Emergency Planning for Sudden Cardiac Events in North Carolina High Schools

Anna Monroe, MD; Daryl A. Rosenbaum, MD; Stephen Davis, MA

Abstract

Background: *This study evaluates the state of emergency planning for sudden cardiac arrest (SCA) in North Carolina high schools, primarily focusing on the existence and characteristics of written plans and the presence of automated external defibrillators (AEDs).*

Methods: *All athletic directors listed in the 2007-2008 North Carolina High School Athletic Association Directory were surveyed via an online survey to determine their level of planning and preparation for SCA.*

Results: *Completed surveys were received from 36.7% (138/376) of the schools. Emergency action plans (EAPs) existed in 55.8% (n = 77) of high schools and were significantly less likely to be present in Divisions 1 and 2 ($p < 0.01$) than in Divisions 3 and 4 which have higher enrollment. EAPs included aims to initiate CPR within one minute (80.5%), and targets to defibrillate within three-five minutes (66.2%) as recommended by recent guidelines from the National Athletic Trainers Association. AEDs were present in 72.5% (n = 100) of the responding schools, and the presence of an AED was related to the presence of an EAP ($p < 0.01$). Schools in Division 1 were less likely to possess an AED ($p < 0.01$) than schools in the larger divisions. Of schools without AEDs, 39.5% (n = 15) reported children or adults attending or working at the school who were at risk for heart disease. Lack of funding was the most commonly reported barrier to obtaining an AED.*

Limitations: *A low response rate and self-reported data may have biased results in favor of those who adopted plans or purchased an AED.*

Conclusions: *The majority of responding schools possessed both an EAP and an AED and reported that they met several current recommended guidelines for emergency preparedness for SCA. These results for North Carolina high schools are similar to reports from other states. Significant room for improvement exists, however, as the number of schools without an EAP or AED is still relatively large and some important components of emergency planning are lacking in the EAPs.*

Keywords: *sudden cardiac arrest; pre-hospital emergency care; automated external defibrillators; adolescents; sports.*

Sudden cardiac arrest (SCA) in high school athletics occurs at a rate of about one per 200,000 participants[1-3] although the exact incidence remains unknown and possibly underestimated due to the absence of a standardized and mandatory reporting system. A recent report from the National Center for Catastrophic Sports Injury Research (NCCSIR) mentions eight football fatalities from the 2006 season attributed primarily to cardiac causes.[4] While the data suggest the relative rarity of SCA in high school and college athletics, the death of a young and apparently healthy athlete can have a profound emotional impact on a community. Even with appropriate pre-participation screening SCA often cannot be prevented.[5] One study of sudden cardiac deaths among athletes notes that in only 3% of the athletes were there any potentially identifiable signs or symptoms of heart disease present at the pre-participation exam.[5]

In the United States, 500,000 people die each year from SCA.[6] The majority of usages of automated external defibrillators (AEDs) at high schools and colleges are actually for non-athletes such as athletic department staff, officials, teachers, event staff, or spectators, suggesting that these devices are important to overall public health as well.[7-9] SCA is fatal in individuals who do not receive immediate cardiopulmonary resuscitation (CPR) followed by defibrillation.[10] For each minute until defibrillation, survival rates decrease by between 7% and 10%; however, when CPR is started immediately survival

Anna Monroe, MD, is an emergency medicine resident at Wake Forest University Baptist Medical Center. She can be reached at amonroe (at) wfubmc.edu.

Daryl A. Rosenbaum, MD, is the director of the Primary Care Sports Medicine Fellowship in the Department of Family and Community Medicine at the Wake Forest University School of Medicine.

