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Emergency cardiac care in the athletic setting: from schools to the Olympics

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ABSTRACT

Medical providers at sporting events must be well-trained in the care of cardiac emergencies. Optimal outcomes are most likely achieved through comprehensive emergency planning that ensures prompt and appropriate care. The diversity of athletic venues, as well as the age and competition level of different athlete populations, present challenges to the provision of appropriate emergency care in sport. An efficient and coordinated medical response to cardiac emergencies requires an established emergency action plan, training of potential first responders in cardiopulmonary resuscitation and use of an automated external defibrillator, coordinating communication and transportation systems, and ensuring access to appropriate medical equipment and supplies. Prompt recognition and early defibrillation are critical in the management of athletes suffering sudden cardiac arrest. This article reviews emergency planning and cardiac care in athletics, with special considerations presented for the school, large arena, mass event and Olympic settings.

INTRODUCTION

Cardiac emergencies in sport require careful planning to respond to and avert a potentially catastrophic outcome. Emergency planning for the cardiovascular care of athletes in medical distress may differ based on the age of the athlete, sport, level of competition, venue and geographic layout of the event.

Sudden cardiac arrest (SCA) is the leading cause of sudden death in athletes during sport.[1–3] Significant advances in the treatment and prognosis of out-of-hospital SCA have emerged through the use of automated external defibrillators (AEDs) and refined cardiopulmonary resuscitation (CPR) measures. Despite this, many cases of cardiac arrest in the athletic setting go unrecognised, are misdiagnosed or receive inadequate care due to delays in necessary interventions or the lack of access to a defibrillator.[4 5]

The aetiology of SCA in athletes varies with age. For athletes 35 years and older, atheromatous coronary disease is the most common aetiology of sudden cardiac death.[6–8] In contrast, SCA in younger athletes is largely the result of genetic or functional structural and electrical cardiac disorders, acquired illnesses (myocarditis) and traumatically-induced SCA (commotio cordis).[1 9 10]

In addition to SCA, recognition and management of acute coronary syndromes (ACS) are important for emergency preparations at sporting events, particularly for events with an older population of athletes. While regular exercise is widely promoted for health and fitness, the risk of ACS and SCA increases transiently with intense physical activity and is most pronounced in individuals who exercise infrequently.[11–13] This 'exercise paradox' combined with the riveting nature of SCA in sport dictates that compulsory preparations be considered to adequately respond to an athlete with a cardiac emergency.

MANAGEMENT OF CARDIOVASCULAR EMERGENCIES

Sudden cardiac arrest

Management of a cardiac emergency begins with prompt recognition, an accurate assessment and in uncertain cases the implementation of response protocols based on proper assumptions. SCA should be suspected in all cases of non-traumatic collapse, and in all cases in which an athlete is collapsed and unresponsive.[14] There are a number of potential pitfalls when evaluating a collapsed athlete that may result in delayed recognition of SCA and resultant critical delays in resuscitation. Agonal breathing and occasional gasping often occur within the first minutes after SCA and can be misinterpreted as normal respirations.[4] Accurate assessment of the presence or absence of a pulse in the emergency setting is also challenging and studies demonstrate that healthcare providers correctly diagnose pulselessness as little as 50% of the time.[15 16] As a result, the 2010 American Heart Association and international guidelines for CPR recommend that healthcare providers spend no more than 10 s assessing for a definitive pulse, and that lay responders not check for a pulse at all.[17–19] In addition, brief myoclonic or seizure-like activity occurs in approximately half of young athletes with SCA.[20] Thus, SCA must be assumed in any athlete with seizure-like activity until cardiac arrest is effectively ruled out.[14]

In cases of presumed or confirmed SCA, key steps in management must occur rapidly, and often simultaneously. These include: (1) calling for help and activating the local emergency medical response system, (2) beginning CPR with chest compressions and (3) retrieving and applying a defibrillator (if available) for rhythm analysis and shock deployment (if indicated) as soon as possible. Most cases of SCA in the athletic setting are witnessed and involve more than one rescuer. Thus, one rescuer can perform CPR while another retrieves the AED if not already present.[17]

Recent CPR guidelines changed the basic life support sequence from 'A-B-C' (Airway, Breathing and Chest compressions) to 'C-A-B' (Chest compressions, Airway and Breathing).[17–19] In the A-B-C sequence, chest compressions are often delayed while the responder opens the airway to give

mouth-to-mouth breaths or retrieves a barrier device or other ventilation equipment. By changing the sequence to C-A-B, chest compressions will be initiated sooner and may ensure that more victims receive chest compressions by rescuers unable or unwilling to provide ventilations. Hands-only (compression only) CPR is encouraged for the untrained lay rescuer and appears to achieve outcomes similar to those of conventional CPR (compressions with rescue breathing).[18 21] Adequate chest compressions include a rate of 100/min with a depth of at least 2 inches, complete recoil of the chest in between compressions and minimisation of any pauses in compressions.[17–19]

Chest compressions should be resumed immediately after shock delivery. Many victims will have pulseless electric activity or asystole after defibrillation. Thus, CPR is needed to provide perfusion to the myocardium during this critical period to decrease recurrent ventricular arrhythmias. Minimising the interval between stopping chest compressions and delivering a shock (ie, the preshock pause) also improves the chance of shock success and patient survival. Resuscitative measures should be continued until the victim becomes responsive or a non-cardiac cause of collapse is clearly identified.

