CPR Training in Schools-Lifeline for Sudden Cardiac Arrest Victims: A Review

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The sudden occurrence of cardiac arrest during sports affects approximately 1 in every 50,000 -80,000 young athletes. The chances of survival are meager for most cardiac arrest cases, especially those that occur outside of a hospital setting. Additionally, survivors often experience poor neurological recovery due to immediate brain damage during cardiac arrest. Unfortunately, only 40% of the patients receive immediate clinically appropriate care. In situations where professional help is not readily available, bystanders play a critical role in administering basic life support. Several studies have shown that children can effectively learn cardiopulmonary resuscitation (CPR) techniques with an apparent increase in their confidence and willingness to perform CPR when appropriately trained. Therefore, many states have begun mandating CPR training to high school students with improved rates of bystander CPR performance and thus improved cardiac arrest survival rates. However, barriers such as cost, need for equipment, and social anxiety exist, and not all states have legislated this requirement for mandated CPR training in schools. This literature review, primarily an analysis of research published in the last decade, aims to evaluate the importance of and the current state of mandated CPR training in high schools and the barriers to its widespread implementation.

Introduction

Sudden cardiac arrest (SCA) is an abrupt loss of heart function due to an abnormal heart rhythm, resulting in an ineffective delivery of blood to the brain and other vital organs. During an SCA event, an individual may stop responding to external stimuli, exhibit shallow breathing or complete cessation of breathing, or suddenly collapse and lose consciousness. Within a span of four to six minutes, SCA can lead to significant brain damage due to a lack of blood flow[1].

SCA may occur due to a wide spectrum of risk factors such as coronary artery disease and arrhythmias related to lifestyle-related factors such as obesity and smoking. There is a rarer and more dramatic variant that occurs in athletes during physical activity. This condition is called sports-related sudden cardiac arrest (SrSCA), which generally happens during moments of intense physical activity. SrSCA may be related to specific risk factors including underlying heart conditions like hypertrophic cardiomyopathy, in which the heart muscles become abnormally thick, and congenital anomalous coronary artery in which a coronary artery has an abnormal origin or course[2]. SrSCA is the most common medical cause of sudden death in athletes, accounting for approximately 100 to 150 sudden cardiac deaths during competitive sports in the United States each year[3]. In many cases, a cardiac arrest may go unexplained. If the heart appears structurally normal and there is a negative toxicology analysis, doctors may be unable to find the cause of cardiac arrest. This implies that SCA can happen without previous knowledge of having an SCA risk factor.

Due to these factors, many cardiac arrests happen outside of hospital settings, with the majority occurring in homes and public settings[4]. There are more than 350,000 out-of-hospital cardiac arrest (OHCA) cases every year, compared to an estimated 290,000 in-hospital cardiac arrests[5]. Unfortunately, less than 10% of patients who suffer OHCA survive to hospital discharge globally[6]. This is because unlike in hospital settings, OHCA cases often rely on lay people to provide immediate care before EMS personnel can arrive.

The first line of treatment for cardiac arrest is generally cardiopulmonary resuscitation (CPR). According to Red Cross guidelines, CPR involves providing effective chest compressions at a rate of 120 beats per minute. This significantly improves both survival and recovery rates in patients. Patients who receive basic CPR have a 2 to 3 times higher survival rate than patients who don't receive any form of resuscitation, for whom the rate of survival decreases by 5.5% every minute[7,8]. To achieve the highest survival rate, CPR must be associated with the effective use of an automated external defibrillator (AED). AEDs are designed to detect abnormal heart rhythms and deliver an electric shock to restore a normal rhythm. They are primarily intended for use by non-medical professionals. The AED provides clear instructions to the user so that defibrillation can be delivered before the arrival of emergency medical technicians and paramedics. AEDs are easily accessible in many public locations such as schools, parks, and airports. When combined with bystander CPR, the application of AEDs nearly doubled

the survival rate of out-of-hospital cardiac arrest cases[9].