Stephen Davis, MA, is an assistant professor in the Department of Family and Community Medicine at the Wake Forest University School of Medicine.

rates decrease by 3% to 4% per minute.[2,11] Because recovery from SCA is a time-dependent phenomenon where even minutes can affect survival, it is unique from other traumatic sports-related injuries. Rapid and therefore effective response to a cardiac arrest requires planning and practice.[2,10]

A recent consensus statement produced by an interassociation task force convened by the National Athletic Trainers' Association (NATA) listed recommendations for essential elements of emergency planning for SCA which included the following elements: ensuring an efficient system for communicating within a school and with a local emergency medical services system (EMS); providing access to an automated external defibrillator and other necessary equipment to be utilized by trained responders; and practicing and perfecting a written action plan.[2] The NATA guidelines which build upon other previously published guidelines such as the Medical Emergency Response Plan Initiative from the American Heart Association (AHA) and the Guidelines for Emergency Medical Care in School from the American Academy of Pediatrics (AAP),[10,12] attempt to establish a standardized approach that all high schools and colleges should implement when preparing for cardiac emergencies.[2]

A study published in 2007 surveyed a random sample of middle and high school athletic directors across the United States in order to assess overall emergency preparedness as defined by a synthesis of recommendations from the recent NATA document, the AHA, and the AAP.[13] This study concluded that while a majority of responding schools (70%) possessed written emergency plans (WEP), emergency preparedness could be improved by attention to practicing the plans, improving communication with EMS, and increasing the numbers of AEDs in schools.[13] Previous studies have concluded that AED programs in high schools save lives and can be cost-effective.[7,14] Other studies have examined the numbers of devices that exist in schools in two other states without attention to their incorporation into a comprehensive emergency plan.[15,16] The NATA guidelines have set specific goals for emergency preparedness for SCA in athletic settings. The following study compares the SCA preparedness of high school athletic programs across the state of North Carolina with the recommendations published by NATA in order to identify potential areas for improvement.

Methods

A letter with a link to an electronic survey developed by the study authors using the online software Survey Monkey (http://www.surveymonkey.com) was emailed to all athletic directors in the state (n = 376) in 2007. Contact information was obtained from the North Carolina High School Athletic Association 2007-2008 Directory. Non-responders were emailed weekly over the course of the one-month study period during October 2007. The study was approved by the Wake Forest University School of Medicine Institutional Review Board and was funded by the Department of Family and Community Medicine at the Wake Forest University School of Medicine.

The 2007 NATA guidelines served as a theoretical gold standard with survey questions designed to assess both crucial and easily measured aspects of emergency planning: a documented, visible, and practiced plan that incorporates an AED (or meets guidelines for not needing one); time-based resuscitation goals; first responders training; and an efficient communication system across campus and with EMS. According to the AHA, the determinants for schools in need of AED programs are as follows: "reasonable probability" of AED use; children or adults at the school at risk for SCA; and inability to achieve an EMS call-to-shock interval of less than five minutes.[2] Time-based resuscitation goals consist of CPR initiation within one minute and defibrillation within three to five minutes of arrest. First responders consist of those people such as police and fire personnel or others who have basic CPR certification and provide assistance in the event of a medical emergency.

The data were analyzed with SPSS version 16.0. Simple descriptive statistics were used to determine the following: the proportion of responding schools reporting EAPs and the frequency that these plans met the NATA recommendations; the proportion of responding schools with AEDs and the frequency that the recommended device access, training, and maintenance guidelines were met; the presence of at-risk populations at schools without AEDs; and the frequency of reported barriers to obtaining an AED. Pearson chi-square testing was used to compare proportion of responders to non-responders by division and region to determine if possessing an AED was associated with the presence of an EAP. Logistic regression was used to determine if there was a trend for schools in smaller divisions to be less likely to report having an EAP or an AED than schools in larger divisions. Significance was set at the level $\alpha = 0.05$.

Results

Responses were obtained from 156 of 376 schools (41.5%). However, 18 surveys were rejected because they were incomplete leaving 138 (36.7%) in the final analysis. Responders and non-responders were similar with respect to athletic division (the level of athletic competition based on size of programs) ($p = 0.558$) and geographic location ($p = 0.627$).

Features of Emergency Action Plans

The majority of schools (55.8%) reported having written emergency action plans. EAPs were less likely to be present in schools from Division 1A ($p < 0.01$) and 2A ($p < 0.01$) than in

a North Carolina is divided into eight geographic regions by the North Carolina Athletic Association. The regions are numbered and run east to west across the state, starting with Region 1 in the far east of the state, and ending with Region 8 in the west.

the larger schools from Divisions 3 and 4 (see Table 1). With the exception of one region (EAP present in only three of 30 schools in Region 1), EAP plans showed little variability across regions (range 51.9% to 68.8%).[a] Further details about the EAPs are presented in Table 2.

