



Electrocardiogram Screening in Athletes: A Good Return on Investment?

In Austin, Texas during May 2015, the Texas Senate considered House Bill 767, a bipartisan bill that would mandate electrocardiogram screening for high-school athletes, with an opt-out for any reason. It had been passed by the House 6 weeks earlier. In fact, for the first time, the American Heart Association took a neutral stance on this issue. While it failed to pass the Senate with one vote shy, other states are now considering such legislation. The authors of this paper (JPH & JBC) testified at both the House and Senate Committee hearings on this bill.

Sudden cardiac death is the number one medical killer of young athletes.¹ In most cases, the first symptom is cardiac arrest.² In the May 28, 2015 *Wall Street Journal* article “Getting to the heart of the matter: Should NCAA require EKG testing?”,³ they referenced the American Heart Association paper in *Circulation*¹ suggesting that the incidence of sudden cardiac death in athletes is much higher than previous estimates, like varsity basketball players who have a 1 in 1300 chance of dying before graduation. This debate over electrocardiogram screening for sudden cardiac death in young athletes often is referred to as one between “emotion” and “science,” the former “for,” the latter “against.”

The American College of Cardiology/American Heart Association guidelines only recommend a history and physical screening before sports participation, which their own document states is “insensitive,” and does not detect the majority of these heart conditions.² The main reasons being that they have low sensitivity of 1%-20% (average 10%), a high false-positive rate of 8%-24%, are poorly adhered to, are sometimes performed by nonmedical examiners, interpretation is subjective, responses vary by sex/culture/age, answers are omitted by athletes for fear of being restricted, and have little/no chance to detect ion channelopathies, which are a significant cause of sudden cardiac

death in young athletes.^{2,4,5} Yet these same guidelines fail to emphasize that electrocardiogram screening is superior in detecting these underlying heart conditions, with sensitivity of 79%-98% (average 94%), and has significantly lower false positives, 4%-8%, than history and physical (see **Table**).^{2,4,5} For example, in hypertrophic cardiomyopathy, the physical examination reveals a murmur in only 25%, whereas the electrocardiogram is abnormal in 95%.^{2,5}

Interestingly, the National Basketball Association does not adhere to the American College of Cardiology/American Heart Association guidelines, and requires an annual standardized electrocardiogram screening as well as rest and stress echocardiogram for every player before training. Further, large organizations worldwide, including the European Society of Cardiology, International Olympic Committee, Israel Ministry of Health, Japanese Ministry of Health, and Fédération Internationale de Football Association, all recommend electrocardiogram screening.⁵ In recent physician polls, one conducted by the American Heart Association in 2013, and the other by the *New England Journal of Medicine* in 2014, 60% and 58%, respectively, were in favor of screening with a history, physical examination, and electrocardiogram of young athletes.⁶

How does electrocardiogram perform as a screening test? It is well validated in studies worldwide, it detects around 94% of these sinister heart conditions in their asymptomatic phase, does not harm the athlete, is cost-effective, is highly objective, and has a low false-positive rate of 6%, on average, in a recent meta-analysis.⁵ In fact, its test characteristics outperform mammography, Prostate-Specific Antigen blood test, and Pap smear, which are major screenings performed daily worldwide. In contrast, the history and physical screening 14-item American Heart Association element checklist is highly subjective and performed and interpreted by primary health care providers, even including nonphysician examiners.^{2,4}

The electrocardiogram is an affordable, noninvasive test and takes about 5 minutes to administer. The 16-point checklist Seattle criteria electrocardiogram screening is readily interpreted by a family physician, internist, cardiologist, or pediatric cardiologist. Given the availability of machines in most medical facilities and the ability for remote reading, it is feasible to implement such electrocardiogram screenings on a large scale.

