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Advanced Sports Medicine Concepts and Controversies

Should Electrocardiograms Be Part of the Preparticipation Physical Examination?

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Introduction

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One of the greatest tragedies that can occur in sport is sudden cardiac death (SCD). There are multiple potential causes for SCD, some of which may be detected with an electrocardiogram (ECG) [1]. Because identifying potential life-threatening medical conditions and thus preventing catastrophic injuries is one of the primary objectives of the preparticipation physical examination (PPE), it has been suggested that ECGs should be incorporated into the PPE [2]. Some sports federations (eg, Federation Internationale de Football Association) or governing bodies (eg, International Olympic Committee) currently recommend ECGs as part of the PPE, whereas others do not (eg, American Heart Association [AHA]) [3-5]. In the following article, the arguments for and against ECG screening in the PPE are presented by prominent sports medicine clinician-researchers. Although the merit of ECG screening during the PPE is up for debate, the importance of this topic is not. Hopefully, the contents of this article will help you to formulate your own opinion about this controversial topic.

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PRO: ECG Screening in the Young Athlete

Kimberly G. Harmon, MD, and
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The primary objective of the PPE is to identify conditions that predispose athletes to death or other catastrophic events. SCD is the leading medical cause of death in young athletes and the number 1 cause of sudden death during sports [1-3]; therefore, it follows that the PPE should serve as an effective screen for underlying cardiovascular conditions that place young athletes at risk for sudden death. The AHA recommends a 14-point history and physical examination cardiovascular screen during the PPE. In addition to the history and physical examination, the European Society of Cardiology, the European Society of Cardiology, the International Olympic Committee, and most professional sporting organizations also require a resting 12-lead ECG [4-7].

The arguments cited against adding ECG to the PPE are myriad, but most are arguments against any type of

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cardiovascular screening. Cardiovascular screening both with and without ECG must be held to the same standards of evidence. Issues to consider when contemplating cardiovascular screening include: (1) the prevalence of disease and incidence of SCD; (2) the accuracy of screening methods; (3) costs/cost-effectiveness; (4) feasibility; (5) physician infrastructure; (6) benefits; and (7) the harms of screening. The validity of each of these concerns will be examined to discern whether they are applicable to cardiovascular screening with ECG or to cardiovascular screening of any type in an attempt to determine best practices.

Prevalence of Cardiovascular Disorders and the Incidence of SCD

The prevalence of underlying cardiovascular disorders in athletes known to predispose to SCD is determined consistently to be approximately 0.3% (or 1 in 300) [5,8-12]. Importantly, this prevalence is validated by numerous screening studies inclusive of ECG. Studies that use only history and physical examination, however, have not demonstrated a similar sensitivity or strength for disease detection and in fact miss the majority of potentially lethal conditions in athletes. Overall, student athletes are approximately 4 times more likely to suffer sudden cardiac arrest (SCA) than their nonathlete peers [13].

Although there is general agreement on the prevalence of at-risk cardiovascular disorders, there is significant variation in estimates of SCA and SCD in the athletic population, primarily attributable to differences in the methods used for case identification (numerator) and estimation of the number of athletes in a population (denominator). In most places, there is no requirement to report SCD or SCA to any authority, so surrogate measures such as registries, media reports, or insurance claims are relied on, which can lead to substantial error. In circumstances in which mandatory reporting is required, incidence numbers are significantly greater compared with studies that use other approaches.

For instance, in the Veneto region of Italy, where there is mandatory reporting of death, systematic autopsy evaluation, and required registration of athletes, the incidence of SCD was 1 in 28,000 athlete-years before the institution of a cardiovascular screening program inclusive of ECG [11]. Similarly, in the U.S. military, where mandatory reporting also is required and a precise denominator exists, the rate of SCD was estimated at 1 in 10,000 recruit-years [14]. This result is in marked contrast to studies that use insurance claim data for death benefits as a proxy for SCD, which estimate SCD to occur in the range from 1 in 200,000 to 1 in 919,000 [15-17]. Insurance claims, however, have been shown to capture only a fraction (9%-15%) of total cardiac-related deaths [1,2].

In college athletes, the incidence of SCD is 1 in 53,000. Athlete groups are at greater risk, including male (1 in 38,000), African American (1 in 21,000), and male basketball athletes (1 in 9000) [1]. Incidence estimates in high school athletes range from 1 in 46,000 to 1 in 919,000 [17,18]. Studies with more rigorous methodology suggest the rate is approximately 1 in 80,000 [13]. Although SCA and SCD can occur in any athlete, National Collegiate Athletic Association (NCAA) incidence studies, the U.S. National Registry for Sudden Death in Athletes, and the National Center for Catastrophic Sports Injury Research demonstrate consistently that approximately 75% of cases occur in 3 sports—men's basketball, football, and soccer.

Misperceptions Regarding Incidence

The chance of SCD in an athlete has been compared repeatedly with the potential of death from lightning strike [4,19]; however, this is more hyperbole than fact. The incidence of death attributable to lightning strikes is 1 in 10,000,000, about 200 times less common than SCD [20]. It also has been stated that deaths attributable to SCD in athletes are "several hundred times less common than the major causes of death such as motor vehicle accidents (MVA) or suicide" [3,19,21,22]. This statement is misleading in that comparisons are made from the absolute number of deaths in young people in the United States to the absolute number of deaths in college athletes, a much smaller population. When the number of deaths within the same group are compared, MVAs are only twice as common as SCD in all NCAA athletes; however, male basketball athletes actually are more likely to die of SCD than an MVA [1]. In addition, SCD in NCAA athletes is more common than homicide and suicide combined [2]. The perpetuation of misleading statements regarding incidence and proportionality is troubling and a major reason the "status quo" for screening has been maintained.

Accuracy of Cardiovascular Screening Methods

Sensitivity and specificity are important when considering screening tests. In a recent meta-analysis encompassing more than 47,000 participants, the sensitivity of ECG was 93%, history 20%, and physical examination 9%, with all having similar specificity (93%-97%) [23]. The false-positive rate has long been a concern with ECG screening, and in early studies, false-positive rates were high. In 2005, the European Society of Cardiology suggested standards for interpreting ECGs in athletes, noting that many findings previously considered abnormal were secondary to the physiologic effects of training in athletes.

As these criteria have been refined, the false-positive rate has progressively fallen and is now about 2%-4% when the Seattle Criteria are used [24]. False-positive rates in the meta-analysis were 6% for ECG, 8% for history, and 10%