AEDs as Part of Emergency Planning

Most (72.5%) schools that responded to the survey reported having an AED. The presence of an AED was related to the presence of an EAP ($p < 0.01$). Schools in Division 1 were less likely to report possessing an AED ($p < 0.01$) than

Table 1.
Association Between School Division: Emergency Action Plans and Automated External Defibrillators

Division (number enrolled)	Schools with Emergency Action Plans (N = 77)		Schools with Automated External Defibrillators (N = 100)	
	n (% of respondents)[a]	Odds ratio (95% confidence interval)	n (% of respondents)[a]	Odds ratio (95% confidence interval)
1A (28-729)	9 (28.1)	0.112 (0.037, 0.336)	16 (50.0)	0.161 (0.050, 0.520)
2A (732-1,041)	14 (46.7)	0.250 (0.086, 0.724)	22 (73.3)	0.444 (0.128, 1.539)
3A (1,056-1,392)	26 (65.0)	0.531 (0.191, 1.471)	31 (77.5)	0.556 (0.167, 1.847)
4A (1,394-2,977)	28 (77.8)	reference	31 (86.1)	reference

a The percent of respondents was derived from the number of respondents in each division. The numbers of respondents are as follows: Division 1A = 32; Division 2A = 30; Division 3A = 40; and Division 4A = 36.

Table 2.
Features of Emergency Action Plans; N=77

	Yes n (%)	No n (%)	Unsure n (%)			
CPR < 1 minute	62 (80.5)	6 (7.8)	9 (11.7)			
AED Shock 3-5 minutes	51 (66.2)	13 (16.9)	13 (16.9)			
Plan visible everywhere	10 (13.0)	60 (77.9)	7 (9.1)			
EMS has plan	17 (22.1)	38 (49.4)	22 (28.6)			
Plan practiced	> Once/Year n (%)	< Once/Year n (%)	Never n (%)	Unsure n (%)		
	14 (18.2)	18 (23.4)	31 (40.3)	14 (18.2)		
Medical oversight[a]	Trainer n (%)	First responder n (%)	EMS n (%)	Nurse n (%)	Team MD n (%)	Other n (%)
	62 (80.5)	29 (37.7)	16 (20.8)	14 (18.2)	9 (11.7)	6 (7.8)
Communication with EMS[a,b]	Cell phone n (%)	Walkie-talkie n (%)	Intercoms n (%)	Other n (%)	Alarm n (%)	Unsure n (%)
	122 (88.4)	90 (65.2)	55 (40.0)	10 (7.2)	5 (3.6)	2 (1.4)

a Respondents could select more than one.

b Respondents were asked to answer regardless of presence of EAP; therefore the denominator was 138 (total amount of people who responded to the survey).

schools in the three larger divisions (see Table 1). Features of AED programs are summarized in Table 3.

Characteristics of Schools Without AEDs

With respect to the AHA criteria for not needing an AED on site at a school, 89.5% of schools without AEDs were certain that no cardiac arrest had occurred on-site within five years, 7.9% reported having no one at risk for SCA, and 34.2% could achieve a call-to-shock interval of less than five minutes. The most commonly reported barrier to obtaining an AED was lack of funds (76.3%). See Table 4 for a complete summary of the responses from schools without AEDs.

Discussion

The majority of North Carolina high schools responding to the survey possessed emergency action plans, but the plans need polishing to improve compliance with published recommendations from the NATA. Appropriate time goals for resuscitation, the major determinant of survival after SCA, were targeted in the majority of plans. Other key measures, however, were lacking in the following areas: practicing the plans, displaying them visibly in all locations, and coordinating with EMS about the presence and details of emergency preparations. Plans were found more often in schools with AEDs, an encouraging result which suggests that schools with devices have incorporated them into a broader emergency plan. Higher divisions (and thus larger schools) were more likely to possess a plan, which indicates that smaller schools could be targeted for education and funding to improve emergency preparedness. As EMS was typically not informed of the presence of EAPs, schools should seek to include EMS in their planning.

