

Winter 12-7-2021

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THE ROLE OF PRE-PARTICIPATION EXAMS IN IDENTIFYING STUDENT ATHLETES
AT RISK FOR SUDDEN CARDIAC DEATH

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HONORS PROJECT

Submitted to the Honors College at Bowling
Green State University in partial fulfillment
of the requirements for graduation with

UNIVERSITY HONORS DECEMBER 2021

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Introduction

January 12th, 2017, Ryan Warner a 16-year-old junior from Beachwood high school passed away due to sudden cardiac death caused by a condition known as Wolff-Parkinson-White syndrome. While Ryan did not pass away at his school or during a practice, he was an athlete and a decent one too as he qualified for multiple invitationals. His death was sudden and shocking to the community, but he had a known condition that was a cause in his sudden death. Alec Kornet, 17, was a triple sport athlete at Brush High school, playing varsity soccer, hockey, and baseball, and had no diagnosed medical conditions. On February 14, 2017, Alec went to hockey practice like he did 4 to 6 times a week in the winter, but little to everyone's knowledge that was his last hockey practice. Halfway through practice Alec felt lightheaded and went to the bench for a quick sip of water, but instead of sitting down for a breather Alec collapsed and went into sudden cardiac arrest. Despite everyone's best efforts he passed away that night, leaving everyone terrified and wondering how it even happened. Cardiomegaly -- also known as an enlarged heart -- is what the final autopsy report found and is what led to sudden cardiac arrest that night. With these two events we question, to what extent can pre-participation physical exams be improved to better identify athletes at risk for sudden cardiac arrest?

A review of the literature

Sudden cardiac arrest (SCA) is the leading cause of sport related death in young student athletes (Drezner et al., 2007). Between January 2004 and December 2008, the NCAA recorded 80 medical causes of sudden death, 45 of those being cardiovascular related deaths. This study demonstrated the overall rate of sudden cardiac death (SCD) in young NCAA athletes comes to be about 1 in 43,000 athletes. They also found that some subpopulations have reported the rate of

sudden cardiac death cases has been as high as 1 in 3,000 and as low as 1 in 76,000 athletes per year. With these cases it has been found that males, African Americans, and basketball players are at the highest risk of SCD when compared to all other athletes (Harmon et al., 2011). It has also been found that 55-80% cases of sudden cardiac death happen to be asymptomatic before the event (Drezner et al., 2007). With a majority of sudden cardiac death cases reported as asymptomatic, it is more important to identify the athletes at risk to better prevent the instances from happening.

There is a very long list of known etiologies for sudden cardiac death, but a few conditions have stuck out to be the most common. One of the most common etiologies of SCD is Hypertrophic cardiomyopathy, with a prevalence of 1 in 500. Hypertrophic cardiomyopathy is an abnormal gene that causes thickening of the ventricular septum. This thickening causes a reduction in the amount of blood that can be taken in and delivered with each heartbeat. Other common etiologies include long and short QT syndrome, Marfan syndrome, Wolff-Parkinson-White, and cardiomegaly. Each of these syndromes increase risk of SCD notably during exertion. Long and short QT syndrome can cause chaotic heartbeats that can become dangerously fast, but often goes undiagnosed. Marfan syndrome is caused by a defect in a gene that allows the body to create a protein that gives connective tissue strength and elasticity, which could cause the weakening of the heart muscles. Wolff-Parkinson-White is an extra electrical pathway in the heart that causes rapid heartbeats. Finally, Cardiomegaly is an enlarged heart, which is normally a sign of another condition that has caused the heart to enlarge. While each of these conditions has a known etiology, several studies have noted high instances of “morphologically normal hearts”, which is commonly referred to as Sudden arrhythmic death syndrome. In these cases, the

autopsy report comes back negative, and the sudden death goes without an explanation. (Emery et al., 2018)

COVID-19 has recently led to an additional cause of sudden cardiac arrest. Since the epidemic started there have been reports surrounding changes in ECGs in infected individuals. A systematic review of twenty research articles has suggested that identifying ECG patterns related to COVID-19 is vital, especially in athletes due to their higher amounts of physical activity. Studies reported an increased risk of QT interval prolongation that could have been influenced by different coronavirus therapies as well as an increase in myocarditis in athletes that have been diagnosed with COVID. As stated above both cause many problems and are common etiologies of sudden cardiac arrest and should be identified in athletes to prevent possible sudden death.