Acute coronary syndromes

ACS should be suspected in any athlete presenting with chest pain. Knowledge of an athlete's medical history and risk factors for coronary artery disease is helpful to guide management. Some symptoms attributed to ACS, such as diaphoresis, dyspnoea, lightheadedness and nausea, may be more difficult to differentiate in the athletic setting. A focused assessment should include vital signs, heart and lung auscultation, and chest wall palpation as reproducible pain with palpation decreases the likelihood of ACS.[22] When there is clinical suspicion for ACS, the athlete should be immediately removed from play, seated or laid supine and the local emergency medical system activated.

Treatment in haemodynamically stable patients includes aspirin 162–325 mg chewed and nitroglycerin 0.4 mg sublingual every 5 min up to three doses as needed for chest pain.[17] If an AED is available, it should be retrieved as acute ischaemia increases the risk of ventricular arrhythmias and SCA.[23 24] New guidelines do not recommend routine use of oral β-blockers and supplemental oxygen in the absence of hypoxia due to lack of evidence that shows a survival benefit.[25] Patients with ACS or SCA are ideally transferred to hospital facilities capable of advanced cardiac care and immediate percutaneous coronary intervention with angiography or bypass surgery if indicated.

EMERGENCY PLANNING

Cardiac emergencies are frightening events and can lead to chaos and confusion on the playing field. Proper emergency planning increases the likelihood of a coordinated, efficient response and a good outcome.

Potential first responders to a cardiovascular emergency during training and competition should be identified. In US high schools, certified athletic trainers and coaches were the most likely first responders (47% and 33%, respectively).[20] Additional personnel may include physiotherapists, strength and conditioning coaches, team physicians, officials and other staff or administrators. All personnel responsible for the care or training or athletes should be educated in the recognition of cardiac emergencies, CPR, AED use and have specific knowledge of the location of the nearest AED.[14 26]

A communication system should be available at all venues to activate the local emergency medical system and any on-site response team. Transportation routes for emergency vehicles to access the specific location, as well as appropriate hospital facilities, should be predetermined.[14 26]

Access to early defibrillation must be ensured through the strategic placement of AEDs. The chance of survival decreases approximately 10% with every minute defibrillation is delayed.[27] The recommended time from collapse to first shock is less than 3 min.[14] The number of AEDs and location, whether mounted or portable, is unique for every venue.

AEDs should be registered with the local emergency medical system and checked regularly (per manufacturer recommendations) for maintenance or replacement of the device battery and leads. An extra set of pads should be available with every device in case the primary set is damaged or does not adequately adhere to the victim's chest. Supplies to remove clothing and improve adhesiveness of the pads should also be available and include a scissors, razor, towel and antiperspirant spray.[14 26]

Other emergency equipment is dependent on the level of training of the first responders and may include bag-valve masks, advanced airways, pulse oximetry, supplemental oxygen, sphygmomanometer, intravenous fluids and medications such as aspirin and nitroglycerin.[14]

A written emergency action plan should be developed for every sporting venue and organisation. The plan should be coordinated with the local emergency medical services system and any on-site safety or security officials. It should also include information on documenting and reporting a cardiac event after the initial resuscitation. Regular review and rehearsal of the plan (at least once annually) should be done with all potential responders.[14 26]

SPECIFIC VENUE AND EVENT CONSIDERATIONS

Schools/youth sporting venues

Schools present unique considerations when preparing for and responding to cardiac emergencies. Cardiac emergencies in schools may involve students, student-athletes, school staff, spectators or other adults on campus. A prospective study of over 2000 US high schools reported an incidence of SCA of 1 in 84 schools per year.[28] The number and location of AEDs should be sufficient to ensure defibrillation within 3 min of collapse.[14 29] Approximately 70% of SCA events on school campuses occur at athletic facilities which should guide priority placement.[20 28] AEDs should be available for after-hours activities and not stored in a locked office or cabinet.[26 29] In schools with on-site AED programmes, a high survival rate from SCA (64–71%) has been demonstrated.[20 28]

Large arenas/major sporting venues

Sporting events in large arenas create challenges regarding the cardiovascular safety of both athletes and spectators. Competitive sports carry a higher risk for acute cardiac events in athletes with underlying cardiovascular disease.[30] However, viewing sports may increase the risk of an acute cardiac event as well.[31 32] Available studies suggest the incidence of SCA is 1–2 per 5–600 000 spectators in major European soccer arenas.[33–35] While the assistance to players may be readily available, barriers exist to provide a sufficiently rapid response in cases of an acute cardiac event in spectators.

