Resolution 17-101
Prevention of Sudden Cardiac Death in Student Athletes
John J. Lanza, M.D., PhD, MPF, FAAP

House Action: Adopted as amended.

RESOLVED, That the FMA encourages the education of parents, school authorities, and physicians on the risk of sudden cardiac arrest (SCA) in student athletes and further encourages schools, teams, and any other youth-focused organizations to implement a Cardiac Emergency Response Plan that includes CPR training for students, educators, athletic personnel, and anyone involved with youth; and be it further

RESOLVED, That the FMA also encourages schools to have Automated External Defibrillators (AEDs) available in athletic departments that would be accessible during school athletic events; and be it further

RESOLVED, That the FMA encourages the Florida Department of Health and the Florida Department of Education, to study the feasibility and cost-effectiveness of a school cardiovascular screening program.

Added to the FMA Policy Compendium as P 445.022
The FMA is working on an educational piece to be published in FMA News.

***House Action:** **Referred to Board of Governors for Decision**

RESOLVED, That the FMA encourages all local hospitals, health facilities, and health care providers (especially cardiologists), and other interested organizations with the ability to perform electrocardiogram (ECG) and echocardiogram (cardiac ECHO) screenings to partner with appropriate schools in their geographic area to provide screenings for eligible young athletes to reduce the incidence of sudden cardiac arrest and death.

Board will review at upcoming Board of Governors meeting

JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY
© 2015 BY THE AMERICAN HEART ASSOCIATION, INC. AND
THE AMERICAN COLLEGE OF CARDIOLOGY FOUNDATION
PUBLISHED BY ELSEVIER INC.

VOL. 66, NO. 21, 2015
ISSN 0735-1097/$36.00
http://dx.doi.org/10.1016/j.jacc.2015.09.034

AHA/ACC SCIENTIFIC STATEMENT

Eligibility and Disqualification Recommendations for Competitive Athletes With Cardiovascular Abnormalities: Task Force 2: Preparticipation Screening for Cardiovascular Disease in Competitive Athletes

A Scientific Statement From the American Heart Association and American College of Cardiology

Barry J. Maron, MD, FACC, *Chair**
Benjamin D. Levine, MD, FAHA, FACC*
Reginald L. Washington, MD, FAHA*
Aaron L. Baggish, MD, FACC*
Richard J. Kovacs, MD, FAHA, FACC*
Martin S. Maron, MD, FACC*

The central purpose of preparticipation screening of trained competitive athletes is to identify or raise suspicion of those cardiovascular abnormalities and diseases that are potentially responsible for sudden unexpected death on the athletic field (1-14). When such athletes are recognized, they are exposed to eligibility and disqualification decisions that become the responsibility of the practicing physician (4,15-17) and are a subject of this document. There is general (although not universal) (12) agreement with the principle that screening to detect important diseases and potentially prevent sudden death is justified and potentially beneficial (1-3,5-9,18).

There are many pathways and strategies by which competitive athletes with cardiovascular disease may be recognized: 1) comprehensive evaluation by a

*On behalf of the American Heart Association Electrocardiography and Arrhythmias Committee of the Council on Clinical Cardiology, Council on Cardiovascular Disease in the Young, Council on Cardiovascular and Stroke Nursing, Council on Functional Genomics and Translational Biology, and the American College of Cardiology.

The American Heart Association and the American College of Cardiology make every effort to avoid any actual or potential conflicts of interest that may arise as a result of an outside relationship or a personal, professional, or business interest of a member of the writing panel. Specifically, all members of the writing group are required to complete and submit a Disclosure Questionnaire showing all such relationships that might be perceived as real or potential conflicts of interest. The Preamble and other Task Force reports for these proceedings are available online at www.onlinejacc.org (J Am Coll Cardiol 2015;66:2343-9; 2350-5; 2362-71; 2372-84; 2385-92; 2393-7; 2398-405; 2406-11; 2412-23; 2424-8; 2429-33; 2434-8; 2439-43; 2444-6; and 2447-50).

This statement was approved by the American Heart Association Science Advisory and Coordinating Committee on June 24, 2015, and the American Heart Association Executive Committee on July 22, 2015, and by the American College of Cardiology Board of Trustees and Executive Committee on June 3, 2015.

The American College of Cardiology requests that this document be cited as follows: Maron BJ, Levine BD, Washington RL, Baggish AL, Kovacs RJ, Maron MS; on behalf of the American Heart Association Electrocardiography and Arrhythmias Committee of the Council on Clinical Cardiology, Council on Cardiovascular Disease in the Young, Council on Cardiovascular and Stroke Nursing, Council on Functional Genomics and Translational Biology, and the American College of Cardiology. Eligibility and disqualification recommendations for competitive athletes with cardiovascular abnormalities: Task Force 2: preparticipation screening for cardiovascular disease in competitive athletes: a scientific statement from the American Heart Association and American College of Cardiology. J Am Coll Cardiol 2015;66:2356-61.

This article has been copublished in *Circulation*.