A recent high-profile example of SrSCA occurred on January 2, 2023, involving football player Damar Hamlin, who plays for the Buffalo Bills of the National Football League. He suddenly collapsed on the field after making a tackle[10]. Fortunately, emergency medical workers were able to administer effective CPR and successfully revive him using an automated external defibrillator (AED). The athlete received initial care on the field before he was transported to a hospital, where he made a satisfactory recovery. This incident highlights the importance of having individuals trained in CPR present in any situation. SCA can occur unexpectedly, as demonstrated by Hamlin's collapse on the field, therefore having CPR-trained individuals increases the likelihood of immediate life-saving interventions.

In situations where professionals trained in CPR are not available, the responsibility for ensuring immediate and effective care falls upon the lay bystanders. Bystander CPR improves survival outcomes for out-of-hospital SCA by two to three times. Widespread knowledge of CPR among the general public ensures the presence of individuals capable of providing resuscitation in such situations. This goal is only possible with mandatory and early training of the general population, preferably beginning with school-going children. This review will discuss the significance of mandatory CPR training for high school students and its associated barriers.

Discussion

CPR Training in Different States

In recent years, many U.S. states have initiated mandatory CPR training in high schools as a requirement for graduation. This initiative aims to increase awareness and training in life-saving techniques such as Basic Life Support (BLS) and increase the number of people proficient in CPR methods. As of 2023, 43 out of 50 states in the United States mandate CPR and automated external defibrillator (AED) training for secondary school students. The bill has been introduced in Alaska, Hawaii, and Massachusetts, and training is only recommended in Colorado. In Wyoming, Nebraska, and New Hampshire, no bills regarding CPR training have been found. This is an improvement from earlier dates such as 2016, when only 32 states out of 50 mandated CPR training in high schools[11].

Laypeople initiated CPR in 40.8% of out-of-hospital cardiac arrests (OHCAs). States with higher bystander CPR rates include Alaska (72%), California (41.8%), Hawaii (45.2%), Mississippi (42.4%), Montana (49.6%), Nebraska (49.1%), North Carolina (42.9%), Oregon (56%), Vermont (53.8%), and Washington (56.3%)[12]. People living in socially deprived communities are also less likely to be trained in CPR. Legally, CPR certification is not regulated by federal law; each state regulates this matter independently. Unfortunately, state laws regarding CPR training for high school graduation and AED requirements in high schools are highly variable, and funding for AEDs is inadequate, especially in schools in lower socio-economic zip codes. To address these inadequacies, it is important to standardize state laws, involve student bodies, increase funding, and allocate appropriate resources. CPR/AED education should start earlier in schools and be part of the standard curriculum rather than implemented as a stopgap measure. Schools need the necessary funding, instructors, supplies, and manikins to effectively teach CPR and AED use, as this paper will discuss in a later section[13].

Bystander CPR

Ever since schools started implementing CPR training, bystander CPR performance rates have seen a significant increase, leading to SCA survival rates seeing almost a 3-fold increase in patients[14]. This is because attitude and willingness to perform bystander CPR directly correlate with the degree of knowledge that individuals have in CPR training[15]. Bystanders who had previous CPR training were 3.4 times more likely to perform CPR than those without prior training due to the increase in their self-confidence and awareness of the importance of CPR[16]. In fact, the greatest barrier to attempting bystander CPR for most individuals is an uncertainty in their skills and a fear of causing harm to the victim, which is caused by a lack of training and knowledge in CPR. In a study of 384 persons by Birkun and Kosova, 46% of respondents reported that a lack of CPR knowledge was a barrier to performing CPR on strangers, and 29% reported a fear of performing CPR on a loved one[17].

Student CPR Training

CPR training laws and guidelines vary across states, leading to diverse approaches in teaching CPR. One example of a basic CPR training course involves implementing a mandatory CPR training program for all high school juniors during their first semester of the school year. The curriculum covers essential CPR techniques such as chest compressions, rescue breathing, and AED use. To simulate real-life scenarios, students would engage in hands-on practice sessions where they would work collaboratively to administer CPR to on a dummy manikin. At the conclusion of the training unit, students would undergo an assessment to evaluate their retention of knowledge and skills. A passing grade in the course signifies that the student is CPR-certified. Training quality and proficiency is measured by the chest compression factor (CCF), which refers to the proportion of time spent on chest compressions during CPR. A higher CCF correlates with reduced downtime and improved survival rates. The primary objective of CPR training is to improve the confidence of the person administering CPR and thus ensure optimal patient outcomes[18].