The consequences and public nature of SCA at major sporting venues highlights the need to implement effective strategies for emergency cardiac care. A recent study showed a varying level of care at 190 major sporting venues in Europe, with 36%

having no written emergency action plan, 28% having no AED and 35% having no basic CPR training of personnel.[36]

The use of AEDs as part of a strategic emergency action plan in large sporting arenas is supported by several studies.[33 35 37] Thirteen witnessed SCAs occurred in the Fritz-Walter Stadium, Germany (capacity of 46 600 spectators) over 80 months (about 0.25 per 100 000 spectators).[33] Basic life support was usually provided within 2 min in addition to defibrillation and advanced life support within 4 min, resulting in 62% survivors without neurological deficits.

The European Society of Cardiology provides recommendations for a consistent level of emergency cardiac care at sports arenas.[34] These recommendations are expected to be implemented by major sporting bodies.

The number of AEDs needed for a major sporting venue can be calculated using existing algorithms that ensure the ability to deliver a shock to a potential victim of SCA anywhere inside the stadium within 3–5 min.[34 38 39] Likewise, the emergency personnel at stadiums should be trained, positioned and numbered to ensure a rapid response to maximise safety for both athletes and spectators.[34]

Separate emergency action plans may be needed at large sporting venues to adequately address medical events occurring on the field versus the care of spectators with medical emergencies in the stands. A medical director, usually appointed by the venue management or club, should be identified to define emergency preparations for the larger arena and spectators. While team physicians may not be the accountable or treating physician for spectator emergencies, they may assist development of an emergency action plan for the larger arena and ensure that resources are effectively coordinated to promote the cardiovascular safety of both athletes and spectators.

Marathons/mass participation events

The marathon and other mass participation events require careful planning to minimise the risk of cardiac catastrophes. Competitor numbers may range from 10 000 to 40 000 runners and the route for many races involves a large area unlike the confines of an athletic arena or stadium. The age distribution of such events is such that the most popular age groups are 30–35 and 40–45 years in whom coronary artery disease is the most implicated condition during a cardiac arrest. Sudden cardiac death rates during marathons are rare and reported to be around 1 in 50 000[40] participants, although other reports from the London marathon and pooled data from the USA suggest figures of 1 in 80 000[41] and 1 in 100 000,[42] respectively. Most deaths occur in males and are due to atherosclerotic coronary artery disease.

Some marathons and half marathons in Europe require a certificate of fitness by a primary-care physician before competition. However, such crude screening methods are too insensitive to detect most individuals with silent cardiac disorders, particularly coronary artery disease. Therefore, the presence of a highly competent medical team with well-defined management protocols, effective communication, an evenly distributed team of responders with access to defibrillators and rapid access to a facility for advanced life support is crucial.

Medical coverage at events generally requires the distribution of many medical personnel along the course. The exact number and distribution of personnel will vary depending on the race course and number of participants. Some experts recommend up to five first aid personnel for every 1000 runners, and at least one medical provider who is competent in advance life support per 2500 runners. First aid stations throughout the course should be equipped with basic life support materials, trained responders and an AED. Larger races may require more first aid posts; the maximum distance between first aid stations is approximately 1 mile for the London marathon, which has 40 000 entrants each year.

The recommended number of ambulances is variable depending on the accessibility to the course and estimated use for cardiac and other medical emergencies. In some marathons, provisions may be upwards of one basic life support unit and one advanced life support unit per 500 participants, and mostly distributed throughout the second half of the course and near the finish. Identifying and coordinating with nearby fire stations should be done in addition to provide backup support when needed. Mobile responders in vehicles or on bicycles equipped with AEDs are an additional means of maintaining a rapid emergency response among the wide distribution of runners along the course with the goal of having an AED less than 1 mile away from any participant during the race. Most mass participation and ultra-endurance events usually concentrate a large proportion of the medical support in the treatment areas around and after the finish where sudden cardiac events have the highest prevalence.[43] The programme is usually coordinated by a designated medical director and a dedicated medical control team that facilitates coordination and communication between all medical resources including ambulances, first aid posts and designated hospitals.

Olympics/multisport events

Olympic games and multisport event medical coverage are unique in that they involve a large medical staff and oftentimes team members assembling together from across the country and even the world. The medical staff is often diverse in training and experience and may consist of physicians of various specialties, athletic trainers, physical therapists, emergency medical technicians and nurses. In some cases, the medical staff may be working together for the first time and the emergency equipment utilised at the event may be different than what the providers typically use.