Copies: This document is available on the World Wide Web sites of the American Heart Association (http://my.americanheart.org) and the American College of Cardiology (www.acc.org). For copies of this document, please contact Elsevier Inc. Reprint Department via fax (212-633-3820) or e-mail (reprints@elsevier.com).

primary care physician; 2) systematic screening of families with known genetic diseases after diagnosis in a relative; 3) incidental and fortuitous findings on clinical examination or imaging, detected during evaluation for another medical problem; 4) systematic screening of large populations, such as high school and college-aged athletes, for the purpose of determining eligibility for competitive sports, with or without diagnostic testing; and 5) symptoms associated or unassociated with sports. It is likely that a large number (or even most) athletes with cardiovascular disease come to clinical attention based on the circumstances described in items 1 through 3, rather than with formal preparticipation screening.

GENERAL CONSIDERATIONS

Currently, broad-based cardiovascular screening is practiced systematically in athletes at all levels of performance (not confined to the elite) in only 3 countries: in the United States, with personal/family history and physical examination (but without ECGs) (1-3,19,20), and in both Italy (4-6,9) and Israel (7), with 12-lead ECGs in addition to history and physical examination. In many European countries, screening of athletes is largely limited to those performing at the elite level (e.g., in international, Olympic, or professional sports) (21). The potential benefit of such initiatives is the identification of a small number of people with potentially lethal genetic or congenital cardiovascular diseases (e.g., hypertrophic cardiomyopathy) so that 1) they may be withdrawn from competitive sports to decrease their personal risk and generally make the athletic field a safer environment, and 2) in the process, some high-risk people may be recognized who may be candidates for disease-modifying medical or surgical intervention, or for prevention of sudden death with implantable defibrillators. In 1973, the Japanese School Health Law mandated cardiovascular screening with modified ECG and history/physical examination for thousands of children in the first, seventh, and tenth grades (22,23). Few disease-related data have emerged from this initiative, although a variety of generally minor cardiovascular abnormalities or arrhythmias (unassociated with underlying organic heart disease) were identified in only 2% to 3% of children (23).

DEBATE AND CONTROVERSY

Within the context of these potential benefits, there has nevertheless been substantial discussion surrounding the most appropriate and efficacious strategy for screening, including national federally sponsored and mandated cardiovascular screening. For example, Italian investigators have intensely promoted screening with a routine 12-lead ECG (as well as history and physical examination) based on a unique >30-year program mandated by Italian law and supported by sports medicine physicians dedicated full-time to the program (4-6,9). Since 1997, Israel has maintained a similar mandatory ECG-based initiative and national sports law (7). For >50 years, it has been customary practice in the United States to routinely screen high school and college-aged athletes with history and physical examination (but without noninvasive testing) (1-3,19,20). In contrast, Denmark has pointedly rejected systematic screening for cardiovascular disease in both athletes and any other segment of the population as being unjustified given the low event rate (12,13). Other than Japan (22,23), no country has systematically attempted broad-based cardiovascular screening in general healthy populations (not limited to athletes), with or without ECGs.

UNIVERSAL SCREENING: ECGs VERSUS HISTORY AND PHYSICAL EXAMINATION

Preparticipation screening for cardiovascular disease with personal/family history and physical examination has been the customary practice for all high school and college-aged competitive athletes in the United States for decades, independent of their performance level. This process is guided by the 14-point history and physical examination elements proposed by the American Heart Association (AHA) (1). The AHA recommendations acknowledge that athletes and others with underlying (but undiagnosed) cardiovascular abnormalities may well manifest clinical warning signs (e.g., chest pain, excessive exertional dyspnea, or syncope) identifiable by careful and systematic history. Because most diseases responsible for sudden death in the young are genetic/familial, a thorough family history may raise suspicion of the disorder. An organic heart murmur can alert the examining physician to valvular or other abnormalities, including left ventricular outflow tract obstruction.

A controversy persists as to whether an ECG (in addition to history and physical examination) is a superior strategy to history/physical examination alone for detecting potentially lethal cardiovascular disease, particularly when taking into account the important issues of false-negative and false-positive results, as well as cost and resource availability (1). Indeed, studies comparing these 2 strategies have failed to demonstrate a mortality benefit for ECG screening (18).

The debate between those who strongly promote routine ECGs and those opposed to ECGs as a routine screening tool is not fully resolved as yet, although a substantial literature consisting largely of editorials and viewpoint commentaries is accumulating rapidly. Nevertheless, several points are indisputable. First, the 12-lead ECG, although a mainstay of hospital-based cardiovascular practice for decades, is an unproven diagnostic tool for reliable detection of cardiovascular disease in generally

healthy populations (1). Second, outcome data on athlete screening and mortality have been driven primarily by only 1 database, from the Veneto region of Italy (9% of the national population) as part of its long-term screening program (6,9). This ambitious Italian initiative has been shown to be successful in identifying some at-risk athletes with potentially lethal cardiovascular disease (primarily right ventricular cardiomyopathy, which appears to be endemic in this area of Italy), resulting in their mandatory withdrawal from sports. In addition, a sharp decrease in mortality rate over a 30-year period was demonstrated, which these investigators attributed to incorporation of the 12-lead ECG into the screening program in the early 1980s.

