

# High School Coaches' Knowledge of Emergency Care

*Bradford Strand<sup>1</sup>*  
*Katie J. Lyman<sup>1</sup>*  
*Shannon David<sup>1</sup>*  
*Kassiann Landin<sup>1</sup>*  
*Jay Albrecht<sup>2</sup>*  
*Joe Deutsch<sup>1</sup>*

<sup>1</sup>Senior author & member of the ICPER SD, North Dakota State University, 1340 Administration Avenue, Fargo, ND 58105, [Bradford.strand@ndsu.edu](mailto:Bradford.strand@ndsu.edu)

<sup>1</sup>North Dakota State University, [Katie.lyman@ndsu.edu](mailto:Katie.lyman@ndsu.edu), ORCID 0000-0000-7905-0526

<sup>1</sup>North Dakota State University, [Shannon.david@ndsu.edu](mailto:Shannon.david@ndsu.edu)

<sup>1</sup>North Dakota State University, [Kassiann.landin@ndsu.edu](mailto:Kassiann.landin@ndsu.edu)

<sup>2</sup>Minnesota State University Moorhead, [Jay.albrecht@mnstate.edu](mailto:Jay.albrecht@mnstate.edu)

<sup>1</sup>Member of ICPHER SD, North Dakota State University, [Joe.deutsch@ndsu.edu](mailto:Joe.deutsch@ndsu.edu)

## Abstract

Although high school coaches are encouraged to obtain certifications in cardiopulmonary resuscitation (CPR), automated external defibrillators (AED), and first aid (FA), there is no national and few state mandates for coaches to maintain adequate knowledge regarding emergency care for youth athletes. As youth participation in organized events continues to grow, the incidence of injury and sudden death has subsequently increased. The purpose of this study was to investigate high school coaches' knowledge of basic FA, CPR, and AED. Coaches (N= 89, 21.3% females, 78.2% males) at a high school coaches' association state conference completed a demographics questionnaire and 20-question, multiple-choice survey about emergency medical care. Although 87.6% of coaches who participated were FA certified and 91% were CPR certified, results of the survey indicated a lack of knowledge of basic skill-related questions in the topics of youth CPR and AED. Based on the results of the current study, coaches did not retain adequate knowledge to act competently in the event of an emergency of cardiac origin. National standards for specific emergency care education and recertification should be implemented for all high school coaches (paid or volunteer); standards that would require coaches to stay current on emergency medical interventions.

*Key words:* CPR, AED, first aid, youth sport

To provide optimal care for pediatric and adolescent athletes who suffer from an injury or emergency condition, coaches are often the first responders when immediate medical care is not provided

by an allied healthcare professional. As of 2016-2017, the number of student athletes in secondary settings was approximately 7.9 million (National Federation of State High School Associations, 2017a). The National Federation of State High School Associations (NFHSA) also reports the number of participants has steadily increased over the last 27 years (NHFSAs, 2016). As participation in organized sport grows, the incidence of injury and sudden death is subsequently on the rise (Pike, Pryor, Vandermark, Mazerolle, & Casa, 2017; Rechel, Yard, & Comstock, 2008; Van Camp, Bloor, Mueller, Cantu, & Olson, 1995). According to the National Athletic Trainers' Association (NATA) position statement, *Preventing Sudden Death in Sports*, approximately half of high schools and other athletic venues may not have access to athletic trainers or other medical staff (Casa, et al., 2012). Thus, injured athletes are dependent on coaches who may or may not be properly trained to recognize the signs and symptoms of emergent conditions or to provide accurate emergency care when necessary.

There are organizations that provide standards and recommendations for coaches who pursue formal education in coaching, yet there is no nationally set requirement to learn FA, CPR, and AED skills regardless of whether they are a career coach or volunteer coach. The Society of Health and Physical Educators (SHAPE) America, provides direction for coaches based on eight specific domains of coaching. Domain 2 consists of Safety and Injury Prevention because, as previously stated, often times a coach may be the only first responder in the event of an emergency (National Association for Sport and Physical Education, 2006). In 2007, the NFHSA implemented a coaching education program, which includes FA and injury prevention education for their coaches; however, there is no governing body mandating participation in this course (NFHSA, 2017b). The NFHSA provides state associations with rules of play for officials and coaches but does not focus on providing emergency care for athletes (NFHSA, 2017c). Due to a lack of national standards at all coaching levels, it is difficult for researchers to obtain data regarding the number of coaches across the country who are adequately prepared to act in the event of an emergency.