Prevention

The first thing that an athlete must complete before participating in their sport is a preparticipation physical exam (PPE) to make sure they are healthy to safely participate in the sport they want to pursue. As part of the current OHSAA preparticipation physical evaluation there is a set of 28-32 questions which include a total of ten heart health questions, three questions about the athlete's-family and seven questions about your health. One portion of the physical exam requires chest auscultation. As a result of COVID there is now an optional form to fill out relating to a previous history of COVID-19. At the very end of the OHSAA physical evaluation form, there is a paper titled "Sudden Cardiac Arrest and Lindsey's Law". This paper requires a parent and an athlete's signature saying they have reviewed the information on the sheet. When asked to take a quick survey about Lindsey's Law greater than 70% of respondents said they did not know what Lindsey's Law was. Lindsey's law is made of three Ohio revised codes that provide information regarding sudden cardiac arrest that is similar to the questions

asked on the OHSAA physical form. Based on these results we can conclude that many athletes are signing the paper without reading it or learning what potential risks they have.

When it comes to PPE's and screening, the American Heart Association (AHA) recommends athletes be given a 14-point evaluation to decide whether a secondary evaluation needs to be done or not (American Heart Association News, 2015). The checklist is a 14-point evaluation that is built to flag those individuals who should be referred to a cardiologist for more evaluation that could include tests such as ECGs and Echocardiograms. The evaluation consists of family and personal history questions as well as a physical exam to check blood pressure and heart. The AHA position does not require mandatory screening with an ECG; however, it ensure the opportunity to set up quality-controlled community or school-based screenings of young athletes that involve doctors and utilizes the 14-point checklist (American Heart Association News, 2015). Based on more current research it has been found the 14-point checklist outperformed ECGs on all measures of statistical performance. Based on these results and the controversial opinions of ECG screening, a greater emphasis can be placed on resources for research and education to advance preventative strategies.

Electrocardiogram, also called ECG, is a test that records the timing and strength of the electrical signals of the heart. The most common ECG, a 12-lead, allows the reading of the heart to be seen on two planes through 10 placed electrode pads. ECGs show the polarization and depolarization through waves known as the P, Q, R, S and T waves. Each of these waves is important in showing whether the heart shows normal or irregular beats. The ECG can be important in determining if further evaluation is necessary which can help better identify athletes that are at risk for sudden cardiac arrest. Not all ECGs can detect all the disorders that predispose athletes to sudden cardiac death, but with the 12-lead ECG added to the history part of the PPE it

has been found to increase the sensitivity compared to the current American model. The suggestions for ECG interpretation from the international standpoint, compared to the American point, have reduced the false positive findings of ECGs to 3% and reduced the cost by 25% without effecting the sensitivity of identifying high risk patients (Dhutia 2018).

The concept of including ECGs in the PPE is very controversial due to cost and effectiveness. While many people argue that ECGs should not be included in PPE's, some current research has found that they can be cost effective. A recent study has shown that the addition of an ECG to the history examination saved 2.1 life years per 1000 athletes screened at a cost of 88 dollars per athlete (Dhutia 2018). The research found that the ending cost effective ratio of adding an ECG to the history and physical exam came out to be \$42,900 per year saved based on the cost of treatment. In addition to the savings a European study found that a modification of ECG interpretation could reduce the cost of screening by nearly 25% without compromising the test. This finding could allow less financially endowed organizations to afford ECG screening and should be welcomed by sporting communities to mandate ECGs for all athletes (Dhutia 2018).