Third, the Italian data showing that ECG screening reduces mortality in athletes have yet to be replicated elsewhere, and evidence from the United States (18) and Israel (7) appears to dispute or diminish the value of the ECG in reducing athlete mortality. For example, contemporary mortality rates in US athletes from Minnesota, where screening is limited to history and physical examination, do not differ from those in the Veneto region of Italy, where the ECG is used routinely (18); furthermore, athlete mortality rates in Israel were not different before and after legislation for mandatory ECGs (7). The fact that it has been difficult to consistently show a reduction in athlete mortality directly attributable to routine ECGs is an observation that may be driven by the generally low event rates in competitive athletes with cardiovascular disease (1-3,6,10,11,18,24-26).

RELEVANCE OF SUDDEN DEATH INCIDENCE TO SCREENING

Indeed, the low frequency with which sudden deaths occur in the competitive athlete population negatively impacts the justification for broad-based screening in large populations of young people, as well as the weight that can be afforded to this issue as a public health problem. In this regard, there is now overwhelming evidence that these events are relatively uncommon, albeit exceedingly tragic in each case. Most data place these cardiovascular sudden deaths in the range of approximately 1 in 80,000 to 1 in 200 000 participants per year, much less common in relative terms than motor vehicle accidents (by 5,000-fold), suicide, drugs, homicide, or cancer in the same age group and similar in frequency to that of fatal lightning strikes (1,11,25). In a college (National Collegiate Athletic Association) athlete population, drugs and suicide combined accounted for a similar number of deaths as confirmed cardiac disease (24), although a non-forensic-based analysis reported a higher incidence for sudden death (27).

Notably, the absolute number of sudden deaths attributable to documented cardiovascular disease in competitive athletes is small in populations for which forensic data are reported. For example, the 33-year US Sudden Death in Athletes Registry has reported a maximum of 75 such deaths in any given year nationally (10), and the Veneto database reports 55 sudden deaths in 26 years, or only ≈2 per year (6). In other populations, the average number of confirmed cardiovascular deaths annually is much less, for instance, <1 in Minnesota high school athletes (11) or ≈4 in college (National Collegiate Athletic Association) athletes (24). Notably, false-negative screening results are a major concern, in which the system fails to identify the cardiac diseases for which it is in fact established. Indeed, a substantial proportion of athletes (≈30% to 40%) may die suddenly of cardiovascular abnormalities that would not necessarily be reliably detected by screening even with ECGs (1,11,24,25).

UNIVERSAL ECG SCREENING

On 3 occasions (1996, 2007, and 2014), AHA consensus expert panels evaluated and decided not to support mandatory national athlete screening in the United States, particularly with routine use of ECGs (1-3). Indeed, sudden cardiovascular deaths in athletes are rare (albeit tragic) events, insufficient in number to be judged as a major public health problem or to justify a change in national healthcare policy. The most frequently cited obstacles to mandatory national screening of trained athletes are as follows: 1) the large number of athletes to be screened nationally on an annual basis (i.e., ≈10 to 12 million); 2) the low incidence of events (1,8,10,11,18,24-26); 3) the substantial number of expected false-negative and false-positive results, in the range of 5% to 20% depending on the specific ECG criteria used (1-3,28-32); 4) cost-efficacy considerations, that is, the extensive resources and expenses required versus few events in absolute numbers; 5) liability issues that unavoidably impact physicians with the sole responsibility to disqualify athletes from competition and enforce that decision; 6) the lack of resources or physicians dedicated to performing examinations and interpreting ECGs, in contrast to the long-standing sports medicine program in Italy (4-6,9); 7) the influence of observer variability, technical considerations, and the impact of ethnicity/race on the interpretation of ECGs, which is particularly important for multicultural athlete populations such as in the United States; 8) the need for repetitive (i.e., annual) ECG screening during adolescence, given the possibility of developing phenotypic evidence of cardiomyopathies during this time period or later (33); 9) the logistical challenges and costs related to second-tier confirmatory screening with imaging and other testing, should primary evaluations raise the suspicion of cardiac disease; and 10) recognition that even with testing, screening cannot be expected to

identify all athletes with important cardiovascular abnormalities, and a significant false-negative rate may occur (34).

NONUNIVERSAL SCREENING FOR ATHLETES

Screening programs on a smaller, nonnational basis have been implemented in some high schools, colleges, and local communities that use ECGs (or echocardiograms) with varying expertise, quality control, and results for identifying important cardiac disease. Consistently, the AHA has not opposed ECG-based screening initiatives (often performed by volunteers) in smaller venues; however, for such screening initiatives, the AHA has prudently advised adequate quality control with due consideration for the prominent limitations of the process (including false-negative and false-positive test results), so that the risks and benefits can be understood and are acceptable to all participants, communities, and organizations (1–3).

There are certain known and anticipated limitations in the use of ECGs in population screening, including but not limited to false-positive and false-negative test results, technical and interpretation issues, "gray zone" ambiguous diagnoses, and cost and logistics involved in arranging second-tier diagnostic testing, all of which promote anxiety, uncertainty, and legal considerations (1,12,25,34).

