# Use of Automated External Defibrillators at NCAA Division I Universities

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**ABSTRACT**

DREZNER, J. A., K. J. ROGERS, R. R. ZIMMER, and B.J. SENNETT. Use of Automated External Defibrillators at NCAA Division I Universities. *Med. Sci. Sports Exerc.*, Vol. 37, No. 9, pp. 1487–1492, 2005. **Purpose:** The placement of automated external defibrillators (AED) at public sporting events is a growing national trend. The purpose of the present study was to investigate the prevalence, past use, and cost of implementing AED at university sporting venues. **Methods:** Questionnaires were sent to the head athletic trainer at all Division I NCAA universities ($N = 326$) and responses collected between August and November 2003. **Results:** Completed surveys were returned by 244 institutions (75% response rate). Ninety-one percent (221/244) had AED for an average of 3.3 yr (range 1–13) with a median of four AED per institution (range 1–30). There were 35 cases of AED use for sudden cardiac arrest with 77% (27/35) occurring in older nonstudents, 14% (5/35) in intercollegiate athletes, and 3% (1/35) in a student nonintercollegiate athlete (information unavailable in two cases). The immediate resuscitation rate was 54% (19/35). A shock was delivered in 21 cases with a resuscitation rate of 71% (15/21). None of the intercollegiate athletes were successfully resuscitated. The average cost per AED was $2460. In a 10-yr model (expected useful life of an AED), the cost per life immediately resuscitated was $52,400, and the estimated cost per life-year gained ranged $10,500 to $22,500. **Conclusions:** Most Division I universities have AED available at selected sporting venues. Although no benefit was demonstrated for intercollegiate athletes, AED were successfully used in older nonstudents with cardiac arrest with a favorable long-term cost analysis. **Key Words:** CARDIAC ARREST, ATHLETE, SPORT, RESUSCITATION.

Out-of-hospital cardiac arrest affects over 400,000 people annually in the United States (3). In the case of shockable cardiac arrest involving ventricular fibrillation or pulseless ventricular tachycardia (VF/VT), the single greatest determinant of survival is the time interval from collapse to defibrillation (5,14,25,30). Public access to early defibrillation by placement of automated external defibrillators (AED) in selected locations for immediate use by trained laypersons is supported by the American Heart Association (AHA) and significantly increases survival from out-of-hospital cardiac arrest (12). Recently, several prospective observational studies have reported favorable results regarding the effectiveness of public access defibrillation (PAD) in casinos, airplanes, airports, and high-risk community locations such as shopping malls and apartment complexes (6,14,21,24).

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The success of AED in other public venues has propelled their placement at public sporting events. Studies estimate that public sports venues and health/fitness facilities are among the top 10 locations with the highest incidence of sudden cardiac arrest (SCA) (4,9). In a joint position statement, the AHA and the American College of Sports Medicine encouraged the effective placement and use of AED at all health/fitness facilities (2).

There is a growing national trend for universities to implement AED at sporting venues. This is motivated in large part by an effort to protect student athletes from a catastrophic event. In an official position statement, the National Athletic Trainer's Association recently recommended that athletic trainers in every work setting have access to an AED and that an AED should be a part of their standard emergency equipment (http://www.nata.org/publicinformation/docs/aedofficialstatement.doc). However, this recommendation is based on PAD studies with an older population of patients, and the results may not be applicable to a younger population of competitive athletes.

Sudden cardiac arrest, although rare, is the leading cause of death in young athletes (16,26). Competitive athletes are perceived as the healthiest population of our society, and their unexpected collapse sparks public debate regarding the appropriateness of established screening guidelines and preparedness of emergency medical services (EMS) at sporting events. The AHA developed consensus recommendations

and preparticipation screening guidelines in 1996 (18). Unfortunately, screening has not been effective in identifying young athletes at risk of sudden death. In a retrospective study of 115 athletes who died suddenly from cardiovascular-related disease, only 3% were suspected of having cardiovascular disease following a standard preparticipation evaluation (17). Dissatisfaction with the limits of standard screening has triggered the investigation of other means to identify athletes at risk. Several studies have evaluated the use of ECG and echocardiography to screen large populations of athletes, but few definitive examples of lethal cardiovascular abnormalities have been detected (10,15,19,29).

