REVIEW

THE AMERICAN JOURNAL of MEDICINE®

March Madness 2011: For Whom the Bell Tolls?

Timothy E. Paterick, MD, JD, MBA,[a] M. Fuad Jan, MBBS, MD,[a] James B. Seward, MD,[b] A. Jamil Tajik, MD[a]

[a]Aurora Cardiovascular Services, Aurora Sinai/Aurora St. Luke's Medical Centers, University of Wisconsin School of Medicine and Public Health, Milwaukee; [b]Mayo Clinic, Rochester, Minn.

ABSTRACT

The American Heart Association has developed 12 recommendations for preparticipation screening of high school and college athletes, but the application of these recommendations across the US is inconsistent. A recent clinical study suggests that the incidence and prevalence of sudden athletic death (SAD) is greater than previously believed. Currently, diagnostic screening is considered too expensive and is delivered sporadically. Logic dictates that the medical community must become more involved in reducing the incidence and prevalence of SAD through an improved preparticipation screening process. An effective screening process must be able to reproducibly predict and prevent potential risk using the most effective resources and keeping the cost-benefit ratio at a minimum. The most effective use of our resources will limit the potential of liability for institutions and physicians and, hopefully, eliminate episodes of SAD.
 • *The American Journal of Medicine (2012) 125, 231-235*

KEYWORDS: Athlete; Prevention; Sudden death

"New opinions often appear first as jokes and fancies, then as blasphemies and treason, then as questions open to discussion, and finally as established truths."

George Bernard Shaw, playwright

When March Madness 2011 came to an end and Butler University experienced the "death" of its quest for the men's college basketball national championship, a far greater tragedy occurred as several families suffered the sudden death of their young sons and daughters. Two 16-year-olds died suddenly during basketball games (March 3, 2011; *Los Angeles Times;* March 14, 2011; *New York Daily News*),[1,2] a 17-year-old collapsed and died during a rugby match (March 7, 2011; *Huffington Post*),[3] a high school athlete collapsed and died during track and field drills (March 9, 2011; Fox News Network),[4] a 17-year-old college freshman died on a treadmill while on a trip for a swim meet (March 26, 2011; *The Daily Darien*),[5] a 28-year-old doctoral student collapsed and died while exercising in a field house (April 5, 2011; *Georgetown Voice*),[6] a 15-year-old 9th grader died during physical training (April 7, 2011; www.ktbs.com, ABC News affiliate),[7] and a 20-year-old basketball player collapsed and died during a game (April 15, 2011; *The Lawrence Journal*).[8] These young people and their families were not ready for the bell to toll. Preliminary autopsy results revealed enlarged hearts in 3 of these athletes and congenital heart defects in 2 others.

Sudden athlete death (SAD) is a catastrophic event that strikes at the core of our hearts and raises a number of practical and ethical issues. It is a cause of considerable anxiety among athletes and their parents, families, coaches, and health care providers, with great emotional, medical, and societal impact. According to the US National Registry of Sudden Death in Athletes, one young athlete dies suddenly every 5 days in the US.[9-12] This database and other studies report the incidence of SAD in the US as 1:23,000 to 1:300,000.[13-15] However, a new 5-year data compilation (2004-2008) from the National Collegiate Athletic Association puts the minimum incidence rate at approximately 1:43,000 student-athletes per year, with considerable variation according to sex, ethnicity, and sport.[16] According to this report, the incidence of SAD among black male basketball players is an alarming 1:5743. Data from this report compare favorably with results of other prospective, population-based studies on incidence of sudden cardiac arrest in

Funding: None.

Conflict of Interest: None.

Authorship: All authors had access to the data and played a role in writing this manuscript.

Requests for reprints should be addressed to A. Jamil Tajik, MD, Aurora Cardiovascular Services, Aurora Sinai/Aurora St. Luke's Medical Centers, University of Wisconsin School of Medicine and Public Health, 2801 W. Kinnickinnic River Parkway, #845, Milwaukee, WI 53215.