SCREENING AND RACE

Sudden deaths attributable to cardiovascular disease have been reported in athletes of both sexes and a variety of races, although they are much less common in females (by 1:9) (10,14). Preparticipation screening is warranted with the same frequency and criteria, independent of sex and across racial lines. In particular, although hypertrophic cardiomyopathy unrecognized during life is a frequent cause of sudden death in African-Americans on the athletic field and a major impetus for screening in the black community (1,14,35), there is no evidence to justify different or separate screening strategies based on race. However, it is becoming increasingly apparent that ethnic/racial differences in ECG patterns may significantly impact the definition of normality (30,36–39) and therefore potentially the outcome of the screening process for minorities.

ETHICAL CONSIDERATIONS: WHO SHOULD BE SCREENED?

Unfortunately, often overlooked in the ECG screening debate is the potentially troublesome ethical dilemma created by confining (or proposing to limit) screening for potentially lethal diseases to those who choose engagement in competitive sports, while in the process excluding those who are not athletes. The degree to which people engaged in competitive athletics are at greater risk (given unsuspected underlying heart disease) is not completely resolved. It is likely that the absolute number of sudden deaths is highest in nonathletes because that segment of the population is much larger in size. The AHA maintains the position (1) that theoretically there is no compelling reason to confine screening for cardiovascular disease to young competitive athletes, and exclude non-athletes.

Recommendations

The guidelines presented here are those of the AHA/American College of Cardiology 2014 initiative (1).

1. **It is recommended that the AHA's 14-point screening guidelines and those of other societies, such as the American Academy of Pediatrics' Preparticipation Physical Evaluation, be used by examiners as part of a comprehensive history taking and physical examination to detect or raise suspicion of genetic/congenital cardiovascular abnormalities *(Class I; Level of Evidence C)*.**
2. **It is recommended that standardization of the questionnaire forms used as guides for examiners of high school and college athletes in the United States be pursued *(Class I; Level of Evidence C)*.**
3. **Screening with 12-lead ECGs (or echocardiograms) in association with comprehensive history-taking and physical examination to identify or raise suspicion of genetic/congenital and other cardiovascular abnormalities may be considered in relatively small cohorts of young healthy people 12 to 25 years of age, not necessarily limited to competitive athletes (e.g., in high schools, colleges/universities or local communities). Close physician involvement and sufficient quality control is mandatory. If undertaken, such initiatives should recognize the known and anticipated limitations of the 12-lead ECG as a population screening test, including the expected frequency of false-positive and false-negative test results, as well as the cost required to support these initiatives over time *(Class IIb; Level of Evidence C)*.**
4. **Mandatory and universal mass screening with 12-lead ECGs in large general populations of young healthy people 12 to 25 years of age (including on a national basis in the United States) to identify genetic/congenital and other cardiovascular abnormalities is not recommended for athletes and nonathletes alike *(Class III, no evidence of benefit; Level of Evidence C)*.**
5. **Consideration for large-scale, general population, and universal cardiovascular screening in the age group 12 to 25 years with history taking and physical examination alone is not recommended (including on a national basis in the United States) *(Class III, no evidence of benefit; Level of Evidence C)*.**

DISCLOSURES

Writing Group Disclosures

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers Bureau/ Honoraria	Expert Witness	Ownership Interest	Consultant/ Advisory Board	Other
Barry J. Maron	Minneapolis Heart Institute Foundation	None	None	None	None	None	None	None
Aaron L. Baggish	Massachusetts General Hospital, Harvard Medical School	None	None	None	None	None	None	None
Richard J. Kovacs	Indiana University	None	None	None	None	None	None	None
Benjamin D. Levine	University of Texas Southwestern Medical Center	None	None	None	Texas Legislature*	None	None	None
Martin S. Maron	Tufts Medical Center	None	None	None	None	None	None	None
Reginald L. Washington	Rocky Mountain Hospital for Children	None	None	None	None	None	None	None

This table represents the relationships of writing group members that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all members of the writing group are required to complete and submit. A relationship is considered to be "significant" if (a) the person receives $10,000 or more during any 12-month period, or 5% or more of the person's gross income; or (b) the person owns 5% or more of the voting stock or share of the entity, or owns $10,000 or more of the fair market value of the entity. A relationship is considered to be "modest" if it is less than "significant" under the preceding definition.
*Modest.

Reviewer Disclosures

Reviewer	Employment	Research Grant	Other Research Support	Speakers Bureau/ Honoraria	Expert Witness	Ownership Interest	Consultant/ Advisory Board	Other
Robert M. Campbell	Children's Healthcare of Atlanta	None	None	None	None	None	None	None
Luciana D.N. Janot De Matos	Hospital Israelita Albert Einstein (Brazil)	None	None	None	None	None	None	None
Christine E. Lawless	Self-employed, Sports Cardiology Consultants	Bryan Health Foundation†	None	None	None	None	SCAA*	None

This table represents the relationships of reviewers that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all reviewers are required to complete and submit. A relationship is considered to be "significant" if (a) the person receives $10,000 or more during any 12-month period, or 5% or more of the person's gross income; or (b) the person owns 5% or more of the voting stock or share of the entity, or owns $10,000 or more of the fair market value of the entity. A relationship is considered to be "modest" if it is less than "significant" under the preceding definition.
*Modest.
†Significant.

