hazinski MF, Markenson D, Neish S, et al. 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. *Circulation.* 2004; 109:278–291.
6. Andersen J, Courson RW, Kleiner DM, McLoda TA. National Athletic Trainers' Association position statement: emergency planning in athletics. *J Athl Train.* 2002;37:99–104.
7. ECC Committee, Subcommittees and Task Forces of the American Heart Association. 2005 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care, part 4: adult basic life support. *Circulation.* 2005;112(suppl 24):IV19–34.
8. ECC Committee, Subcommittees and Task Forces of the American Heart Association. 2005 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care, part 5: electrical therapies. Automated external defibrillators, defibrillation, cardioversion, and pacing. *Circulation.* 2005;112(suppl 24):IV35–46.
9. Ellsworth EG, Ackerman MJ. The changing face of sudden cardiac death in the young. *Heart Rhythm.* 2005;2:1283–1285.
10. Sen-Chowdhry S, McKenna WJ. Sudden cardiac death in the young: a strategy for prevention by targeted evaluation. *Cardiology.* 2006;105: 196–206.
11. Drezner JA, Rogers KJ, Zimmer RR, Sennett BJ. Use of automated external defibrillators at NCAA Division I universities. *Med Sci Sports Exerc.* 2005;37:1487–1492.
12. Maron BJ, Doerer JJ, Haas TS, Tierney DM, Mueller FO. Profile and frequency of sudden death in 1463 young competitive athletes: from a 25 year U.S. national registry, 1980–2005. American Heart Association Scientific Sessions; November 12-15, 2006; Chicago, IL.
13. Basso C, Maron BJ, Corrado D, Thiene G. Clinical profile of congenital coronary artery anomalies with origin from the wrong aortic sinus leading to sudden death in young competitive athletes. *J Am Coll Cardiol.* 2000; 35:1493–1501.
14. Maron BJ, Thompson PD, Puffer JC, et al. Cardiovascular preparticipation screening of competitive athletes: a statement for health professionals

from the Sudden Death Committee (clinical cardiology) and Congenital Cardiac Defects Committee (cardiovascular disease in the young), American Heart Association. *Circulation.* 1996;94:850–856.