According to the *National Coaching Report* (NASPE, 2008), only 65% of individual state associations require FA training, while only 29% of states require CPR training for all of their coaches. Meanwhile, only 22% of state high school associations require all coaches to hold a current CPR certification. Maine is the only state that requires AED training for all coaches regardless of level of sport (NASPE, 2008).

Recently reported out of Minnesota, coaches at a high school helped save the life of a student-athlete who suffered a cardiac emergency during basketball practice (NFHSA, 2017d). Despite the media reports of sudden cardiac death in athletes, there is no national mandate for coaches to be certified in FA, CPR, or AED (National Association for Sport and Physical Education, 2006; Almquist, et al., 2003; National Collegiate Athletic Association, 2012; Bales, & Ryan, 2012; National Council on Youth Safety,

2016; National Committee for Accreditation of Coaching Education, 2015; Patterson, 2016; Alberts, 2014).

Multiple researchers have reported findings that less than 90% of coaches were certified in CPR, AED, or FA at the time of their studies (Albrecht, Strand, & Mozumdar, 2010; Cross, et al., 2010; Harer & Yaeger, 2014). One study found less than 30% of the coaches were CPR certified and even less were FA certified (Albrecht, Strand, & Mozumdar, 2010). Although there is data supporting the need for coaches to be trained in FA, CPR, and AED, there is a lack of information regarding the number of coaches who are actively coaching with proper certifications. There is also a lack of information regarding the current level of knowledge among active coaches who are CPR, AED, and FA certified. The purpose of this study was to illustrate state high school coaches' knowledge of basic FA (including heat-related illness and asthma), CPR, and AED.

**Methods**

**Participants and Procedures**

Participants of this study were coaches who attended a Midwestern state high school annual coaches' conference. During registration at the convention, participants were recruited and provided consent information. A mid-sized, research university Institutional Review Board approved all procedures and instrumentations for this study. Inclusion criteria included being a high school athletics coach who was 18 years of age or older. Ninety coaches participated in the study (N= 90), but not all participants fully completed the survey (n= 89). As displayed in Table 1, more males than females took part in the research, (21.3% females, 78.7% males). Table 1 also displays the age groups, status of participants, highest degree earned (n=88), sport coached, and number of years of coaching experience. With respect to the years in the coaching profession, data indicated there were a relatively even spread of years among participants. Data were also relatively evenly spread regarding the degree participants had acquired. The majority of coaches were teachers of a subject other than physical education (59.6%). The top sports that were represented were basketball (28.6%), American football (18.7%) and cross country (16.5%).

**Table 1. Demographics of Participants**

Variable	Number (Percentage)
Gender (n=89)*	
Male	70 (78.7%)
Female	19 (21.3%)
Age Groups (n=89)*	
20-29	11 (12.4%)
30-39	34 (38.2%)
40-49	30 (33.7%)
50+	14 (15.7%)
Highest Degree (n=88)	
Bachelor's Degree	46 (52.3%)
Master's Degree	42 (47.7%)

Experience (in years) (n=89)*	
1-5	18 (20.2%)
6-10	22 (24.7%)
11-15	16 (18%)
16-20	11 (12.4%)
20 +	22 (24.7%)
Status (n=89)*	
Coach Only	10(11.2%)
PE Teacher Only	2 (2.2%)
PE Teacher + Coach	24(27%)
Other Subject + Coach	53(59.6%)
Sports Coached (90)**	
American Football	17(18.7%)
Baseball	7(7.7%)
Cross Country	15(16.5%)
Track and Field	9(9.9%)
Swimming	1(1.1%)
Basketball	26(28.6%)
Softball	3(3.3%)
Tennis	2(2.2%)
Wrestling	1(1.1%)
Volleyball	7(7.7%)

\* n denotes how many participants actually answered the question

\*\* denotes that one participant may have coached more than one sport

Ninety-one percent (91%) of high school coaches who were surveyed held a current CPR certification at the time of the study while 9% of coaches surveyed did not. Concerning FA, 87.6% of participants held a current certification, while 12.4% did not. Table 2 displays the percentages of coaches currently CPR certified, currently FA certified, as well as the entity of certification.