REFERENCES

1. Maron BJ, Friedman RA, Kligfield P, Levine BD, Viskin S, Chaitman BR, Okin P, Saul JP, Salberg L, Van Hare GF, Soliman EZ, Chen J, Matherene P, Bolling SF, Mittten MJ, Caplan A, Balady GJ, Thompson PS, on behalf of the American Heart Association Council on Clinical Cardiology, Advocacy Coordinating Committee, Council on Cardiovascular Disease in the Young, Council on Cardiovascular Surgery and Anesthesia, Council on Epidemiology and Prevention, Council on Functional Genomics and Translational Biology, Council on Quality of Care and Outcomes Research, and American College of Cardiology. Assessment of the 12-lead electrocardiogram as a screening test for detection of cardiovascular disease in healthy general populations of young people (12–25 years of age): a scientific statement from the American Heart Association and the American College of Cardiology. J Am Coll Cardiol. 2014;64:1479–514. http://dx.doi.org/10.1016/j.jacc.2014.05.006.

2. Maron BJ, Thompson PD, Ackerman MJ, Balady G, Berger S, Cohen D, Dimeff R, Douglas PS, Glover DW, Hutter AM Jr., Krauss MD, Maron MS, Mitten MJ, Roberts WO, Puffer JC. Recommendations and considerations related to preparticipation screening for cardiovascular abnormalities in competitive athletes: update 2007: a scientific statement from the American Heart Association, Nutrition, Physical Activity, and Metabolism Council. Circulation. 2007;115:1643–55. http://dx.doi.org/10.1161/CIRCULATIONAHA.107.181423.

3. Maron BJ, Thompson PD, Puffer JC, McGrew CA, Strong WB, Douglas PS, Clark LT, Mitten MJ, Crawford MH, Atkins DL, Driscoll DJ, Epstein AE. Cardiovascular preparticipation screening of competitive athletes: a statement for health professionals from the Sudden Death Committee (Clinical Cardiology) and Congenital Cardiac Defects Committee (Cardiovascular Disease in the Young), American Heart Association. Circulation. 1996;94:850–6.

4. Pelliccia A, Zipes DP, Maron BJ. Bethesda Conference #36 and the European Society of Cardiology Consensus Recommendations revisited: a comparison of U.S. and European criteria for eligibility and disqualification of competitive athletes with cardiovascular abnormalities. J Am Coll Cardiol. 2008;52:1990–6. http://dx.doi.org/10.1016/j.jacc.2008.08.055.

5. Corrado D, Pelliccia A, Bjørnstad HH, Vanhees L, Biffi A, Borjesson M, Panhuyzen-Goedkoop N, Deligiannis A, Solberg E, Dugmore D, Mellwig KP, Assanelli D, Delise P, van-Buuren F, Anastasakis A, Heidbuchel H, Hoffmann E, Fagard R, Priori SG, Basso C, Arbustini E, Blomstrom-Lundqvist C, McKenna WJ, Thiene G, Study Group of Sport Cardiology of the Working Group of Cardiac Rehabilitation and Exercise Physiology and the Working Group of Myocardial and Pericardial Diseases of the European Society of Cardiology. Cardiovascular pre-participation screening of young competitive athletes for prevention of sudden death: proposal for a common European protocol. Consensus Statement of the Study Group of Sport Cardiology of the Working Group of Cardiac Rehabilitation and Exercise Physiology and the Working Group of Myocardial and Pericardial Diseases of the European Society of Cardiology. Eur Heart J. 2005;26:516–24. http://dx.doi.org/10.1093/eurheartj/ehi108.

6. Corrado D, Basso C, Pavei A, Michieli P, Schiavon M, Thiene G. Trends in sudden cardiovascular death in young competitive athletes after implementation of a

preparticipation screening program. JAMA. 2006;296:1593–601. http://dx.doi.org/10.1001/jama.296.13.1593.

7. Steinvil A, Chundadze T, Zeltser D, Rogowski O, Halkin A, Galily Y, Perluk H, Viskin S. Mandatory electrocardiographic screening of athletes to reduce their risk for sudden death: proven fact or wishful thinking? J Am Coll Cardiol. 2011;57:1291–6. http://dx.doi.org/10.1016/j.jacc.2010.10.037.

8. Maron BJ. Sudden death in young athletes. N Engl J Med. 2003;349:1064–75. http://dx.doi.org/10.1056/NEJMra022783.

9. Corrado D, Basso C, Schiavon M, Thiene G. Screening for hypertrophic cardiomyopathy in young athletes. N Engl J Med. 1998;339:364–9. http://dx.doi.org/10.1056/NEJM199808063390602.

10. Maron BJ, Doerer JJ, Haas TS, Tierney DM, Mueller FO. Sudden deaths in young competitive athletes: analysis of 1866 deaths in the United States, 1980-2006. Circulation. 2009;119:1085–92. http://dx.doi.org/10.1161/CIRCULATIONAHA.108.804617.