E-mail address: publishing14@aurora.org

0002-9343/$ -see front matter
doi:10.1016/j.amjmed.2011.07.043

children and young adults in North America, showing a greater incidence of SAD than commonly believed,[17,18] with profound implications for both primary and secondary prevention strategies.

An American Heart Association consensus statement promotes cardiovascular preparticipation screening of competitive athletes.[19] The current American Heart Association screening process identifies only a subset of student-athletes at risk for SAD. The cardiovascular community must address whether alternative approaches can identify a larger subset of student-athletes at risk for SAD and whether identification allows prevention of SAD.

The issues are:

- Does detection of an abnormality via electrocardiography (ECG) or echocardiography lead to increased detection of causes of SAD, allow for the true prognostic significance of the abnormality, and ultimately, reduce the incidence and prevalence of SAD?
- Given the present economic constraints of the US health care system, will a new screening policy be cost-effective?
- Will a new screening policy expand or limit the legal implications of an undiagnosed cardiac pathology resulting in SAD?

CLINICAL SIGNIFICANCE

- One sudden athlete death occurs every 5 days in the US.
- The vast majority of etiologies for sudden athlete death can be identified by echocardiography.
- Conservatively, a "limited" screening echocardiography program will benefit society $21 million.
- Utilizing echocardiography in preparticipation screening and disqualification in a carefully structured screening program would reduce potential liability for physicians and universities.

ROLE OF ECHOCARDIOGRAPHY

The vast majority of etiologies for SAD can be identified by echocardiography. A focused questionnaire and brief physical examination are inexpensive, but these have the potential to identify only 50% of at-risk athletes.[20] We must address the other 50%.

A fundamental question is not whether ECG and echocardiography testing will improve the detection of the known causes of SAD, but at what cost. It is axiomatic that these 2 modalities specifically verify the morphologic and electrical causes of SAD. The causes of SAD (and their most common methods of diagnosis) are listed in decreasing prevalence in the **Table**.[9] Echocardiography is the single most utilized diagnostic test for identification of the common causes of SAD.

The more vexing problem for a cardiologist consulting on a student-athlete is whether the detected abnormality has true prognostic significance. ECG and echocardiography are the tools needed to answer this question. ECG allows us to identify some of the ion channelopathies, and echocardiography allows an expert cardiologist to detect morphologic aberrations that, in conjunction with diastolic physiology, allow prediction of potential risk for adverse events (ie, prognostication). How does morphology and diastolic function help the consulting physician prognosticate? This is the classic conundrum the cardiologist encounters: differentiating hypertrophic cardiomyopathy from an athletic heart. The conundrum is frequently solved using the diastolic parameters of e′ (early diastolic mitral annual velocity) and Sm (systolic mitral annual velocity).[21-23] Echocardiography allows the detection of the major causes of SAD, and there are recommendations available to assist in disqualification decisions.[24,25]

Table Causes of Sudden Athlete Death and Their Common Methods of Diagnosis

Cause	Prevalence	Diagnostic Modality
Hypertrophic cardiomyopathy	30%	Echocardiography
Coronary anomalies	19%	Echocardiography and, less frequently, CT/MRI
Normal heart	10%	n/a
Valve disease	7%	Echocardiography
Indeterminate LVH	6%	Echocardiography
Coronary artery disease	6%	Stress echocardiography
Myocarditis	5%	Echocardiography
ARVD	5%	Echocardiography or MRI
Coronary heart disease	2%	Echocardiography
Dilated cardiomyopathy	2%	Echocardiography
Aortic rupture	2%	Echocardiography
Ion channelopathies	2%	ECG

ARVD = arrhythmogenic right ventricular dysplasia; CT = computed tomography; ECG = electrocardiography; LVH = left ventricular hypertrophy; MRI = magnetic resonance imaging.