15. American Academy of Family Physicians, American Academy of Pediatrics, American College of Sports Medicine, American Medical Society for Sports Medicine, American Orthopaedic Society for Sports Medicine, American Osteopathic Academy of Sports Medicine. *Preparticipation Physical Evaluation.* 3rd ed. New York, NY: McGraw-Hill; 2005.
16. Maron BJ, Douglas PS, Graham TP, Nishimura RA, Thompson PD. Task Force 1: preparticipation screening and diagnosis of cardiovascular disease in athletes. *J Am Coll Cardiol.* 2005;45:1322–1326.
17. Rea TD, Eisenberg MS, Sinibaldi G, White RD. Incidence of EMS-treated out-of-hospital cardiac arrest in the United States. *Resuscitation.* 2004; 63:17–24.
18. Larsen MP, Eisenberg MS, Cummins RO, Hallstrom AP. Predicting survival from out-of-hospital cardiac arrest: a graphic model. *Ann Emerg Med.* 1993;22:1652–1658.
19. The American Heart Association in collaboration with the International Liaison Committee on Resuscitation. Guidelines 2000 for cardiopulmonary resuscitation and emergency cardiovascular care, part 4: the automated external defibrillator. Key link in the chain of survival. *Circulation.* 2000;102(suppl 8):I60–76.
20. Valenzuela TD, Roe DJ, Cretin S, Spaite DW, Larsen MP. Estimating effectiveness of cardiac arrest interventions: a logistic regression survival model. *Circulation.* 1997;96:3308–3313.
21. White RD, Russell JK. Refibrillation, resuscitation and survival in out-of-hospital sudden cardiac arrest victims treated with biphasic automated external defibrillators. *Resuscitation.* 2002;55:17–23.
22. Berg MD, Clark LL, Valenzuela TD, Kern KB, Berg RA. Post-shock chest compression delays with automated external defibrillator use. *Resuscitation.* 2005;64:287–291.
23. Carpenter J, Rea TD, Murray JA, Kudenchuk PJ, Eisenberg MS. Defibrillation waveform and post-shock rhythm in out-of-hospital ventricular fibrillation cardiac arrest. *Resuscitation.* 2003;59:189–196.
24. Herlitz J, Ekstrom L, Wennerblom B, Axelsson A, Bang A, Holmberg S. Effect of bystander initiated cardiopulmonary resuscitation on ventricular fibrillation and survival after witnessed cardiac arrest outside hospital. *Br Heart J.* 1994;72:408–412.
25. Stiell I, Nichol G, Wells G, et al. Health-related quality of life is better for cardiac arrest survivors who received citizen cardiopulmonary resuscitation. *Circulation.* 2003;108:1939–1944.
26. Wik L, Kramer-Johansen J, Myklebust H, et al. Quality of cardiopulmonary resuscitation during out-of-hospital cardiac arrest. *JAMA.* 2005; 293:299–304.
27. Kerber RE, Becker LB, Bourland JD, et al. Automatic external defibrillators for public access defibrillation: recommendations for specifying and reporting arrhythmia analysis algorithm performance, incorporating new waveforms, and enhancing safety. A statement for health professionals from the American Heart Association Task Force on Automatic External Defibrillation, Subcommittee on AED Safety and Efficacy. *Circulation.* 1997;95:1677–1682.
28. Gundry JW, Comess KA, DeRook FA, Jorgenson D, Bardy GH. Comparison of naive sixth-grade children with trained professionals in the use of an automated external defibrillator. *Circulation.* 1999;100:1703–1707.
29. Weisfeldt ML, Becker LB. Resuscitation after cardiac arrest: a 3-phase time-sensitive model. *JAMA.* 2002;288:3035–3038.
30. Yakaitis RW, Ewy GA, Otto CW, Taren DL, Moon TE. Influence of time and therapy on ventricular defibrillation in dogs. *Crit Care Med.* 1980;8:157–163.
31. Niemann JT, Cairns CB, Sharma J, Lewis RJ. Treatment of prolonged ventricular fibrillation. Immediate countershock versus high-dose epinephrine and CPR preceding countershock. *Circulation.* 1992;85:281–287.
32. Cobb LA, Fahrenbruch CE, Walsh TR, et al. Influence of cardiopulmonary resuscitation prior to defibrillation in patients with out-of-hospital ventricular fibrillation. *JAMA.* 1999;281:1182–1188.
33. Wik L, Hansen TB, Fylling F, et al. Delaying defibrillation to give basic cardiopulmonary resuscitation to patients with out-of-hospital ventricular fibrillation: a randomized trial. *JAMA.* 2003;289:1389–1395.
34. Vanden Hoek TL, Shao Z, Li C, Zak R, Schumacker PT, Becker LB. Reperfusion injury on cardiac myocytes after simulated ischemia. *Am J Physiol.* 1996;270(4 Pt 2):H1334–H1341.