A paradigm shift may be occurring in the sports medicine community, with resources shifting away from screening and toward the treatment of SCA. The presence and timely access of AED at university sporting venues provides 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. The decision to have AED available at sporting events depends on many factors including cost, size of the event, and availability of conventional EMS. At smaller or geographically isolated athletic venues, AED may be the only means to achieve early defibrillation. Currently, no studies or policy recommendations are available to guide universities in the implementation of AED at sporting venues. The purpose of this study was to evaluate the prevalence, past utilization, and cost of AED at NCAA (National Collegiate Athletic Association) Division I universities in the United States.

## METHODS

**Study design.** This study was a retrospective survey. Questionnaires were mailed to head athletic trainers at all Division I universities ($N = 326$) in the NCAA with three follow-up requests sent via e-mail over a 4-month period (August to November 2003). Head athletic trainers are in part responsible for determining the type of medical services at university sporting events and were thought to be the most reliable source of information regarding the presence and past use of AED. The study was approved by the institutional review board of the University of Pennsylvania.

Outcome measures included 1) the prevalence and location of AED at Division I universities, 2) analysis of past use of AED, 3) rate of sudden cardiac death (SCD) in intercollegiate athletes, 4) cost analysis, and 5) obstacles to implementing AED.

**Statistical analysis.** Descriptive statistics such as proportions, means, medians, and cross tabulations were used to analyze collected data. For prevalence data, Division I universities were further subdivided into Division IA, IAA, and IAAA based on their NCAA classification to identify trends that may be influenced by university or athletic department resources. In general, Division IA schools have higher profile athletic programs with greater attendance at football games than do Division IAA schools, and Division IAAA schools do not have football programs (http://www.ncaa.org).

Only those cases in which the AED was used to treat a cardiac arrest were further analyzed and included in the cost model. Cases in which the AED was used to monitor an unresponsive patient with a noncardiac collapse (i.e., a severe head injury), and cases in which the AED used was provided by the arriving ambulance were excluded. AED uses for SCA were examined for their immediate resuscitation rate and deployment of a shock. A general age range for the SCA victim was obtained, and victims further subdivided into older nonstudents (such as spectators, coaches, officials, or other attendees on campus), intercollegiate athletes, or student nonintercollegiate athletes.

The rate of SCD in intercollegiate athletes was calculated by taking the total number of intercollegiate athlete years during the average time AED were implemented at the universities and dividing by the number of intercollegiate athlete deaths. The total number of intercollegiate athletes per institution reported by the athletic trainer was cross-referenced with published data by the NCAA to ensure accuracy.

A 10-yr predictive model was used for the cost analysis based on an expected 10-yr useful life of an AED (8). Survival rates to hospital discharge after successful immediate resuscitation were extrapolated from previous studies of PAD performed in the United States (6,14,21,24). Life expectancy after surviving cardiac arrest was taken from existing studies to estimate the cost per life-year gained (1,8).

## RESULTS

Completed surveys were returned by 244 NCAA Division I institutions for a 75% response rate (244/326). Head athletic trainers completing the survey had worked at their institution for an average of 12.6 yr (range 0.5−37). Within Division I institutions, 84% of Division IA schools (98/117), 64% of Division IAA schools (78/121), and 77% of Division IAAA schools (68/88) returned completed surveys.

**Prevalence and location.** Ninety-one percent of institutions (221/244) had AED for an average of 3.3 yr (range 1−13). Prevalence was highest at Division IA schools with 97% (95/98) having AED, followed by 88% (69/78) of Division IAA schools and 84% (57/68) of Division IAAA schools (Fig. 1A). The average number of AED per institution was 5.2 with a median of 4 (range 1−30). The median number of AED per institution was highest at Division IA schools (6), followed by Division IAA schools (4) and Division IAAA schools (3) (Fig. 1B).

Most institutions (82%) had at least one AED located in the athletic training room, followed by the basketball arena (43%), campus police (40%), football stadium (27%), baseball/softball field (21%), and recreation/fitness facility (21%) (Fig. 2). Other selected locations of AED placement included the student health center, ice hockey arena, crew house, and swim facility.