An athlete that dies due to sudden cardiac death can leave a lasting impression on those in a community that experience a loss. The South-Euclid Lyndhurst Community suffered this unimaginable loss late at night on February 14th, 2017. The loss of Alec Kornet hit the community very hard as it was sudden and surprising based on his athletic past and his apparent physical health. In personal interviews with friends and teammates of Alec, the responses of how they reacted were all very similar, shocked, and confused. Justin, a teammate of Alec's, stated his reaction was "filled with grief and guilt" and when he participates in exercise, he thinks how sudden cardiac arrest could happen to anyone and that's part of the reason he is thankful for his

yearly ECG (Frey & Hamilton). “Alec’s passing was the biggest shocks and one of the hardest things I’ve had to go through” Connor said, one of Alec’s longtime friends. After Alec’s passing, Connor’s doctors found an irregularity in his heart and implanted a loop recorder, which was very concerning to Connor based on the tragedy he just experienced. After getting the okay to participate in sports from his doctors Connor was very nervous to participate again but he didn’t want to sit out any longer and decided it was worth a shot to continue playing (Frey & Martin).

Although the interviewees are not experts in the public health field their statements give an impression on what it must have been like to experiences such a traumatic event, and how they feel about the topic since their experience. When asked about their thoughts of ECGs all interviewees agreed that all athletes should get ECGs regardless. Statements regarding the idea of all athletes getting ECGs included this statement from Rebecca, “If it could save just 1 life, I think it is worth it. The effect Alec’s passing had on our community and his family was so great that if a similar loss could be prevented then it should be prevented.” (Frey & Rossi). With similar statements from Adam and Connor, they both agreed that sometimes, like in Alec’s case, could have an underlying condition that you don’t know about until it’s too late (Frey & Turk). While there is no science behind their response, their response leaves the lasting impression that nobody should ever have to experience the trauma they had to experience in 2017.

When asked “How do you think pre-participation exams could be improved?” the responses were very interesting knowing that every interviewee dealt with the loss of Alec. Rebecca stated, “I think education and accessibility would be two ways they could be improved.” When Rebecca got her physicals, she never realized how important they could be, and the explanation of how important they are could help student athletes becoming better at reading them before they sign any of it. “Brush High School was able to bring in health care providers to

provide-free physicals that included ECGs if needed at a low cost, but that's not the case everywhere. Something like this could help low-income communities that don't have the best resources at identifying those at risk." (Frey & Rossi).

Results

After reviewing the research, I can conclude that pre-participation exams can be improved to an extent to help better identify individuals at risk for sudden cardiac arrest. However, more research is required regarding PPEs before improvements can be made to identify those high-risk individuals. Before any research is done an even simpler step could take place and that is educating the populations about sudden cardiac arrest and death. A way to start this is informing and educating the populations about sudden cardiac arrest, starting with a simple infographic that can be found in appendix A. As improved education the population on this topic continues, more research can be implemented to improve PPEs for the future.

There are many points of research that need to be reevaluated due to science and technology constantly changing and improving. The AHA 14-point evaluation has been important to identify at risk individuals in the past but based on more current research the check list needs to be re-evaluated as to how much it helps in prevention. Addition of an electrocardiogram is also a point that is still under review. The idea of adding in an ECG is so controversial due to the cost effectiveness, and the research done has not been able to conclude if it would be an effective way of identifying at risk individuals. While research professionals agree that sudden cardiac death is tragic and identifying those at risk is very important, the first steps of improving the PPEs have become inconclusive as to what the best way to change the exams would be.

Implications for future research and practice

It has become clear that more research is required as far as the best way to identify athletes at risk for sudden cardiac death. Based on what I have found, I believe that there is a way to start this process by first educating all student athletes as to why PPEs are so important. As Rebecca mentioned during her interview, she saw the physicals as something she just needed to get done and sign before playing and never realized how important they were. A survey conducted in 2021 found that 64.5% of parents fill out the PPE without the assistance of their student-athlete. While the parents should help to fill in the family and medical history, the student athlete's assistance in answering personal questions is very important in preventing discrepancies and allowing the best examination for prevention. Based on this we can conclude that most student athletes don't really know the importance of a PPE. The easiest thing the OHSAA could implement is a required educational video or supplement explaining the importance of the PPE in keeping athletes safe from injury and death.