Individual students' factors such as limited knowledge and fear of causing further injuries to the cardiac arrest victim, particularly the fear of doing it incorrectly. Low confidence and high academic stress levels can also influence the effectiveness of learning CPR training [19].

Similar to fire safety drills and practice, which most schools teach students from a young age, CPR is a life-saving skill that requires practice and repetition. Early training helps decrease anxiety about making errors and increases people's confidence, as they have more experience with performing CPR [20]. Children have shown their ability to complete training courses with relative ease and their potential to act in an emergency scenario. A study that evaluates children's ability to learn life-supporting first-aid (LFSA) found that primary school children as young as age 6 were able to effectively retain the learning, with up to 51% of students being able to properly identify the various steps in using an AED post-training. Furthermore, when the students' parents were interviewed, 82% of parents (28 out of 34) claimed that their kids were capable of taking action in an emergency situation [21].

CPR training Courses

While it is true that CPR training courses are available outside of schools, studies find that more people are likely to be trained in CPR if training is provided in high schools. In those states that require mandatory CPR training, 34% of persons are more likely to have CPR knowledge than in states that don't require it [22]. There are several reasons why that is true. Many untrained individuals who have considered attending a training course may struggle to find an affordable and accessible CPR class. In addition, unlike in one's school years, adults might not have the time to fit training into their schedules. In the study by Birkun and Kosova, more than half of the 49% of individuals not trained in CPR said they had never considered attending a training course, revealing the importance of implementing training courses in schools [23].

It is also important for individuals to continue to retain CPR skills as adults. In most states, CPR certification is valid for two years. For individuals who have previously received training, the recertification process tends to be relatively quick and straightforward, involving a hands-on skills test and a written test [24]. The participation of community-based training programs allow for certification renewal and regular practice. Additionally, OSHA-mandated workplace training programs provide opportunities for CPR refreshers in a professional setting [25]. These opportunities make practicing CPR skills after leaving school highly feasible because of their accessibility as well as their efficiency.

Barriers and Potential Solutions

While mandating CPR/AED training in schools is a first step to increasing public awareness of the skills, it is not enough to issue training mandates without realizing that several barriers exist to providing effective training [26]. Without the necessary resources and support, many schools cannot ensure successful training implementation. Addressing key barriers, such as providing adequate funding, access to trained instructors, addressing anxiety about learning and performing CPR, and making attempts to eliminate the barriers is crucial to making mandated training truly effective and impactful.

Financial Constraints

There are several barriers when implementing high-quality CPR training in schools. One potential barrier is the cost of providing training. In a 2011 Iowa study involving 84 surveyed schools, approximately 35 identified equipment availability as a significant barrier in implementing CPR training, with around 12 ranking it as their most significant barrier. The purchase and maintenance of equipment such as AED simulators, face shields, and mannequin lungs can be expensive, with a start-up cost estimated at $1000 USD and a maintenance cost of $500 USD. The costs associated with providing CPR training are typically allocated from the school district's finances [27], which may place a burden on other areas of funding. For many public schools in the United States, training fees can be out of the budget range and act as significant barriers [13]. A potential solution to this challenge could be using a durable, multi-use CPR student training kit, which would reduce the cost of maintenance and storage and eliminate the need for repeated purchase of equipment.

CPR Instruction Skills

CPR training costs also include finding an athletic trainer. Out of 20 athletic directors representing full-time public high schools across the United States, 18 mentioned that budgetary concerns were a major barrier to providing certified athletic trainers at their schools [28]. This could result in a subpar quality of teaching. A different study investigating CPR courses found that despite clearly defined curricula, the instructors did not teach in a standardized way. Practice time was limited and errors in performance were not corrected. The study concludes that the problem of poor retention of CPR skills may lie not with the learner or the curriculum, but with the instructor [29]. To enhance teaching quality, students could potentially receive training from multiple sources, including articles, audio, and video demonstrations, in addition to trainer-led sessions. This approach provides diverse learning options and accommodates various learning preferences.