**AED use and outcomes.** There were 43 cases of AED use occurring at 41 institutions. In five cases, the AED was used to monitor an injured or unresponsive patient with

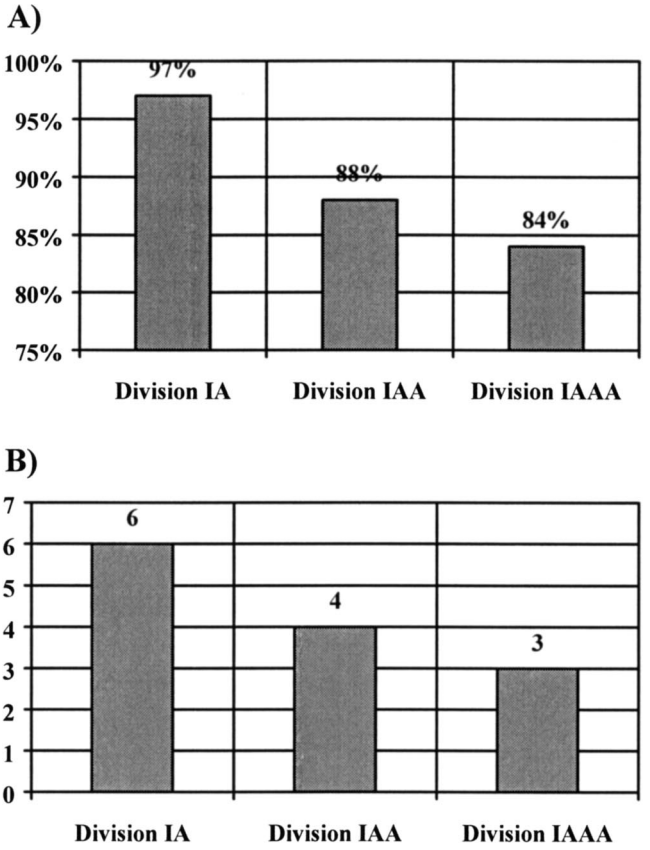


**FIGURE 1—Prevalence (A) and median number (B) of automated external defibrillators at Division I universities.**

a noncardiac collapse. Two cases of monitoring occurred in intercollegiate athletes (one with chest pain and one1 with a massive head trauma), and three cases of monitoring occurred in older nonstudents. Three cases of SCA were also excluded from further analysis because the AED used was brought by the arriving ambulance.

An AED was used in 35 cases of SCA occurring at 33 institutions. Older nonstudents (such as spectators, coaches, officials, event staff, and other attendees on campus) accounted for 77% (27/35) of cases. There were five (14%) cases of SCA in intercollegiate athletes, one (3%) case in a student nonintercollegiate athlete, and information was unavailable for two (6%) cases (Fig. 3). The majority (54%) of AED use occurred at university sporting events (14 in older nonstudents and five in intercollegiate athletes). An additional four (11%) cases of AED use occurred at a sporting

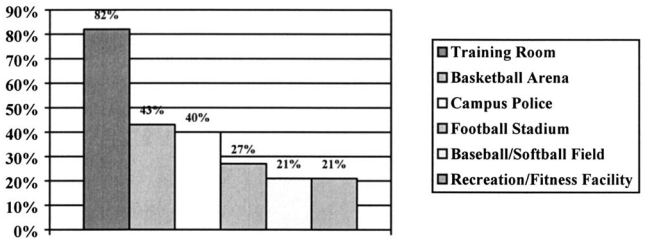


**FIGURE 2—Location of automated external defibrillators at Division I universities. Values represent the percentage of institutions with at least one AED in that location.**

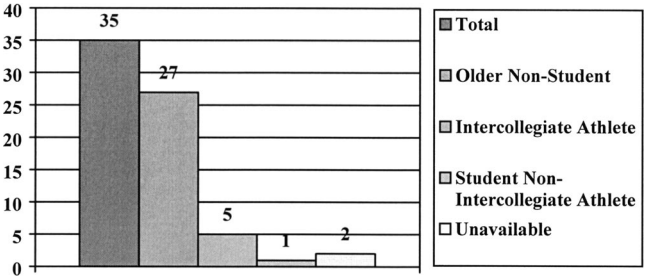


**FIGURE 3—Demographics of automated external defibrillator use for sudden cardiac arrest. Older nonstudents represent older spectators, coaches, officials, event staff, and other attendees on campus.**

venue during a nonsporting event (such as a seminar or graduation ceremony). There were five (14%) cases of AED use at recreation/fitness facilities (four in older nonstudents and one in a student nonintercollegiate athlete), and in five (14%) cases an available AED was used to treat an older pedestrian on campus (Table 1).