**Table 2. CPR/AED/First Aid Certification Demographics**

FA Certification (n=89)*	n	% (Adjusted)
Yes Certified	78	87.6
Not Certified	11	12.4
FA Certifying Body		
American Red Cross	51	68.8
American Heart Association	16	21.6
PREPARE	1	1.4
American Sport Ed. Program	1	1.4
Other	5	6.8
(missing)	16	
CPR/AED Certification (n=89)*		
Certified	81	91
Not Certified	8	9
CPR/AED Certifying Body		
ARC	53	68.8
AHA	22	28.6
Other	2	2.6
(missing)	13	

\* n denotes how many participants actually answered the question

**Instrumentation**

The survey instrumentation used for this study consisted of three sections. Section 1 regarded coaching certification and consisted of 8 questions. Section 2 consisted of 10 demographic questions. Section 3 was a 20-question, multiple-choice examination with 5 questions related to each of the following categories: asthma knowledge, heat-related illness knowledge, CPR knowledge, and AED knowledge. The exam was developed by modifying FA, CPR, and AED questions from American Red Cross (ARC) and American Heart Association (AHA) tests. Section 3 was similar to a survey used in previous research, which was directed toward understanding coaches' qualifications and knowledge in youth sports (Albrecht, Strand, & Mozumdar, 2010).

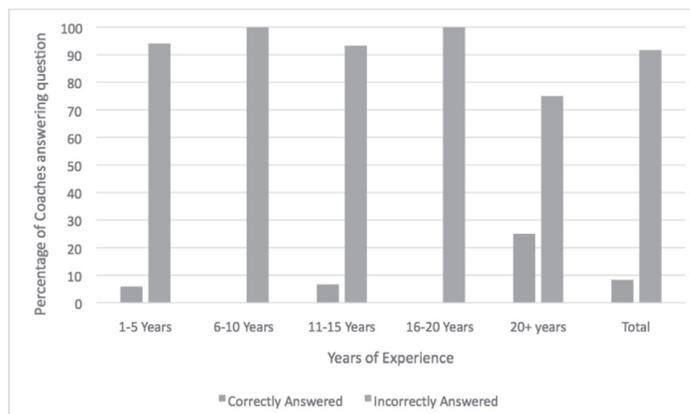
**Analysis of Data**

SAS version 9.4 (SAS Institute, Cary, NC) was used to analyze the data. An alpha level of 0.05 was used to determine statistical significance. Fisher's Exact test was used to analyze the relationship between years of experience and coaches' knowledge of asthma, heat-related illness, CPR, and AED. In addition, an independent samples t-test was used to compare scores in the four topic areas and coaches' level of education. Although the questions on the survey were grouped into four categories, we wanted to compare the results of individual questions as opposed to the broad category. By evaluating each question, we were able to identify specific content youth coaches could not recall and explore particular traits to try to identify trends.

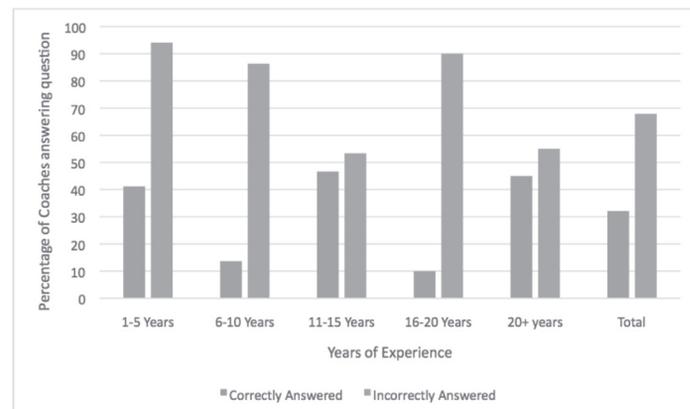
**Results**

According to Fisher's Exact test, years of coaching experience had a significant effect on coaches' knowledge of asthma (question 1), child CPR (questions 12 and 15), and child AED (question 20). Figure 1 indicates coaches with less experience (1-15 years) answered asthma-related questions correctly ( $p = .019$ ). Figure 2 and Figure 3 show coaches in all groups, regardless of years of experience, answered child CPR questions (questions 12 and 15) incorrectly with statistical significance ( $p = .039$ ,  $p = .047$ , respectively). Figure 4 displays coaches with 1-5 years of experience had significantly less knowledge than those with more coaching experience regarding AED usage on a child ( $p = .036$ ). In regards to questions pertaining to heat-related illness, years of experience did not have a significant effect on coaches' knowledge.