35. Caffrey SL, Willoughby PJ, Pepe PE, Becker LB. Public use of automated external defibrillators. *N Engl J Med.* 2002;347:1242–1247.
36. Hallstrom AP, Ornato JP, Weisfeldt M, et al. Public-access defibrillation and survival after out-of-hospital cardiac arrest. *N Engl J Med.* 2004;351: 637–646.
37. Page RL, Joglar JA, Kowal RC, et al. Use of automated external defibrillators by a U.S. airline. *N Engl J Med.* 2000;343:1210–1216.
38. Valenzuela TD, Roe DJ, Nichol G, Clark LL, Spaite DW, Hardman RG. Outcomes of rapid defibrillation by security officers after cardiac arrest in casinos. *N Engl J Med.* 2000;343:1206–1209.
39. Weaver WD, Hill D, Fahrenbruch CE, et al. Use of the automatic external defibrillator in the management of out-of-hospital cardiac arrest. *N Engl J Med.* 1988;319:661–666.
40. White RD, Asplin BR, Bugliosi TF, Hankins DG. High discharge survival rate after out-of-hospital ventricular fibrillation with rapid defibrillation by police and paramedics. *Ann Emerg Med.* 1996;28:480–485.
41. Myerburg RJ, Fenster J, Velez M, et al. Impact of community-wide police car deployment of automated external defibrillators on survival from out-of-hospital cardiac arrest. *Circulation.* 2002;106:1058–1064.
42. White RD, Bunch TJ, Hankins DG. Evolution of a community-wide early defibrillation programme experience over 13 years using police/fire personnel and paramedics as responders. *Resuscitation.* 2005;65:279–283.
43. Mosesso VN Jr, Davis EA, Auble TE, Paris PM, Yealy DM. Use of automated external defibrillators by police officers for treatment of out-of-hospital cardiac arrest. *Ann Emerg Med.* 1998;32:200–207.
44. Jones E, Vijan S, Fendrick AM, Deshpande S, Cram P. Automated external defibrillator deployment in high schools and senior centers. *Prehosp Emerg Care.* 2005;9:382–385.
45. Coris EE, Miller E, Sahebzamani F. Sudden cardiac death in Division I collegiate athletics: analysis of automated external defibrillator utilization in National Collegiate Athletic Association Division I athletic programs. *Clin J Sport Med.* 2005;15:87–91.
46. Drezner JA, Rogers KJ. Sudden cardiac arrest in intercollegiate athletes: detailed analysis and outcomes of resuscitation in nine cases. *Heart Rhythm.* 2006;3:755–759.
47. Maron BJ, Gohman TE, Kyle SB, Estes NA 3rd, Link MS. Clinical profile and spectrum of commotio cordis. *JAMA.* 2002;287:1142–1146.
48. Maron BJ, Wentzel DC, Zenovich AG, Estes NA 3rd, Link MS. Death in a young athlete due to commotio cordis despite prompt external defibrillation. *Heart Rhythm.* 2005;2:991–993.
49. Salib EA, Cyran SE, Cilley RE, Maron BJ, Thomas NJ. Efficacy of bystander cardiopulmonary resuscitation and out-of-hospital automated external defibrillation as life-saving therapy in commotio cordis. *J Pediatr.* 2005;147:863–866.
50. Strasburger JF, Maron BJ. Images in clinical medicine: commotio cordis. *N Engl J Med.* 2002;347:1248.
51. Berger S, Utech L, Hazinski MF. Lay rescuer automated external defibrillator programs for children and adolescents. *Pediatr Clin North Am.* 2004;51:1463–1478.
52. Maron BJ, Shen WK, Link MS, et al. Efficacy of implantable cardioverter-defibrillators for the prevention of sudden death in patients with hypertrophic cardiomyopathy. *N Engl J Med.* 2000;342:365–373.
53. Begley DA, Mohiddin SA, Tripodi D, Winkler JB, Fananapazir L. Efficacy of implantable cardioverter defibrillator therapy for primary and secondary prevention of sudden cardiac death in hypertrophic cardiomyopathy. *Pacing Clin Electrophysiol.* 2003;26:1887–1896.
54. Link MS, Maron BJ, Stickney RE, et al. Automated external defibrillator arrhythmia detection in a model of cardiac arrest due to commotio cordis. *J Cardiovasc Electrophysiol.* 2003;14:83–87.
55. Holmberg M, Holmberg S, Herlitz J. Effect of bystander cardiopulmonary resuscitation in out-of-hospital cardiac arrest patients in Sweden. *Resuscitation.* 2000;47:59–70.
56. Guideline 1c: Emergency Care and Coverage. NCAA Sports Medicine Handbook 2006-07. Available at: http://www.ncaa.org/library/sports_sciences/sports_med_handbook/2006-07/2006-07_sports_medicine_handbook.pdf. Accessed September 4, 2006.
57. Nichol G, Stiell IG, Laupacis A, Pham B, De Maio VJ, Wells GA. A