The overall immediate resuscitation rate was 54% (19/35). In 21 instances, the defibrillator deployed a shock with an immediate resuscitation rate of 71% (15/21). In the five cases of SCA in intercollegiate athletes, a shock was deployed in four cases. None of the intercollegiate athletes were successfully resuscitated.

**Rate of SCD in intercollegiate athletes.** The 221 institutions with AED had an average of 453.5 intercollegiate athletes per year reported by the athletic trainers or 100,223 total intercollegiate athletes per year. This calculation was cross-referenced and consistent with reported data by the NCAA, which lists 148,614 total Division I athletes, or an estimated 100,747 athletes for 68% (221/326) of the schools. There were five cases of SCD in intercollegiate athletes during the 3.3 yr AED were present at these institutions or 1.5 cases of SCD per year. The risk of SCD in intercollegiate athletes was 1:67,000 athletes per year (95% CI, 1:28,000 to 1:159,000).

**Cost analysis.** A cost analysis was performed using a 10-yr model (expected useful life of an AED). Within the university setting, training, installation, and upkeep costs were estimated to be minimal or absent. The NCAA currently requires all athletic trainers, coaches, and "personnel associated with practices, competitions, skills instruction, strength and conditioning" to be certified in cardiopulmonary resuscitation (CPR) (http://www.ncaa.org/health-safety). Given that training in AED use has become a standard part of CPR instruction, no additional training costs are acquired by the university. In addition, skill retention after successful AED instruction is greater than 95% and no retraining would be necessary except standard CPR recertification (23). Installation costs are also minimal, and for many institutions, no additional payment would be required to facilities management personnel already employed by the university. To account for any miscellaneous expenses related to AED installation and upkeep, $1000 per university was added to the total purchasing cost.

TABLE 1. Demographics, location, and successful immediate resuscitation of sudden cardiac arrest at Division I universities.

| Demographics and Location | Cardiac Arrest (%) (*N* = 35) | Successful Immediate Resuscitation (*N* = 19) | Shock Deployed (*N* = 21) | Successful Resuscitation after Defibrillation (*N* = 15) |
|---|---|---|---|---|
| Older nonathlete | 27 (77) | 16 | 14 | 12 |
| University sporting event | | | | |
| Spectator | 9 | 6 | 7 | 6 |
| Coach | 2 | 0 | 0 | 0 |
| Event staff | 2 | 1 | 0 | 0 |
| Official | 1 | 1 | 1 | 1 |
| Pedestrian on campus | 5 | 2 | 2 | 2 |
| Attendee at sporting venue for nonsporting event | 4 | 3 | 2 | 2 |
| Campus recreation/fitness facility | 4 | 3 | 2 | 1 |
| Intercollegiate athlete | | | | |
| University sporting event | 5 (14) | 0 | 4 | 0 |
| Student nonathlete | | | | |
| Campus recreation/fitness facility | 1 (3) | 1 | 1 | 1 |
| Information unavailable | 2 (6) | 2 | 2 | 2 |
| Overall (%) | 35 | 19/35 (54) | 21 | 15/21 (71) |

The average cost per AED was $460 (range $0 to $6100). There were a total of 1147 AED at 221 institutions yielding a total purchasing cost of $2.82 million with $221,000 added for miscellaneous expenses for a total cost of $3.04 million. The cost per institution was $13,800. Over the 10-yr life of the AED, an estimated 106 cases of SCA would occur with 58 on-site survivors. The estimated cost per AED use for a SCA during this 10-yr period is $28,700, with an estimated cost per life immediately resuscitated of $52,400. Of the available studies on PAD performed in the United States, the survival rate to hospital discharge following successful onsite resuscitation ranges from 46 to 100% (Table 2) (6,14,21,24). Taking into account that many cardiac arrest survivors would receive implantable cardiac defibrillators, the average life expectancy following hospital discharge from a cardiac arrest was predicted to be 5 yr (1,8). Accordingly, the cost incurred by the university per life-year gained ranges between $10,500 and $22,500.

**Obstacles to implementing AED.** Twenty-three universities did not have AED and were surveyed regarding the obstacles to implementing AED at their institution. Seventy percent identified financial resources as an obstacle. Uncertainty as to where to place AED (57%) and medicolegal concerns (48%) were also reported as common obstacles.