11. Maron BJ, Haas TS, Ahluwalia A, Rutten-Ramos SC. Incidence of cardiovascular sudden deaths in Minnesota high school athletes. Heart Rhythm. 2013;10:374–7. http://dx.doi.org/10.1016/j.hrthm.2012.11.024.

12. Holst AG, Winkel BG, Theilade J, Kristensen IB, Thomsen JL, Ottesen GL, Svendsen JH, Haunsø S, Prescott E, Tfelt-Hansen J. Incidence and etiology of sports-related sudden cardiac death in Denmark: implications for preparticipation screening. Heart Rhythm. 2010;7:1365–71. http://dx.doi.org/10.1016/j.hrthm.2010.05.021.

13. Maron BJ. Diversity of views from Europe on national preparticipation screening for competitive athletes. Heart Rhythm. 2010;7:1372–3. http://dx.doi.org/10.1016/j.hrthm.2010.06.001.

14. Maron BJ, Carney KP, Lever HM, Lewis JF, Barac I, Casey SA, Sherrid MV. Relationship of race to sudden cardiac death in competitive athletes with hypertrophic cardiomyopathy. J Am Coll Cardiol. 2003;41:974–80.

15. Mitchell JH, Maron BJ, Epstein SE. 16th Bethesda Conference: cardiovascular abnormalities in the athlete: recommendations regarding eligibility for competition: October 3-5, 1984. J Am Coll Cardiol. 1985;6:1186–232.

16. Maron BJ, Mitchell JH. 26th Bethesda Conference: recommendations for determining eligibility for competition in athletes with cardiovascular abnormalities: January 6-7, 1994 [published correction appears in Med Sci Sports Exerc. 1994;26:followi]. J Am Coll Cardiol. 1994;24:845–99.

17. Maron BJ, Zipes DP. 36th Bethesda Conference: eligibility recommendations for competitive athletes with cardiovascular abnormalities. J Am Coll Cardiol. 2005;45:1313–75.

18. Maron BJ, Haas TS, Doerer JJ, Thompson PD, Hodges JS. Comparison of U.S. and Italian experiences with sudden cardiac deaths in young competitive athletes and implications for preparticipation screening strategies. Am J Cardiol. 2009;104:276–80. http://dx.doi.org/10.1016/j.amjcard.2009.03.037.

19. Glover DW, Glover DW, Maron BJ. Evolution in the process of screening United States high school student-athletes for cardiovascular disease. Am J Cardiol. 2007;100:1709–12. http://dx.doi.org/10.1016/j.amjcard.2007.07.018.

20. Glover DW, Maron BJ. Profile of preparticipation cardiovascular screening for high school athletes. JAMA. 1998;279:1817–9.

21. Corrado D, Schmied C, Basso C, Borjesson M, Schiavon M, Pelliccia A, Vanhees L, Thiene G. Risk of sports: do we need a pre-participation screening for competitive and leisure athletes? Eur Heart J. 2011;32:934–44. http://dx.doi.org/10.1093/eurheartj/ehq482.

22. Tasaki H, Hamasaki Y, Ichimaru T. Mass screening for heart disease of school children in Saga city: 7-year follow up study. Jpn Circ J. 1987;51:1415–20.

23. Haneda N, Mori C, Nishio T, Saito M, Kajino Y, Watanabe K, Kijima Y, Yamada K. Heart diseases discovered by mass screening in the schools of Shimane Prefecture over a period of 5 years. Jpn Circ J. 1986;50:1325–9.

24. Maron BJ, Haas TS, Murphy CJ, Ahluwalia A, Rutten-Ramos S. Incidence and causes of sudden death in U.S. college athletes. J Am Coll Cardiol. 2014;63:1636–43. http://dx.doi.org/10.1016/j.jacc.2014.01.041.

25. Maron BJ. Counterpoint: mandatory ECG screening of young competitive athletes. Heart Rhythm. 2012;9:1646–9. http://dx.doi.org/10.1016/j.hrthm.2012.03.019.

26. Risgaard B, Winkel BG, Jabbari R, Glinge C, Ingemann-Hansen O, Thomsen JL, Ottesen GL, Haunsø S, Holst AG, Tfelt-Hansen J. Sports-related sudden cardiac death in a competitive and a noncompetitive athlete population aged 12 to 49 years: data from an unselected nationwide study in Denmark. Heart Rhythm. 2014;11:1673–81. http://dx.doi.org/10.1016/j.hrthm.2014.05.026.

27. Harmon KG, Asif IM, Klossner D, Drezner JA. Incidence of sudden cardiac death in National Collegiate Athletic Association athletes. Circulation. 2011;123:1594–600. http://dx.doi.org/10.1161/CIRCULATIONAHA.110.004622.

28. Baggish AL, Hutter AM Jr., Wang F, Yared K, Weiner RB, Kupperman E, Picard MH, Wood MJ. Cardiovascular screening in college athletes with and without electrocardiography: a cross-sectional study. Ann Intern Med. 2010;152:269–75. http://dx.doi.org/10.7326/0003-4819-152-5-201003020-00004.