The data for AEDs yielded encouraging results as the devices were found in the majority of schools and were reported to be accessible. There seemed to be good coordination with EMS with respect to knowledge of the presence of a defibrillator, and it is possible that in the event of a collapse, EMS personnel could direct school responders in the location and use of the AED. As the majority of schools listed less than 10 people trained in the use of an AED, schools that possess the device should consider training a larger number of people to use the defibrillators.

After surveying a random sample of NATA members from across the country, a 2007 study found that 70% of schools possessed written emergency action plans, a proportion higher than the 55.8% reported in this study.[13] However, a similar percentage of schools represented in both studies never practiced their plans (36% and 40% in the national study and present study respectively) and did not coordinate with EMS (51% and 49% in the national study and present study respectively).[13] The national survey study also reached the conclusion that increasing the number of AEDs in schools was indicated as only 61% of schools reported having the devices.[13] Although 72.5% of high schools in North Carolina possess AEDs, the large number of non-responders and the fact that there are at-risk adults and children at schools without AEDs imply that more devices may also be needed in North Carolina high schools. Data for written emergency plans as well as the number of AEDs in high schools exist for one other state (Tennessee), and data for either the number of written plans or the number of AEDs exist for several other states (Tennessee, Washington, Wisconsin, and Iowa).[13,15-18] Table 5 compares these results with the findings for North Carolina.

It is difficult to determine if schools without AEDs did not require an AED based on AHA guidelines, but most schools probably need a defibrillator based on previous research about response times and the fact that risk for SCA is hard to determine.[2,9,19] A meta-analysis of data for EMS systems and response to cardiac arrest showed that overall mean time from dispatch to defibrillation was 6.1 minutes.[19] The majority of responding schools did not know if EMS could arrive and defibrillate within five minutes. No school reported a cardiac arrest at the school within the last five years, but a substantial number (39.5%) felt there were people at the school at risk for SCA. The most commonly reported barrier to obtaining an AED in our study was cost, which is consistent with previous studies.[2,7,8,18] Schools in higher divisions (larger schools) with presumably greater resources reported possession of AEDs more frequently than schools in smaller divisions. If the estimated cost is $1,500 per AED,[2] can North Carolina schools and communities be convinced to make this investment?

Two studies analyzed comprehensive programs for establishing AED use in high schools.[7,14] In Boston, 35 AEDs were donated to schools who agreed to develop a plan for the use of the AED in accordance with American Heart Association protocols, train necessary people, and buy additional AEDs after assessing the needs of that particular school.[7] The majority of schools purchased more AEDs, and the program served as an impetus for AED training in the schools the community. AEDs were used in two cases, and both victims survived. A similar program, project ADAM, provides AEDs, education, and training for high schools in Milwaukee, Wisconsin.[14] In a study of this program, authors concluded that project ADAM was cost-effective.

Limitations

The primary limitation of this study is that only 36.7% of the high school athletic programs in North Carolina are represented. However, the total number of 138 usable responses from this study still provides substantial insight into the state of emergency preparedness of schools across the state. Representation of schools by division and geographic region was similar to the overall population.

Furthermore, although the survey was short and easily answered, those who took the time to respond likely already know the importance of emergency planning, leading to a possible selection bias. However there were no significant differences between the responders and non-responders by division or region, making a large selection bias less likely. The study also relies on honest subjective estimates for many

Table 3.
Characteristics of Plans for Use of Automated External Defibrillation (AED) N=100