Student athletes are responsible for filling out their yearly physical forms because it keeps them responsible for their health as they grow and learn. While filling out the forms can be intimidating or hard for a high schooler, the help of a parent is allowed. However, based on the survey the help of a parent is being abused a bit and students aren't even looking at the forms that are about them and their health. This can be leading to some falsified information about personal health, and because of this some high-risk individuals are not being flagged. Based on the assumptions, health care professionals should be asking the students who filled it out and confirming that they were present with their parent when it was filled out. Another caution that can be taken is physicians or nurses during the PPEs can ask the physical questions again during

the physical appointment to fact check the physicals. This could help prevent the bias of a parent filling out the physicals without their student.

Another part of improving PPE is making Lindsey's Law more known. A recent survey found that 70% of respondents did not know what Lindsey's Law was when completing their physicals (Frey, 2021). Making Lindsey's Law more well-known can increase the discussion about sudden cardiac arrest and allow prevention and awareness to be more common knowledge in schools. This can be done by including posters around schools specifically close to the athletic departments and AEDs, having assemblies or speakers in classrooms to talk about the subject of sudden cardiac arrest and its relationship with Lindsey's Law, or having the topic of sudden cardiac death be a lesson in school gym and health classes. A great example of a way to start this is using the infographic found in appendix A that talks all about SCD and has resources to learn more about the signs and symptoms, how to get checked, and what Lindsey's Law is.

One final implication is figuring out the specifics on what topics are important and require more research. Based on the current literature more research needs to be done on the 14-point evaluation and ECGs. Based on the current questions towards the AHA 14-point evaluation, research on how effective it is seeming to be more pressing than research of ECGs and echocardiograms. However, the controversy in ECGs has been a long going topic and could be continued for a while if new research isn't done soon.

Based on the research that I have completed health care professionals should start being more concerned with athletes whose physicals check out, but complications occur later especially if the athletes have anatomically normal hearts. I also believe it could be a major concern that current research is saying that the American Heart Association 14-point evaluation is not as accurate as it used to be due to recent advances in science and medicine. Based on these

concerns health care workers should be a little more concerned with how accurate the PPEs are screening the athletes for possible red flags.

There are a lot of questions that health care professionals dealing with athletes should start asking in terms of sudden death in athletics. There is known information about athletes that die suddenly for many reasons such as heat, undiagnosed heart conditions, and even diagnosed conditions. So, when tragedy like this occurs health care professionals should ask questions, get research started and do their best to become better, so that event like this don't happen as often in the future. One of the biggest questions that could be asked everyday regardless is "how can we be better at what we do?" In the end, that question can help the process of knowing the topics of research that needs to be done to start the process of bettering the pre-participation exam to better identify at risk individuals.

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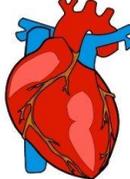
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Appendix A

Sudden Cardiac Death (SCD)

On average
1 in 43,000



Athletes will die of sudden cardiac arrest a year. While its rare, SCD in young athletes can cause a large impact on the community

Knowing SCA

Sudden Cardiac Arrest is a problem with the hearts **electrical** system

Usually strikes with **little to no** warning



 People in SCA have **no pulse**



AHA 14 element checklist

The American Heart Association 14 element list used during yearly physicals to assess young athletes to see if further screening may be necessary. For the full checklist list visit

http://med.stanford.edu/content/dam/sm/ppc/documents/HSupervision/AHA_14-point.pdf

Quick Actions Save Lives



Call for Help



Start CPR



Restart Heart

Top Causes of SCD in Athletes and Youth

Top causes of SCD can be caused from congenital/genetic or acquired conditions, and can be associated with having a structurally normal and abnormal heart. The top conditions in youth are hypertrophic cardiomyopathy and abnormal formation of the coronary artery. For a full list of the possible causes visit <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4969030/>

SCD Prevention

- Medical History & Physical exam which includes AHA 14 element checklist
- Electrocardiogram and Cardiac screening
- Learning about Lindsey's Law
 - To learn more go visit <https://odh.ohio.gov/wps/portal/gov/odh/know-our-programs/lindsays-law/lindsays-law>
- Cardiac specialist if recommended
- Having an AED in athletic facilities
- Being CPR certified
 - To find a class near you visit www.redcross.org



AED
Automated
External Defibrillator