29. Malhotra R, West JJ, Dent J, Luna M, Kramer CM, Mounsey JP, Battle R, Saliba E, Rose B, Mistry D, MacKnight J, DiMarco JP, Mahapatra S. Cost and yield of adding electrocardiography to history and physical in screening Division I intercollegiate athletes: a 5-year experience. Heart Rhythm. 2011;8:721–7. http://dx.doi.org/10.1016/j.hrthm.2010.12.024.

30. Magalski A, McCoy M, Zabel M, Magee LM, Goeke J, Main ML, Bunten L, Reid KJ, Ramza BM. Cardiovascular screening with electrocardiography and echocardiography in collegiate athletes. Am J Med. 2011;124:511–8. http://dx.doi.org/10.1016/j.amjmed.2011.01.009.

31. Pelliccia A, Maron BJ, Culasso F, Di Paolo FM, Spataro A, Biffi A, Caselli G, Piovano P. Clinical significance of abnormal electrocardiographic patterns in trained athletes. Circulation. 2000;102:278–84.

32. Weiner RB, Hutter AM, Wang F, Kim JH, Wood MJ, Wang TJ, Picard MH, Baggish AL. Performance of the 2010 European Society of Cardiology criteria for ECG interpretation in athletes. Heart. 2011;97:1573–7. http://dx.doi.org/10.1136/hrt.2011.227330.

33. Pelliccia A, Di Paolo FM, Quattrini FM, Basso C, Culasso F, Popoli G, De Luca R, Spataro A, Biffi A, Thiene G, Maron BJ. Outcomes in athletes with marked ECG repolarization abnormalities. N Engl J Med. 2008;358:152–61. http://dx.doi.org/10.1056/NEJMoa060781.

34. Rowin EJ, Maron BJ, Appelbaum E, Link MS, Gibson CM, Lesser JR, Haas TS, Udelson JE, Manning WJ, Maron MS. Significance of false negative electrocardiograms in preparticipation screening of athletes for hypertrophic cardiomyopathy. Am J Cardiol. 2012;110:1027–32. http://dx.doi.org/10.1016/j.amjcard.2012.05.035.

35. Maron BJ, Gardin JM, Flack JM, Gidding SS, Kurosaki TT, Bild DE. Prevalence of hypertrophic cardiomyopathy in a general population of young adults: echocardiographic analysis of 4111 subjects in the CARDIA Study. Circulation. 1995;92:785–9.

36. Papadakis M, Carre F, Kervio G, Rawlins J, Panoulas VF, Chandra N, Basavarajaiah S, Carby L, Fonseca T, Sharma S. The prevalence, distribution, and clinical outcomes of electrocardiographic repolarization patterns in male athletes of African/Afro-Caribbean origin. Eur Heart J. 2011;32:2304–13. http://dx.doi.org/10.1093/eurheartj/ehr140.

37. Magalski A, Maron BJ, Main ML, McCoy M, Florez A, Reid KJ, Epps HW, Bates J, Browne JE. Relation of race to electrocardiographic patterns in elite American football players. J Am Coll Cardiol. 2008;51:2250–5. http://dx.doi.org/10.1016/j.jacc.2008.01.065.

38. Di Paolo FM, Schmied C, Zerguini YA, Junge A, Quattrini F, Culasso F, Dvorak J, Pelliccia A. The athlete's heart in adolescent Africans: an electrocardiographic and echocardiographic study. J Am Coll Cardiol. 2012;59:1029–36. http://dx.doi.org/10.1016/j.jacc.2011.12.008.

39. Basavarajaiah S, Boraita A, Whyte G, Wilson M, Carby L, Shah A, Sharma S. Ethnic differences in left ventricular remodeling in highly-trained athletes: relevance to differentiating physiologic left ventricular hypertrophy from hypertrophic cardiomyopathy. J Am Coll Cardiol. 2008;51:2256–62. http://dx.doi.org/10.1016/j.jacc.2007.12.061.

KEY WORDS **ACC/AHA Scientific Statements, athletes, cardiovascular abnormalities, competitive athletes, preparticipation screening, sudden death**

ACC/AHA Release Recommendations For Congenital and Genetic Heart Disease Screenings in Youth

Sep 15, 2014

ACC News Story

Health care professionals should use a 14-element checklist when evaluating healthy, young individuals ages 12-25 for congenital and genetic heart disease vs initial screening using electrocardiograms (ECGs), according to a **new scientific statement** released by the ACC and the American Heart Association and published in the *Journal of the American College of Cardiology*.

The recommended 14-element screening checklist includes assessing young people for findings on the physical examination, including heart murmurs, and for any history of unexplained fainting, exertional chest pain, or excessive shortness of breath or fatigue during exercise. It also includes questions about family history of premature death or disability due to heart disease or known cardiac conditions involving the heart muscle or heart rhythm before age 50 in one or more family members. The checklist also questions whether an individual has been restricted from participation in sports in the past or has had prior testing for the heart ordered by a health care provider.