	Yes n (%)	No n (%)	Unsure n (%)						
AED within 1-5 minutes walking	54 (54)	38 (38)	8 (8)						
EMS aware of AED	63 (63)	4 (4)	33 (33)						
AED used	1 (1)	99 (99)	n/a						
AED maintained	> Once per year n (%)	< Once per year n (%)	Never n (%)	Unsure n (%)					
	19 (19)	3 (3)	36 (36)	42 (42)					
Number of AEDs available	1 n (%)	2-5 n (%)	6-10 n (%)	> 11 n (%)	Unsure n (%)				
	49 (49)	50 (50)	0	0	1 (1)				
Trained to use AED	1-10 n (%)	11-20 n (%)	21-50 n (%)	> 51 n (%)	Unsure n (%)				
	64 (64)	15 (15)	12 (12)	1 (1)	8 (8)				
Who is trained[a]	Athletic trainer n (%)	School nurse n (%)	First responder n (%)	Athletic director n (%)	Coach n (%)	Teacher n (%)	Principal n (%)	Other n (%)	Unsure n (%)
	78 (78)	69 (69)	64 (64)	60 (60)	58 (58)	25 (25)	19 (19)	8 (8)	4 (4)

a Respondents could select more than one.

Table 4.
Characteristics of Schools Without AEDs (N=38)

	Yes n (%)	No n (%)	Unsure n (%)			
Cardiac arrest within past 5 years	0	34 (89.5)	4 (10.5)			
Adults working at or children attending who are at risk for sudden cardiac arrest (SCA)	15 (39.5)	3 (7.9)	20 (52.6)			
EMS can achieve call-to-shock interval < 5 minutes	13 (34.2)	9 (23.7)	16 (42.1)			
Barriers to obtaining AED[a]	I feel it is unnecessary n (%)	Lack of funds n (%)	Lack of ability to train people n (%)	Lack of familiarity with SCA n (%)	No barriers n (%)	Other n (%)
	0	29 (76.3)	4 (10.5)	4 (10.5)	4 (10.5)	7 (18.4)

a Respondents could select more than one.

Table 5.
Comparison Between Selected States and the Nation for the Presence of EAPs and AEDs in High Schools[13,15-18]

	Percentage of high schools with an EAP	Percentage of high schools with an AED
Nation	70	61
North Carolina	56	73
Tennessee	76	47
Washington	n/a[a]	54
Iowa	n/a	25
Wisconsin	73[b]	n/a

a "n/a" refers to the fact that this particular study did not address that data.
b This study dealt only with the presence of EAPs for football; it did not address whether other sports had adequate emergency planning.

values such as EMS response times and walking distance to the AEDs that were not otherwise verified.

Conclusion

When a family, an athletic team, and a school find themselves faced with an SCA event the results can be devastating. Having a planned approach based on current understanding of resuscitation physiology can help improve outcomes.[2] This study found that nearly three-quarters of the North Carolina high schools that responded possess AEDs, and this compares favorably with other states. Still, schools should consider increasing the number of people trained to use the devices. Fewer schools have a written an emergency plan, and only about two-thirds of these plans aim to achieve the recommended call-to-shock interval of less than five minutes, suggesting specific areas for improvement. Also, those schools with plans should consider practicing the plans more frequently and improving coordination with EMS. As smaller schools are deficient in both planning and possession of AEDs, efforts to improve emergency planning could be targeted towards these schools. **NCMJ**

Addendum:

Much has transpired since the data was collected for this study in October of 2007.

Through the AED Placement Project, initiated and funded by the North Carolina High School Athletic Association, over 100 high schools in need have received devices after completing required staff training and developing an appropriate cardiac emergency action plan.

During the fall of 2008, three high school students died as a result of athletic participation. The announced cause of death for one of the athletes was second impact syndrome head injury. One of the first responses by the North Carolina High School Athletic Association (NCHSAA) to these unfortunate tragedies was to mandate that by January 1, 2009 all member schools create a written Emergency Action Plan.

The NCHSAA also formed a safety task force in November of 2008. This group developed specific guidelines to help schools create an optimal EAP and also made several recommendations including: 1) mandate use of a single pre-participation examination form endorsed by leading sports medicine organizations; 2) standardized baseline and post-injury concussion assessment and return to play guidelines; 3) mandatory annual athletic safety education for all athletics personnel and participants similar to the annual eligibility rules review; and 4) ideally, all schools should hire a certified athletic trainer to lead the sports medicine team and coordinate health care of athletes.

Two additional high school athletes have died in 2009. The announced cause of death for one of the athletes was myocarditis.

— Daryl A. Rosenbaum, MD

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