For such events, the host country is generally in-charge of providing emergency coverage and emergency care. This creates challenges for the visiting medical staff as they may have limited access to venues for medical coverage. For example, the visiting medical staff may have access to the athlete in the athletic training area prior to competition; however, when the athlete enters the venue, the host country medical staff assumes care. If immediate care is rendered and the athlete is transported back to the athletic training area, the visiting medical staff may resume care of their athlete.

Delivery of medical care for Olympic games and multisport events is complicated by having multiple venues spread throughout a large geographical area at which competition is simultaneously occurring. Therefore, critical to providing prompt evaluation and treatment of a potential cardiac emergency is establishing venue-specific emergency action plans that are reviewed and rehearsed by all medical staff beforehand. Medical staff should be provided venue maps and be familiar with the facilities and grounds. Ideally, medical staff should conduct emergency scenarios in the venue to ensure an understanding of the emergency action plan, awareness of the location of emergency equipment, effective use of the communication system and teamwork of the medical staff during an emergency.

Communication is a critical component of medical coverage of large-scale multivenue events. All medical staff should be familiar with and part of the communication system, which

may include the use of radios, headsets in loud environments and secondary means of communication in the event of equipment failure (ie, telephone and hand signals). Mobile spotters on cycles or carts with communication equipment may be necessary for large venues such as the marathon, race walk and cycling in order to provide immediate coverage throughout the course. Additionally, medical interpreters should be available to address language differences and facilitate communication between injured or ill athletes as well as visiting medical staff.

Medical staff may be called upon to provide emergency cardiac care to athletes and also to other persons at the event such as officials and spectators. During the opening ceremony of the 1996 Summer Olympic Games in Atlanta, Georgia, a Chef de Mission from a visiting country suffered a fatal SCA in the stadium infield as the participants marched in. A mobile team of two athletic trainers with the track and field medical staff covering the venue witnessed the event, providing immediate CPR in the infield. They radioed for medical support and a second team arrived with a defibrillator, guided to the site in the crowded infield with the assistance by radio of a medical spotter located overhead in the emergency management box. The official was transported by medical cart to the stadium medical area for advanced cardiac life support with intubation and cardiac medications prior to hospital transport. Later during the Games, the track and field medical staff saved the life of a track and field official with a complete airway obstruction.

Although most illness and injury in Olympic Games and multisport events are relatively minor, cardiac emergencies are unpredictable and can occur without warning. Owing to a relatively low incidence rate of catastrophic injuries, those tasked with overseeing organised athletic events can develop a false sense of security. The key to emergency management is advanced preparation, which may save critical time in an emergency (box 1).

Box 1 Summary recommendations

Planning for cardiac emergencies in the athletic setting

- Establish an emergency action plan for each venue.
- Identify anticipated first responders (coaches, officials, administrators and the medical team) and provide training in Sudden cardiac arrest (SCA) recognition, cardiopulmonary resuscitation (CPR) and automated external defibrillators (AED) use.
- Develop an internal communication system and a means to activate the local emergency response system.
- Install AEDs in strategic locations and equip key medical staff with portable AEDs as needed to ensure early access to defibrillation (within 3 min of collapse)
  - Register AEDs with the local emergency medical system.
  - Identify the person responsible for AED maintenance.
- Determine routes for emergency vehicles to easily access each athletic venue in case of a cardiac emergency.
- Practice and review the emergency action plan at least annually with all potential first responders.
- Consider acquiring additional emergency equipment and medications depending on the population at risk and the experience of the medical providers.
- Coordinate onsite ambulances and other mobile responders for certain high-risk events.

Management of cardiac emergencies in the athletic setting

- Promptly recognise a cardiac emergency by maintaining a high level of suspicion.
  - Assume SCA in any collapsed and unresponsive athlete.
  - Avoid misdiagnosis as a result of agonal breathing and/or seizure-like activity.
- Elicit help from people nearby.
- Activate the local emergency response system.
- Begin chest compressions, retrieve an AED and apply it as soon as possible for defibrillation (if indicated).
- Continue CPR, AED use and resuscitative efforts until the victim becomes responsive or care is transferred to an emergency facility capable of advanced cardiac life support.
- In a conscious athlete suspected of having an acute coronary syndrome, provide aspirin and nitroglycerin, activate the emergency response system and monitor closely.

CONCLUSIONS

All sporting venues and organisations should have an established emergency response plan for cardiac emergencies. Prompt recognition, the presence of trained rescuers to initiate CPR, and access to early defibrillation through on-site AEDs are critical in improving survival from SCA. To avoid potentially fatal delays in resuscitation, SCA should be suspected in any collapsed and unresponsive athlete and an AED applied as soon as possible for rhythm analysis and defibrillation if indicated.

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