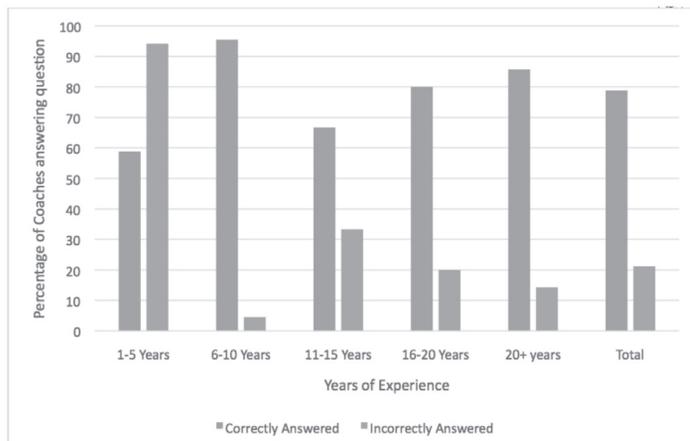
scarring and impaired diffusion/D. Inflammation and spasm] in the bronchi.)



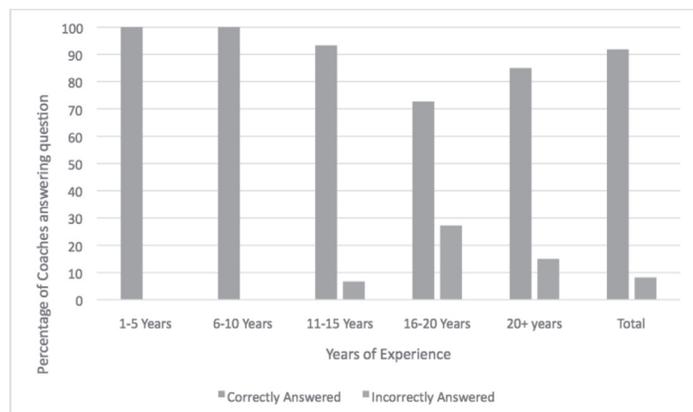
**Figure 2.** Fishers Exact Test for Question 12 (What is the proper depth of chest compressions when performing CPR on a Child? [A.1/2 inch/B. 1 inch/C. 1 1/2 inches/D. 2 inches])



**Figure 3.** Fishers Exact Test for Question 15 (The correct compression to ventilation ratio for 1 rescuer Child CPR is...[A.15:2/B. 15:1/C. 30:2/D. 30:1])



**Figure 4.** Fishers Exact Test for Question 20 (What is the correct order of steps when using an AED? [A. Ensure the patient is unresponsive; Cut the pads to fit the chest; Place the pads on the chest; Turn on the AED./B. Ensure the patient is unresponsive; Provide 5])



**Figure 1.** Fishers Exact Test for Question 1 (Asthma produces [A.Bleeding and obstruction/B. Spasm and rales/C. Fibrous

An independent-samples t-test was conducted to compare coaches' level of education (i.e., Bachelor's or Master's degree) to the answers provided in the four topic areas. There was a significant difference in the scores for coaches with their Bachelor's and Master's degrees in two questions. Significant difference in question 11 relating to CPR was noted for coaches with Bachelor's degrees ( $M=.81, SD=.394$ ) versus Masters degrees [ $(M=.98, SD=.158); t(56)=-2.476, p=.016$ ]. Significant difference also occurred in question 19, an AED question, for coaches with Bachelor's degrees ( $M=.186, SD=.3937$ ) compared to Master's degrees [ $(M=.429, SD=.5009); t(78)=-2.478, p=.015$ ]. These results suggest that while there is significance in two questions out of a total of 20, degree status, overall, does not effect coaches' knowledge in the aforementioned subjects.

### Discussion

The current study found 87.6% of the surveyed high school coaches held their FA certification and 91% held a current CPR certification. Although these coaches participated in formal education to receive these certifications, we found their knowledge is still lacking in the areas related to youth CPR and AED as well as asthma, but were well educated in heat-related illness. Of the five questions pertaining to the heat-related illness category, we found most coaches were able to answer questions related to identifying the illness, diagnosis, and initial treatment. In an effort to investigate perceived knowledge of coaches regarding heat-related illness, Adams et al. (2014) interviewed 38 high school head football coaches for an in-depth analysis of their confidence in managing an associated illness. Of the 38 coaches, 63% felt as though they were prepared to handle an emergency related to exertional heat illness. In contrast to our findings, the researchers noted that coaches' self-confidence did not match their actual knowledge of signs and symptoms or diagnostic tools. The media has assisted with an emphasis on understanding heat-related illness, prevention strategies, and management of the illness (Bernstein, 2011). However, more research, specifically related to scenario-based questions, should be conducted to assist coaches with their overall handling of a heat-related illness.