cumulative meta-analysis of the effectiveness of defibrillator-capable emergency medical services for victims of out-of-hospital cardiac arrest. *Ann Emerg Med.* 1999;34(4 Pt 1):517–525.
58. Eisenberg MS, Horwood BT, Cummins RO, Reynolds-Haertle R, Hearne TR. Cardiac arrest and resuscitation: a tale of 29 cities. *Ann Emerg Med.* 1990;19:179–186.
59. Sideline preparedness for the team physician: consensus statement. *Med Sci Sports Exerc.* 2001;33:846–849.
60. Berger S, Whitstone BN, Frisbee SJ, et al. Cost-effectiveness of Project ADAM: a project to prevent sudden cardiac death in high school students. *Pediatr Cardiol.* 2004;25:660–667.
61. Rothmier JR, Drezner JA, Harmon KG. Automated external defibrillators in Washington State high schools: an assessment of emergency preparedness. *Clin J Sport Med.* 2006;16:434.
62. England H, Hoffman C, Hodgman T, et al. Effectiveness of automated external defibrillators in high schools in greater Boston. *Am J Cardiol.* 2005;95:1484–1486.
63. Sapien RE, Allen A. Emergency preparation in schools: a snapshot of a rural state. *Pediatr Emerg Care.* 2001;17:329–333.
64. Gagliardi M, Neighbors M, Spears C, Byrd S, Snarr J. Emergencies in the school setting: are public school teachers adequately trained to respond? *Prehospital Disaster Med.* 1994;9:222–225.
65. England H, Weinberg PS, Estes NA 3rd. The automated external defibrillator: clinical benefits and legal liability. *JAMA.* 2006;295:687–690.
66. International Liaison Committee on Resuscitation. 2005International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations, part 1: introduction. *Resuscitation.* 2005;67:181–186.
67. ECC Committee, Subcommittees and Task Forces of the American Heart Association. 2005American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care, part 3: overview of CPR. *Circulation.* 2005;112(suppl 24):IV12–18.
68. Eftestol T, Sunde K, Steen PA. Effects of interrupting precordial compressions on the calculated probability of defibrillation success during out-of-hospital cardiac arrest. *Circulation.* 2002;105:2270–2273.
69. Kern KB, Hilwig RW, Berg RA, Sanders AB, Ewy GA. Importance of continuous chest compressions during cardiopulmonary resuscitation: improved outcome during a simulated single lay-rescuer scenario. *Circulation.* 2002;105:645–649.
70. Yu T, Weil MH, Tang W, et al. Adverse outcomes of interrupted precordial compression during automated defibrillation. *Circulation.* 2002;106:368–372.
71. Roberts WO. Exercise-associated collapse in endurance events: a classification system. *Physician Sportsmed.* 1989;15(5):49–59.
72. O'Connor FG, Oriscello RG, Levine BD. Exercise-related syncope in the young athlete: reassurance, restriction or referral? *Am Fam Physician.* 1999;60:2001–2008.
73. Hauff SR, Rea TD, Culley LL, Kerry F, Becker L, Eisenberg MS. Factors impeding dispatcher-assisted telephone cardiopulmonary resuscitation. *Ann Emerg Med.* 2003;42:731–737.
74. Bergfeldt L. Differential diagnosis of cardiogenic syncope and seizure disorders. *Heart.* 2003;89:353–358.
75. Terry GC, Kyle JM, Ellis JM Jr, Cantwell J, Courson R, Medlin R. Sudden cardiac arrest in athletic medicine. *J Athl Train.* 2001;36:205–209.
76. Ruppert M, Reith MW, Widmann JH, et al. Checking for breathing: evaluation of the diagnostic capability of emergency medical services personnel, physicians, medical students, and medical laypersons. *Ann Emerg Med.* 1999;34:720–729.
77. Eberle B, Dick WF, Schneider T, Wisser G, Doetsch S, Tzanova I. Checking the carotid pulse check: diagnostic accuracy of first responders in patients with and without a pulse. *Resuscitation.* 1996;33:107–116.
78. Eftestol T, Sunde K, Ole Aase S, Husoy JH, Steen PA. Predicting outcome of defibrillation by spectral characterization and nonparametric classification of ventricular fibrillation in patients with out-of-hospital cardiac arrest. *Circulation.* 2000;102:1523–1529.
79. Eftestol T, Wik L, Sunde K, Steen PA. Effects of cardiopulmonary resuscitation on predictors of ventricular fibrillation defibrillation success during out-of-hospital cardiac arrest. *Circulation.* 2004;110:10–15.
80. Kleiner DM. Inter-Association Task Force for Appropriate Care of the Spine-Injured Athlete. Prehospital care of the spine-injured athlete: monograph summary. *Clin J Sport Med.* 2003;13:59–61.
81. Prehospital Care of the Spine-Injured Athlete: A Document from the Inter-Association Task Force for Appropriate Care of the Spine-Injured Athlete. National Athletic Trainers' Association. Available at: http://www.nata.org/statements/consensus/NATAPreHospital.pdf. Accessed September 4, 2006.
82. Weinstock J, Maron BJ, Song C, Mane PP, Estes NA 3rd, Link MS. Failure of commercially available chest wall protectors to prevent sudden cardiac death induced by chest wall blows in an experimental model of commotio cordis. *Pediatrics.* 2006;117:e656–e662.
83. Smith JE. Cooling methods used in the treatment of exertional heat illness. *Br J Sports Med.* 2005;39:503–507.
84. Fontanarosa PB. Electrical shock and lightning strike. *Ann Emerg Med.* 1993;22:378–387.
85. Roberts WO, Maron BJ. Evidence for decreasing occurrence of sudden cardiac death associated with the marathon. *J Am Coll Cardiol.* 2005;46:1373–1374.
86. Lyster T, Jorgenson D, Morgan C. The safe use of automated external defibrillators in a wet environment. *Prehosp Emerg Care.* 2003;7:307–311.
87. Gao C, Abeysekera J. A systems perspective of slip and fall accidents on icy and snowy surfaces. *Ergonomics.* 2004;47:573–598.
88. McKiernan FE. A simple gait-stabilizing device reduces outdoor falls and nonserious injurious falls in fall-prone older people during the winter. *J Am Geriatr Soc.* 2005;53:943–947.