## DISCUSSION

Out-of-hospital cardiac arrest is a leading cause of death in the United States. In our nation's largest cities, overall survival rates have historically been low (<5%) (5,11). Survival rates for VF/VT decline approximately 10% with every minute that defibrillation is delayed, and early defibrillation strategies aimed at decreasing the interval from collapse to defibrillation through use of AED have become an important component of EMS (12). Technological advancements have allowed the safe and expedient use of AED by nontraditional responders and the lay public. A recent study showed that untrained sixth-grade students performed almost as quickly as trained paramedics using AED in a mock cardiac arrest scenario with only a 23-s difference in mean time to defibrillation (13). Several studies in which first responders (such as firefighters, police, and emergency medical technicians) were equipped with AED have demonstrated improved survival rates (17–58%) from out-of-hospital cardiac arrest involving VF/VT (20,28,30). More recently, PAD programs involving placement of AED at high-risk locations of cardiac arrest (such as casinos, airplanes, and airports) for use by trained rescuers or lay persons have also demonstrated a survival benefit (6,21,24). The Public Access Defibrillation (PAD) Trial also demonstrated a survival benefit of training nonmedical volunteers in CPR and AED use to respond to a cardiac arrest at various public facilities compared with CPR alone (14).

This study investigated the prevalence, location, past use, and cost of implementing AED at Division I universities. More than 90% of Division I schools that responded to the survey already have AED. The most common location for an AED was in the athletic training room, a place reserved for intercollegiate athletes, supporting the premise that preventing a catastrophic event in student athletes has been the

TABLE 2. A comparison of studies using public access defibrillation in the United States.

| | Casinos (24) | Airline (21) | Airports (6) | PAD Trial (14) | Division I Universities |
|---|---|---|---|---|---|
| Total cases of cardiac arrest treated | 148 | 36 | 21 | 128 | 35 |
| Overall immediate resuscitation rate | 48% (71/148) | 36% (13/36) | 52% (11/21) | 39% (50/128) | 54% (19/35) |
| Overall survival to hospital discharge | 38% (56/148) | 17% (6/36) | 52% (11/21) | 23% (30/128) | — |
| Percentage survival to hospital discharge after successful immediate resuscitation | 79% (56/71) | 46% (6/13) | 100% (11/11) | 60% (30/50) | — |
| Total cases of cardiac arrest from VF/VT | 105 | 15 | 18 | 71 | 21[a] |
| Immediate resuscitation rate from VF/VT | 63% (66/105) | 87% (13/15) | 61% (11/18) | — | 71% (15/21) |
| Survival to hospital discharge from VF/VT | 53% (56/105) | 40% (6/15) | 61% (11/21) | — | — |

VF/VT, ventricular fibrillation and pulseless ventricular tachycardia.
[a] Presumed VF/VT because AED deployed a shock.

motivating concern for acquiring AED. There was a trend for higher prevalence and more AED per institution at Division IA schools compared to Division IAA or IAAA schools (Fig. 1). This finding likely reflects the availability of resources from universities and athletic departments to purchase AED.

This is the first study characterizing outcomes of publicly placed AED at university sporting venues and recreation/fitness facilities. Thirty-five cases of SCA were identified, with the majority of cases occurring in older nonstudents (Fig. 3). The overall immediate survival rate of 54% is consistent with other studies of PAD (Table 2). The survival rate improved to 71% if a shock was deployed, implying that these cases involved a shockable rhythm such as VF/VT. AED have also been successful as part of planned emergency response systems at large stadiums. In an Australian study, lay rescuers trained and equipped with AED were part of a tiered response to cardiac arrests at major sporting and public events and demonstrated an onsite survival of 86% with a subsequent 71% survival to hospital discharge (27). In our study, 66% (23/35) cases of cardiac arrest occurred at sporting venues, with 19 of these occurring during a sporting event and four during a nonsporting event (Table 1). Additional follow-up information is needed to better characterize the specific venues that had incidents of SCA, the size of the venue, number of attendees, and response time to AED placement and defibrillation.