According to our findings, as reported in Figure 1, coaches with more years of experience had limited knowledge regarding the pathological process of asthma (question 11: related to asthma in the bronchii). It has been well documented that youth diagnosed with asthma can participate in organized sport provided both the child and the coach are prepared to intervene in the event of an emergency (Cardwell & Elliott, 2018; Miller, Weiler, Baker, Collins, & D'Alonzo, 2005). Coaches should have a basic understanding of an emergent bronchospasm as opposed to being out of shape. A misdiagnosis of asthma or exercise-induced asthma (EIA) can be detrimental to youth suffering from the conditions (Storms, 1995). Even though asthma is one of the most common chronic illnesses in childhood and can be fatal (CDC, 2018), no specific research to coaches' knowledge about asthma can be ascertained. Therefore, our research highlighting specific content coaches should receive during formal FA education is critical to evidence-based changes to the coaching curriculum.

Further, the results of this study revealed a deficiency in the knowledge of coaches regarding youth CPR and AED mechanics.

These questions are of particular importance because they are directly related to the basics of how to properly perform CPR and operate an AED. According to Figures 2 and 3, coaches in all groups, regardless of years of experience, answered youth CPR questions incorrectly. These questions involved knowing the proper depth of chest compressions for youth CPR (question 12), as well as the correct compression to ventilation ration for single rescuer performed on a patient ages 8 to 18 (question 15). The AHA releases updated guidelines based on contemporary and existing research every five years (AHA, 2018). Therefore, coaches must make a conscious effort to attend formal training and learn the recommendations to provide high-quality CPR. Based on the changes made every five years, we hypothesized coaches who had greater longevity would have less knowledge than those coaches who may have more recently been privy to the newest AHA guidelines. However, we found no relationship to years of experience and knowledge related to athletes ages 8 to 18. Although previous research and editorials have all agreed that coaches should be certified in CPR and AED (Butler, 2005; Ransone & Dunn-Bennett, 1999), limited research has been conducted on coaches' familiarity of the specifics of CPR. Researchers have suggested that formal and recurrent education can assist healthcare providers with their overall knowledge and confidence in performing CPR (Kallestedt et al., 2012). While we are unable to directly compare our results to the research of others, we suggest coaches, regardless of years of experience, participate in initial and annual training to ensure coaches have the knowledge and skill set to intervene in the event of sudden cardiac arrest.

Finally, as established in Figure 4, coaches with less years of experience had significantly less knowledge in the topic of AED operation on a child. This is concerning because question 20 asked the correct order of steps when using an AED; a medical intervention that coaches who have been properly trained should be able to answer correctly. The lack of knowledge in high school coaches is concerning, especially for schools without the support of medical staff. A specific example from the North Dakota High School Athletic Association (NDHSAA) suggests high school coaches must hold the state certified coaching permit. This permit requires coaches be CPR and AED certified, and it also requires coaches complete a FA and concussion management course (NDHSAA, 2012). While the requirements are a step in the right direction to guarantee all coaches are CPR/AED and FA certified, the state permit only needs to be renewed every five years. The current AHA and ARC recommendation is to complete refresher training every two years; therefore, there is the potential for a three-year gap between coaching and CPR/AED and first aid training.

Previous literature suggests coaching education has improved in the past due to the introduction of accredited coaching education programs and the proposal of training by multiple organizations. Results from the current study indicate there is still knowledge that is lacking in emergency care topics (Almquist, et al., 2003; Harer, & Yaeger, 2014; NASPE, 2006; National Collegiate Athletic Association, 2012; Cross, et al., 2010). Our findings show the degree status does not significantly effect knowledge even though literature suggests that overall coaching education has improved. Our findings paired with results from studies completed by Cross et al. (2010) regarding coaches in South Dakota, as well as Harer

and Yaeger (2014) regarding coaches in Wisconsin, substantiate that coaches across separate states are not upholding best practices encouraged by the Inter-Association Task Force (Albrecht, Strand, & Mozumdar, 2010; Almquist, et al., 2003; Cross et al., 2010; Harer & Yaeger 2014; NASPE, 2008; Ransone, & Dunn-Bennett, 1999).

The National Alliance for Youth Sports (NAYS) released a document, which discusses the specific standards related to youth participation in sports as well as the expectations of coaches. This document states, "it is important for programs to take every precaution to protect participants from dangerous situations and in the event of an accident or emergency, everyone must be prepared to act" (McLeod, et al., 2011, p. 7). The standards also state there should be an adult trained in CPR, AED, and FA at every practice or game; yet there are no national standards requiring certification for coaches (McLeod, et al., 2011). It is worth noting that coaches correctly answered questions pertaining to heat-related illness, thus demonstrating some knowledge coaches have accrued deems valuable in specific content areas. The Centers for Disease Control and Prevention (CDC) calls for coaches to pay attention to temperature and ensure proper prevention of heat-related illness (CDC, 2017). Heat-related illness is a part of FA education, and coaches are responsible to minimize the risk of a heat-related event (NDHSAA, 2012; NFSHA, 2017c; McLeod, et al., 2011).