Revision and Retraining of CPR Skills

One final potential barrier is time commitment. It is generally recommended that individuals keep CPR skills fresh and revise training at least once every two years. This regular retraining ensures the highest level of skill retention. Finding time to implement a complete CPR training course to meet this recommendation into the school curriculum can be challenging for high schools, particularly for higher grade levels such as the 11th and 12th grades. These students are generally involved in numerous advanced classes as well as extracurricular activities, hobbies, and clubs of their interest. However, one study found that the average time commitment needed for training was less than two hours per student[30]. Despite the requirement for frequent training revisions, the revisions themselves do not need to be extensive. Only 7% of the schools in the study responded that students received training outside of school hours, and most schools were able to successfully integrate training into the schedule. Training can be implemented into the schedule through a mandatory health or physical education course.

Barriers at The Individual Level

Barriers also exist that prevent individuals from performing CPR. In a survey of 548 subjects addressing why women receive bystander CPR less frequently than men, the study found that the major reasons include the sexualization of women, the belief that women are more susceptible to injury, and general misconceptions regarding women facing cardiac arrest[31]. Many people fear inappropriately touching someone and worry about being accused of sexual assault or facing legal action, which deters them from providing CPR. To address this issue, comprehensive education and policy efforts are necessary to challenge these perceptions and increase awareness about sex differences. Comprehensive education is also essential to raise awareness that individuals are protected by Good Samaritan laws[32].

These laws shield individuals from civil liability when they provide necessary aid, prompting swift action by bystanders in emergencies without the fear of legal repercussions. Some individuals may also be unwilling to perform CPR due tos severe panic, fear and high levels of stress, preventing them from calling 911 or performing CPR. When CPR is performed and an AED is used, stress levels increase in over 40% of responders. This increased stress may be due to a lack of self-confidence in their skills or their belief in their ability to execute CPR, even among trained healthcare professionals. These issues lead to increased conflict and disagreements, resulting in poor coordination during CPR efforts, potentially affecting the efficiency of CPR performed[33,34]. To alleviate this concern, incorporating emotional stressors into CPR training sessions can be beneficial. By simulating realistic scenarios during which stress levels are naturally high, students can better understand their capabilities and develop the confidence needed to perform CPR effectively in real-life situations.

Conclusion

Sports-related cardiac arrest is a major cause of death in athletes. Rates of survival for sudden cardiac arrest, especially in out-of-hospital situations, are extremely low. To increase the number of individuals trained in CPR, states have started to mandate CPR training in schools as part of the curriculum. Several studies have shown that children find CPR easy to learn with an apparent increase in their confidence and willingness to perform CPR when appropriately trained. While barriers such as cost, equipment, and time commitment make it difficult for schools to provide training, these barriers can be overcome. Identifying CPR success rates as well as these barriers leads to a better understanding of what has worked and what can be done to improve the training. As we progress CPR training in schools, the upward trend of SCA survival rates we are currently seeing will most likely continue. Therefore, training students in CPR is both a short-term and long-term investment in the progress of bystander first aid and SCA rates.

Methodology

Relevant literature was found using keywords in the PubMed and Google search engine databases because they offer an extensive coverage of existing peer-reviewed research articles and literature on a particular topic. Their broad scope allows for a comprehensive search across multiple fields, ensuring that a diverse range of relevant literature on CPR training is included in the review. Keywords were chosen based on their relevance to the topic of interest, which in this case is CPR training among high school students and sudden cardiac arrest. Keywords include cardio-pulmonary resuscitation, basic life support, CPR, young athletes, and high school students. To minimize bias and ensure the reliability of the included studies, preference was given to peer-reviewed sources and those frequently cited in the literature. The exclusion criteria also limited the research to publication dates within the last 20 years. This restriction ensured that data was recent and included the latest advances.

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