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Appendix. Task Force Members, Participating National Organizations, and Endorsing National Societies

Inter-Association Task Force Members

Co-Chairs

Ron W. Courson, ATC, PT, NREMT-I
Director of Sports Medicine
University of Georgia

Jonathan A. Drezner, MD
Associate Professor and Team Physician
Department of Family Medicine
University of Washington

Invited speakers

Randy Cohen, ATC, PT
Director of C.A.T.S.
Athletic Treatment Center
University of Arizona

Bernie DePalma, ATC, PT
Assistant Director of Athletics for Sports Medicine
Cornell University

Chuck Kimmel, ATC
President, National Athletic Trainers' Association
Austin Peay State University

David Klossner, PhD, ATC
Associate Director of Education Outreach
National Collegiate Athletic Association

Mark S. Link, MD, FACC
Director, Center for the Evaluation of Athletes
Tufts-New England Medical Center

Michael Meyer, MS, ATC
Assistant Athletic Trainer
Vanderbilt University

Tim Neal, MS, ATC
Assistant Athletic Director for Sports Medicine
Syracuse University

Robert Schriever
President, Sudden Cardiac Arrest Association

Andrew Smith, MS, ATC
Head Athletic Trainer
Canisius College

Invited participants

Glenn Henry, NREMT-P
Medical Director, Ware County Emergency Medical Services
Waycross, GA

James Kyle, MD, FACSM
Family, Athletic, and Recreational Medicine
Ponte Vedra, FL

Barry J. Maron, MD, FACC
Director, Hypertrophic Cardiomyopathy Center
Minneapolis Heart Institute Foundation

John Payne, MD
Director, Cardiac Electrophysiology
University of Mississippi Medical Center

Fred Reifsteck, MD
Team Physician
University of Georgia

Representatives from national organizations

Jon Almquist, ATC
National Athletic Trainers' Association Secondary School Athletic Training Committee

Jeffrey Anderson, MD
American Medical Society for Sports Medicine

Jeffrey Bytomski, DO
American Osteopathic Academy of Sports Medicine

Steven Chudik, MD
American Orthopaedic Society for Sports Medicine

Ian Greenwald, MD
American College of Emergency Physicians

Michael Krauss, MD
National Collegiate Athletic Association Competitive Safeguards Committee

Shahram Lotfipour, MD, MPH
American Academy of Emergency Medicine

Eugene Luckstead, Sr, MD
American Academy of Pediatrics

Raina Merchant, MD
American Heart Association

Connie Meyer, MICT
National Association of Emergency Medical Technicians

Vincent N. Mosesso, Jr, MD
National Association of Emergency Medical Service Physicians

William O. Roberts, MD, FACSM
American College of Sports Medicine

Johnny Scott, PhD, MD
National Federation of State High School Associations

Michele Weinstein, PT, MS, SCS, ATC
American Physical Therapy Association Sports Physical Therapy Section

Staff

Rachael Oats
Special Projects Manager
National Athletic Trainers' Association

Teresa Foster Welch, CAE
Assistant Executive Director
National Athletic Trainers' Association

Participating national organizations

American Academy of Emergency Medicine
American Academy of Pediatrics
American College of Emergency Physicians
American College of Sports Medicine
American Heart Association
American Medical Society for Sports Medicine
American Orthopedic Society for Sports Medicine
American Osteopathic Academy of Sports Medicine
American Physical Therapy Association Sports Physical Therapy Section
National Association of Emergency Medical Service Physicians
National Association of Emergency Medical Technicians
National Athletic Trainers' Association
National Collegiate Athletic Association
National Federation of State High School Associations
Sudden Cardiac Arrest Association

Endorsing national societies

For an updated list of endorsing national societies, go to http://www.nata.org/statements/consensus/sca_endorsements.htm