With the incidence of injury in youth athletics well substantiated, athletics programs should ensure coaches are prepared to provide high-quality, emergency care (Casa, et al., 2012; CDC, 2017a; CDC, 2017b; Maron, et al., 2017; McLeod, et al., 2011; NAYS, 2017; Rechel, Yard, & Comstock, 2008; Van Camp, et al., 1995). Administrators and sporting organizations should require coaches and volunteers to obtain CPR, AED and FA certification in hopes of protecting the safety and well-being of youth athletes.

### Limitations

The primary limitation to the current study is that researchers investigated knowledge but did not investigate FA, CPR, or AED psychomotor skills. Previous research has been conducted regarding skill retention for those performing CPR and AED skills, noting performance decreases substantially over time (Gajewski & Saul, 2010; Papalexopoulou, et al., 2014). Based on these studies, it appears skill acquisition is also dependent on the type of training or education originally provided (Abella, et al., 2007; Batcheller, et al., 2000; Braslow, et al., 1997; Gajewski & Saul, 2010; Lynch, et al., 2005; Nord, et al., 2016; Papalexopoulou, et al., 2014). Thus, formal education for coaches should focus on integrating knowledge and skill to reinforce retention.

Another limitation of this study is that researchers did not analyze confidence levels of coaches' perceived abilities to perform FA or CPR/AED in the event of an emergency. Thus, further research should be completed similar to Strand, David, Lyman, and Albrecht's (2017) study related to knowledge and confidence regarding athlete safety and injury management. This research should also be completed to ensure skill retention is adequate such that coaches are confident in performing appropriate skills necessary to provide quality emergency care. A final limitation is that researchers utilized a convenience sample of high school coaches in one state; thus, the results may not be representative of

other areas. However, researchers in all 50 states should consider surveying coaches to add to the discussion about a universal mandate of coaches' emergency preparation.

### Conclusion

Modern society has seen an ongoing trend of increasing student athlete numbers participating in organized sport, and with that trend is a corresponding rise of injury and illness in connection with sport participation. Coaches are often the first responders for an injured or ill athlete when allied health professionals are not immediately available in a competitive sport setting. Indeed, they should have the knowledge and psychomotor skills to assist youth athletes until more advanced medical help arrives to manage an injury or illness occurrence.

Given this reality, it is no surprise that the national organizations cited throughout this study recommend that CPR and FA training be part of the education provided to future and present-day coaches. Despite this laudable goal, however, there are no national requirements or mandates as to CPR or FA training for coaching certification.

This study explored coaches' knowledge regarding four emergency medical content areas, and the results show that further attention is needed to ensure that coaches have the adequate knowledge and ability to intervene in the event of an emergency involving a sport-related incident. We acknowledge that current and updated AHA- and/or ARC-directed certifications for coaches at the secondary sport levels of competition have moved in the correct direction. Indeed, some coaches with those certifications had improved abilities to respond to the questions asked in this study; however, the results were mixed. Further, even for coaches who tested better, the experience with those programs certainly did not assure that a coach would know what to do in all four emergency content areas.

Sport organizations that certify coaches have an excellent opportunity to mandate training for coaches and should require that the coaches become CPR and/or FA certified. Administrators and parents of youth who are participating in athletics have reasonable expectations that the environment of organized sport will be safe and that the youth will be in the care of competent coaches who are able to handle emergency safety issues until allied health professionals arrive on the scene. Improving the training and setting certification requirements for coaches would be a step in the right direction to meet those reasonable expectations.

### References

- Abella, B. S., Edelson, D. P., Kim, S., Retzer, E., Myklebust, H., . . . & Becker, L. B. (2007). CPR quality improvement during in-hospital cardiac arrest using a real-time audiovisual feedback system. *Resuscitation*, 73, 54-61.
- Alberts, L. (2014). Do you know CPR? *National Alliance for Youth Sports*. Retrieved From. <http://www.nays.org/cmscontent/File/Feature-pdf.pdf>
- Albrecht, J., Strand, B., & Mozumdar, A. (2010). Basic first aid qualifications and knowledge among youth sport coaches. *Journal of Coaching Education*, 3(3), 3-18.
- Almquist, J., Pally, R., Shields Jr, C., Loud, K., Jenkinson, D., Hunter, R., ... Iezzi, J. (2003). *National athletic trainers'*