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Table History and Physical Screening vs Electrocardiogram Screening in Young Athletes

| Characteristics | History and Physical Screening | Electrocardiogram Screening |
|---------------------------------|--|---|
| Who performs | Primary health care providers even including nonphysician examiners | Electrocardiogram Technologist |
| Time to perform | ~ 10 minutes | ~ 5 minutes |
| Remote data gathering available | No — person performing needs to be present to ask questions and perform physical examination | Yes — electrocardiogram can be read remotely |
| Who interprets data | Primary health care providers, even including nonphysician examiners | Family physician, Internist, Cardiologist, Pediatric Cardiologist |
| Data interpretation | Highly subjective | Highly objective |
| Number of items on checklist | 14 — American Heart Association Elements | 16 — Seattle criteria |
| Sensitivity | 1%-20% (average 10%) ⁴ | 79%-98% (average 94%) ⁴ |
| False positive | 8%-24% ^{3,4} | 4%-8% ⁴ |

The electrocardiogram screening can also add value outside of saving high-risk athletes from sudden cardiac death. Most of these heart conditions are inherited in an autosomal-dominant manner; thus, identifying one person could save others in their family. The electrocardiogram can also detect some non-life-threatening heart conditions, such as atrial septal defect, that are important to treat because of their longer-term consequences. In fact, the 16-year-old son of the author (JBC) was asymptomatic, and after electrocardiogram screening, was discovered to have an ostium primum atrial septal defect with a large shunt, coupled with significant dilatation of his right heart, and required urgent surgery. Of note, this boy had been seen and cleared over his life by 7 different physicians using the usual history and physical, and the subtleties on examination were missed. Further, because most of those performing the history and physicals are primary health care providers including non-physicians, the chance of detecting such abnormalities is even lower.

Those who testified in opposition to mandated electrocardiogram screening raised these concerns:

1. The high rate of false positives, which they quote as around 20%. The false-positive rates of electrocardiogram screening were much higher about 20 years ago, around 20%; however, the current criteria have reduced that number down to 6% or less.⁵
2. The high cost (time and money) of further workup for those false positives, often quoting > \$10,000 per false positive and months benched. The cost of workup for most false positives is about \$250, the cost of a limited echocardiogram and a single physician visit, taking about 2 weeks of their time.
3. That electrocardiogram screening should be extended to include nonathletes who may also have undiagnosed, underlying heart conditions.⁷ This is a fair question that requires more research. However, athletes have a higher rate of dying from sudden cardiac death, so should be screened as a priority.¹

4. Concern about the psychological harms of screening. A recent study found that electrocardiogram screening does not cause excessive anxiety in US high school athletes across spectrums of age, race, and sex.⁸

In the US, we standardize things to help people get through their day while staying safe and avoiding injury such as wearing seatbelts, and Transportation Security Administration screenings. Both are mandated, and save lives. But should we mandate electrocardiogram screening? In voluntary electrocardiogram screenings performed free of charge in the US for high school students, 4% participated.⁹ In contrast, with mandated vaccinations, approximately 95% participate. In other words, the participation rate is much higher with an “opt out” than with an “opt in” structure. This is known as the “Default Effect” in psychology, where the default option provided is the one chosen by the most.

Just as important as mandating screening, we need to mandate reporting of sudden cardiac death cases via a national registry, which should include data from the National Federation of State High School Associations and the National Collegiate Athletic Association.

The preponderance of evidence suggests that history and physical are insufficient in detecting athletes at high risk for sudden cardiac death. If we make no changes now, we will continue to lose those young athletes, whose lives could have otherwise been saved by electrocardiogram screening. Based on current evidence, the electrocardiogram is a legitimate first step in tackling this problem. And right now, there is no good alternative. As a society, we need to protect our valuable assets in the best way we can. For a modest investment in time and money, electrocardiogram screening will help identify these high-risk athletes and thus allow preventive measures to be implemented before another collapses. In addition, other family members may be identified, as well as other conditions that are associated with long-term morbidity and mortality. Therefore, electrocardiogram screening in young athletes seems like a good return on investment!

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