The presence of AED at university sporting events has been largely influenced by the desire to protect intercollegiate athletes from a catastrophic event. This study did not show a survival benefit for intercollegiate athletes who suffer SCA. The reason for this finding is uncertain and explanations are only speculative. With only five cases of SCA in intercollegiate athletes, there is insufficient information to support strong conclusions. The etiology of SCA in young athletes is usually a structural cardiac abnormality that is asymptomatic until the time of death, with hypertrophic cardiomyopathy accounting for 26–36% of cases (16,17). Is it possible that shockable dysrhythmias in patients with structural cardiac anomalies become more resistant to defibrillation over time than ischemia-induced VF/VT? The lower survival rate may also be influenced by the duration and intensity of exercise before cardiac arrest, which might lead to secondary metabolic disturbances modifying the effectiveness of defibrillation. Larger studies are needed to monitor the efficacy of immediate cardiac defibrillation and to delineate variables that affect outcomes from cardiac arrest in a young athletic population. The rate of SCD in intercollegiate athletes in this study was 1.5 out of 100,000 athletes per year, and is consistent with other estimates (26).

The cost incurred by the university over a 10-yr period to immediately resuscitate one life was approximately $52,400, and the estimated cost per life-year gained $10,500 to $22,500. In other words, it would cost a university about $1000 to $2300 per year for 10 yr to save 1 life-year. Our cost analysis approximates predictions from a cost-effectiveness study reporting a cost of $45,000 per life-year gained and a cost of $62,000 per quality-adjusted life-year gained for placement of AED at public sports venues (8). Further and more detailed economic analyses are needed to confirm these findings.

Financial resources were the most common obstacle to implementing AED. Cardiac arrests and AED use were five times more likely in older nonstudents than in intercollegiate athletes. Thus, implementing AED should not be limited to the resources of university athletic departments but should be based on a shared expense of a university-wide or community-wide program. Medicolegal concerns were also a barrier to acquiring AED. Currently, the federal government and all 50 states have expanded good Samaritan laws to provide some level of protection from liability for AED users, with the exception of gross negligence and willful misconduct (22). In contrast, many large sports stadiums and public venues may be implementing AED out of liability concern for not having the devices available. In one lawsuit, a plaintiff received a $2.5 million award from a fitness facility for not having an AED available when the plaintiff had a heart attack (7).

The AHA has set a goal for an EMS call-to-shock time of less than 5 min in the treatment of prehospital cardiac arrest (12). If this goal cannot be met with conventional EMS, PAD programs that train and equip first responders or laypersons with AED to recognize and treat cardiac arrest should be established. In the university setting, no existing guidelines are available to assist universities in implementing an AED program. For some universities, it may be reasonable to rely on campus public safety officials and local EMS. However, as demonstrated in this study, many university athletic departments fueled by the hope of saving a student athlete from a rare but catastrophic event have acquired AED and placed them in selected athletic venues. A coordinated effort by all agencies potentially involved in the treatment of a cardiac arrest on university grounds (campus public safety officials, local EMS, student health services, university medical center, and the athletic department) should be involved in formulating appropriate emergency action plans. The size and geographic makeup of the university, distance to sporting venues, population density, and any environmental obstacles for an emergency responder must be considered.

The limitations of this study must be recognized when interpreting its results. The study was a retrospective survey and raises the potential for recall bias. Information collected was dependent on the respondents being aware of AED use and also knowing the specifics about that use. Cases of AED use unknown to the athletic trainers would not have been reported, and, thus, it is possible that this study has underestimated the number of cases of AED use and their potential impact. In addition, there was no comparison group, and it is uncertain how many patients would have survived with standard EMS alone. Another limitation of the study is that actual electrocardiographic data were not reviewed. Logistically, this would be difficult given the number of different institutions with AED use, but more specific information

regarding the initial rhythm, initiation of CPR, and time from collapse to defibrillation would be valuable.

## CONCLUSION

In conclusion, the placement of AED at university sporting venues and recreation/fitness facilities is common at NCAA Division I universities. Use of AED for cardiac arrest occurred mostly in older nonstudents and resulted in a favorable immediate survival rate and long-term cost analysis. No benefit was demonstrated for a small number of intercollegiate athletes with SCA. Larger longitudinal studies are needed to better define the optimal location of AED placement on university grounds and to monitor the effectiveness of early defibrillation in younger athletes with unexpected cardiac arrest. At present, implementation of AED at university sporting venues and recreation/fitness facilities as part of a structured emergency response system is encouraged.

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