- association consensus statement: *Appropriate medical care for secondary school-age athletes*. Retrieved From <https://www.nata.org/sites/default/files/appropriatemedicalcare4secondarieschoolageathletes.pdf>
- American Heart Association. (2018). CPR & ECC Guidelines. Retrieved from <https://eccguidelines.heart.org>.
- Bales, J., & Ryan A. (2012). *International sport coaching framework*. Retrieved from <http://www.icce.ws/projects/international-sport-coaching-framework.html>
- Batcheller, A. M., Brennan, R. T., Braslow, A., Urrutia, A., & Kaye, W. (2000). Cardiopulmonary resuscitation performance of subjects over forty is better following half-hour video self-instruction compared to traditional four-hour classroom training. *Resuscitation*, 43, 101-110.
- Bernstein, L. (2011, July 26). Sudden death during exercise: How we fall short protecting young athletes. *The Washington Post*.
- Braslow, A., Brennan, R. T., Newman, M. M., Bircher, N. G., Batcheller, A. M., & Kaye, W. (1997). CPR training without an instructor: Development and evaluation of a video self-instructional system for effective performance of cardiopulmonary resuscitation. *Resuscitation*, 34, 207-220.
- Butler, L. L. (2005). What level of competence in sports medicine should be required of coaches? *Journal of Physical Education, Recreation, & Dance*, 76(8), 14-15.
- Cardwell, F & Elliott, S. (2018). Investigating youth sport coach perspectives of an asthma education module. *Journal of Environmental and Public Health*, 2018, 1-12.
- Casa, D., Guskiewicz, K., Anderson, S., Courson, R., Heck, J., Jimenez, C., ... Walsh, K. (2012). National athletic trainers' association position statement: preventing sudden death in sports. *Journal of Athletic Training*, 47, 96-118.
- Centers for Disease Control and Prevention. (2018). Most recent asthma data. Available from: [http://www.cdc.gov/asthma/most\\_recent\\_data.htm](http://www.cdc.gov/asthma/most_recent_data.htm).
- Centers for Disease Control and Prevention. (2017a). *Protect the ones you love: Child injuries are preventable*. Available from: [http://www.cdc.gov/safekid/Sports\\_Injuries/](http://www.cdc.gov/safekid/Sports_Injuries/)
- Centers for Disease Control and Prevention. (2017b). Sudden death in young athletes. *The New England Journal of Medicine*, 349, 1064-1075.
- Cross, P., Karges, J., Adamson, A., Arnold, M., Meier, C., & Hood, J. (2010). Assessing the need for knowledge on injury management among high school athletic coaches in South Dakota. *South Dakota Medicine*, 5, 241-245.
- Gajewski, K. K., & Saul, J. P. (2010). Sudden cardiac death in children and adolescents (excluding Sudden Infant Death Syndrome), *Annals of Pediatric Cardiology*, 3, 107-112.
- Harer, M., & Yaeger, J. (2014). A Survey of certification for cardiopulmonary resuscitation in high school athletic coaches. *Wisconsin Medical Journal*, 113(4), 144-148.
- Kallestedt, M-L., Berglund, A., Herlitz, J., Leppert, J., & Enlund, M. (2012). The impact of CPR and AED training on healthcare professionals' self-perceived attitudes to performing resuscitation. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine*, 20(26).
- Lynch, B., Einspruch, E. L., Nichol, G., Becker, L. B., Aufderheide, T. P., & Idris, A. (2005). Effectiveness of a 30-min CPR self-instruction program for lay responders: a controlled randomized study. *Resuscitation*, 67(1), 31-43.
- Maron, B. J., Shirani, J., Poliac, L. C., Mathenge, R., Roberts, W. C., & Mueller, F. O. (2017). Sudden death in young competitive athletes: Clinical, demographic, and pathological profiles. *Journal of American Medical Association*, 276, 199-204.
- McLeod, T., Decoster, L., Loud, K., Micheli, L., Parker, R., Sandrey, M., & White, C. (2011). National Athletic Trainers' Association Position Statement: Prevention of Pediatric Overuse Injuries. *Journal of Athletic Training*, 46, 206-220.
- Miller, M., Weiler, J., Baker, R., Collins, J., and D'Alonzo, G. (2005). National Athletic Trainers' Association Position Statement: Management of Asthma in Athletes. *Journal of Athletic Training*, 40, 224-245.
- National Alliance for Youth Sports. (2017). *National standards for youth sports*. Retrieved from: [http://www.nays.org/default/assets/File/download-forms/National%20Standards%20for%200Youth%20Sports%202017%20\(2\).pdf](http://www.nays.org/default/assets/File/download-forms/National%20Standards%20for%200Youth%20Sports%202017%20(2).pdf)
- National Association for Sport and Physical Education. (2006). *National standards for sport coaches* (2nd ed.). Retrieved from <http://www.shapeamerica.org/standards/coaching/>
- National Association for Sport and Physical Education. (2008). *National coaching report*. (2nd ed.). Reston, VA. National Association for Sport and Physical Education.
- National Collegiate Athletic Association. (2012). *NCAA participates in inter-association task force to prevent sudden death in sport*. Retrieved From <http://www.ncaa.org/about/resources/media-center/news/ncaa-participates-inter-association-task-force-prevent-sudden>
- National Committee for Accreditation of Coaching Education. (2015). *Registry of accredited programs*. Retrieved from <http://www.qualitycoachingeducation.org/accredited-programs/>
- National Council on Youth Safety. (2016). *When it comes to kids, safety is no accident*. Retrieved from <http://www.ncys.org/safety/8-ways-to-keep-athletes-safe.php>
- National Federation of State High School Associations. (2016, Sept.). *High school sports participation increases for 27th consecutive year*. Retrieved from <https://www.nfhs.org/articles/high-school-sports-participation-increases-for-27th-consecutive-year/>
- National Federation of State High School Associations. (2017a). *High school athletics participation survey results*. Retrieved from [http://www.nfhs.org/ParticipationStatistics/PDF/201617\\_Participation\\_Survey\\_Results.pdf](http://www.nfhs.org/ParticipationStatistics/PDF/201617_Participation_Survey_Results.pdf)
- National Federation of State High School Associations. (2017b). *NFHS core course first aid, health and safety*. Retrieved from <https://nfhslearn.com/courses/26/first-aid-health-and-safety>
- National Federation of State High School Associations. (2017c). *NFHS member state and affiliate associations*. Retrieved from <http://www.nfhs.org/resources/state-association-listing>
- National Federation of State High School Associations. (2017d). *Thanks to the miracle in Monticello, a life is saved*. Retrieved from <https://www.nfhs.org/articles/thanks-to-the-miracle-in-monticello-a-life-is-saved/>
- Nord, A., Svensson, L., Hult, H., Kreitz-Sandberg, S., & Nilsson, L. (2016). Effect of mobile application-based versus DVD-based CPR training on students' practical CPR skills and willingness