The statement authors note that 12-lead ECGs may in some cases detect congenital heart disease that can lead to sudden cardiac death, and should be used when a health care provider has determined a young person may be at higher risk for a heart abnormality based on family history, physical examination and other parts of

the 14-element questionnaire. They add that health care providers may find that other tests, such as echocardiograms, would be helpful in some individuals as well.

However, the authors stress that use of ECGs to detect underlying congenital and genetic heart disease in this group prior to employing the checklist has not been shown to save lives. There is currently insufficient evidence to conclude that mandating screening of either competitive athletes or the general young U.S. population with a 12-lead ECG would save lives, they said. In addition, the value of the test varies based on the expertise of those interpreting the test. For example, assessing pediatric ECGs can be particularly difficult, because the ECG changes with growth and development, and the expertise required is not widely available.

“Although sudden death among young people is rare, it is always a tragedy, and the infrequency of these events in no way mitigates their importance or impact on families and the community. However, the media coverage of sudden cardiac arrests in athletes may have created the exaggerated impression that these tragic events are far more common than they actually are, or that they are limited to athletes,” said Barry J. Maron, MD, FACC, chair of the writing panel for the statement and director of the Hypertrophic Cardiomyopathy Center at the Minneapolis Heart Institute Foundation.

Barron explains that those who do not sign up for sports are just as likely to have the genetic heart diseases that raise the risk for sudden death. “Since there are by far more non-athletes — only about 1 percent of college students and 30 percent of high school students participate in competitive sports — there are more deaths in non-athletes participating in recreational sports and normal daily activities,” he said.

The statement also advocates for broader dissemination of automatic external defibrillators in public gathering places, such as sports arenas and schools moving forward, as they can be highly effective in saving young lives on the athletic field or elsewhere, when cardiac arrest does occur.

Additional Resources

- **Assessment of the 12-Lead ECG as a Screening Test for Detection of CVD in Healthy General Populations of Young People (12-25 Years of Age)**
- 10 Points to Remember
- Is ECG Detection of Cardiac Abnormalities Same For Black and White Athletes?
- Practicality of Nationwide ECG Screenings Questioned in Two Studies
- Sports and Exercise Cardiology Expands in the US

- Exercise Training Intensity and HF *(JACC: Heart Fail)*
- Standard ECG, Stress Testing Lifelong Learning and MOC Activities
- Sports and Exercise Cardiology Membership Section
- **CardioSmart for Your Patients: SD in College Athletes: Cause for Concern**

The 14-Element Cardiovascular Screening Checklist for Congenital and Genetic Heart Disease:

Personal history:

1. Chest pain/discomfort/tightness/pressure related to exertion
2. Unexplained syncope/near-syncope*
3. Excessive exertional and unexplained dyspnea/fatigue or palpitations, associated with exercise
4. Prior recognition of a heart murmur
5. Elevated systemic blood pressure
6. Prior restriction from participation in sports
7. Prior testing for the heart, ordered by a physician

Family history:

8. Premature death (sudden and unexpected, or otherwise) before age 50 attributable to heart disease in ≥1 relative
9. Disability from heart disease in close relative <50 y of age
10. Hypertrophic or dilated cardiomyopathy, long-QT syndrome, or other ion channelopathies, Marfan syndrome, or clinically significant arrhythmias;

specific knowledge of certain cardiac conditions in family members

Physical examination:

11. Heart murmur**
12. Femoral pulses to exclude aortic coarctation
13. Physical stigmata of Marfan syndrome
14. Brachial artery blood pressure (sitting position)***

*Judged not to be of neurocardiogenic (vasovagal) origin; of particular concern when occurring during or after physical exertion.
**Refers to heart murmurs judged likely to be organic and unlikely to be innocent; auscultation should be performed with the patient in both the supine and standing positions (or with Valsalva maneuver), specifically to identify murmurs of dynamic left ventricular outflow tract obstruction.
***Preferably taken in both arms.

Clinical Topics: Arrhythmias and Clinical EP, Cardiac Surgery, Congenital Heart Disease and Pediatric Cardiology, Heart Failure and Cardiomyopathies, Sports and Exercise Cardiology, Implantable Devices, Genetic Arrhythmic Conditions, SCD/Ventricular Arrhythmias, Aortic Surgery, Cardiac Surgery and Arrhythmias, Cardiac Surgery and CHD and Pediatrics, Cardiac Surgery and Heart Failure, Congenital Heart Disease, CHD and Pediatrics and Arrhythmias, CHD and

Pediatrics and Prevention, CHD and Pediatrics and Quality Improvement, Sports and Exercise and Congenital Heart Disease and Pediatric Cardiology

Keywords: *Athletes, Students, Cardiomyopathy, Hypertrophic, Syncope, Sports, Blood Pressure, Electrocardiography, Checklist, Mortality, Premature, Marfan Syndrome, Questionnaires, Channelopathies, Physical Exertion, Death, Sudden, Cardiac, Valsalva Maneuver, Defibrillators, Health Personnel, Auscultation, Dyspnea, Heart Diseases, Chest Pain, Heart Murmurs, Cardiomyopathy, Dilated*