- to act: A cluster randomised study. *BMJ Open*, 6(4), 1-9.
- North Dakota High School Athletic Association. (2012). *Coaches certified permit requirements*. Retrieved from <http://www.ndhsca.com/certificationchecklist.pdf>
- Papalexopoulou, K., Chalkias, A., Dontas, I., Pliatsika, P., Giannakakos, C., Papapanagiotou, P. ... Xanthos, T. (2014). Education and age affect skill acquisition and retention in lay rescuers after a European Resuscitation Council CPR/AED course. *Heart Lung, The Journal of Acute and Critical Care*, 43(1), 66-71.
- Patterson, D. (2016). A coaches guide to first aid. *National Alliance for Youth Sports, Sporting Kid Live*. Retrieved from <http://www.nays.org/sklive/for-coaches/a-coach-s-guide-to-first-aid/>
- Pike, A., Pryor, R., Vandermark, L., Mazerolle, S., & Casa, D. (2017). Athletic trainer services in public and private secondary schools. *Journal of Athletic Training*, 52, 5-11
- Rechel, J., Yard, E., & Comstock, R. (2008). An epidemiologic comparison of high school sports injuries sustained in practice and competition. *Journal of Athletic Training*, 43, 197-204
- Ransone, J., & Dunn-Bennett, L. R. (1999). Assessment of first-aid knowledge and decision making of high school athletic coaches. *Journal of Athletic Training*, 34, 267-271.
- Strand, B., David, S., Lyman, K., & Albrecht, J. (2017). Coaching in the United States: High school coaches' knowledge and confidence regarding athlete safety and injury management. *International Sport Coaching Journal*, 4, 220-234.
- Storms, W. W. (1995.) Exercise-induced asthma in athletes: Current issues. *Journal of Asthma*, 32, 245-247.
- Van Camp, S., Bloor, C., Mueller, F., Cantu, R., & Olson, H. (1995). Nontraumatic sports death in high school and college athletes. *Medicine and Science in Sports and Exercise*, 27, 641-647. ■