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AHA/ACC SCIENTIFIC STATEMENT

Eligibility and Disqualification Recommendations for Competitive Athletes With Cardiovascular Abnormalities: Task Force 14: Sickle Cell Trait

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

Barry J. Maron, MD, FACC, *Chair**
Kevin M. Harris, MD, FACC*
Paul D. Thompson, MD, FAHA, FACC*
E. Randy Eichner, MD*
Martin H. Steinberg, MD*

Sickle cell trait (SCT), in which a normal hemoglobin gene and an abnormal mutated β-globin sickle gene (*HbS*) are inherited, occurs in 8% of blacks in the United States (0.08% of nonblacks) (1,2). SCT has been regarded as a benign condition that generally does not expose affected people to health risks, although for many years it has also been recognized as a potential cause of death in military training recruits during vigorous and intense physical exertion (3). More recently, evidence has been assembled proposing SCT as a cause of sudden death in competitive athletes, usually during training and conditioning (4,5). In 2010, the National Collegiate Athletic Association (NCAA) mandated SCT screening (with solubility testing) for all student-athletes in division I sports (division II, 2012; division III, 2013). In addition, all newborns have been routinely tested for SCT shortly after birth since 1987 in accordance with a National Institutes of Health recommendation (1,6). Much of the controversy regarding SCT and athletes has focused on mandatory screening measures for the genetic defect, an issue that we have not addressed in this statement.

*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; 2356-61; 2362-71; 2372-84; 2385-92; 2393-7; 2398-405; 2406-11; 2412-23; 2424-8; 2429-33; 2434-8; 2439-43; and 2447-50).

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That SCT can be responsible for lethal sudden collapse (7), including on the athletic field, is based on evidence from the forensic-based US National Sudden Death in Athletes Registry (4,8,9) and other databases (10), as well as numerous case reports and considerable expert experience acquired in athletic venues (5). The epidemiology and characterization of SCT-related events in athletes are evolving. A large experience from the US Sudden Death in Athletes Registry documented SCT-associated collapse and death in 0.9% of 2462 athletes. This outcome occurred in 3.3% of the blacks in the registry (4). Ages of the victims were 12 to 22 years, and 90% were male. Events were most common in college football players during conditioning drills.

A distinctive clinical presentation has emerged that involves gradual deterioration over several minutes. Symptoms include cramping, dyspnea, muscle pain and severe weakness, and fatigue and exhaustion, provoked by vigorous physical exertion, often with sequential brief bursts of sustained maximal physical activity (e.g., interval training). Events typically occur early in the training season or after periods of deconditioning, often in ambient temperatures ≥80°, at high altitude, or associated with development of rhabdomyolysis (4,11–14). Notably, this scenario is in striking contrast to collapse caused by cardiovascular disease with ventricular tachyarrhythmias, which is typically virtually instantaneous (8,9).

Although the pathophysiology and clinical determinants of death in people with SCT participating in intense exercise are not fully understood, cardiovascular collapse likely occurs under conditions that (in laboratory studies) promote *HbS* polymerization and erythrocyte sickling. These include hyperthermia, dehydration, acidosis, and hypoxemia (11–14). It is possible that with intense exercise, a cascade of events ensues under unpredictable circumstances that recreates some of the laboratory conditions that lead to *HbS* polymerization and erythrocyte sickling, thereby triggering vascular occlusion, endothelial damage, and impaired muscular blood flow (12–16). This exertional sickling scenario could promote rhabdomyolysis and disseminated intravascular coagulation, which in turn could lead to hyperkalemia, lactic acidosis, worsening hypoxia, impaired cardiac and renal function, and lethal arrhythmias. However, widespread sickling in the heart and other organs identified at autopsy does not itself represent definitive evidence for SCT-related death, because postmortem *HbS* polymerization and erythrocyte sickling are an expected consequence of the diminished oxygen environment at death.

These considerations have advanced specific precautionary recommendations for targeted and tailored measures during training for athletes with SCT to enhance the prevention of sudden death (15,16). These precautions, which can also benefit all athletes, include more gradual conditioning at the beginning of the training season (or after periods of deconditioning) with attention to modifying pace, providing adequate rest and hydration during conditioning drills, and promoting a high index of suspicion to immediately cease physical activity should muscle weakness, cramping or pain, fatigue, and disproportionately excessive dyspnea occur.

Indeed, collapse of an athlete with SCT is a medical emergency that requires support of vital signs, administration of supplemental oxygen, intravenous hydration, possibly cooling to protect against fulminating rhabdomyolysis, and likely rapid transport to a medical facility. A metabolic insult with lactic acidosis, hyperkalemia, and hypocalcemia can lead to pulseless electrical activity, so that the effectiveness of external defibrillation in this clinical setting is unpredictable. Such modified conditioning strategies and surveillance are now widely used by athletic trainers and coaching staffs in college athletic programs to prevent SCT-related complications and catastrophes.

SCT should now be included among the myriad of nontraumatic risks of sports participation capable of leading to the demise of some susceptible athletes, the vast majority of whom are black.

Recommendations

1. **Recognition of SCT status is not itself a justification for disqualification from competitive sports *(Class I; Level of Evidence C)*.**
2. **Recommended preventive strategies (including adequate rest and hydration) should be performed to minimize the likelihood of an event occurring on the athletic field in a person known to have SCT *(Class I; Level of Evidence B)*.**
3. **It is critical to be prospectively aware of acute emergency medical strategies should suspicion of an emerging event arise in an athlete known to have SCT *(Class I; Level of Evidence C)*.**
4. **Particular caution should be exercised for athletes known to have SCT who are competing or training in high environmental temperatures or at extreme altitude *(Class I; Level of Evidence C)*.**

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Barry J. Maron	Minneapolis Heart Institute Foundation	None	None	None	None	None	None	None
E. Randy Eichner	University of Oklahoma	None	None	None	None	None	None	None
Kevin M. Harris	Minneapolis Heart Institute Foundation	None	None	None	None	None	None	None
Martin H. Steinberg	Boston University	None	None	None	None	None	None	None
Paul D. Thompson	Hartford Hospital	None	None	None	None	None	None	None

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Reviewer Disclosures

Reviewer	Employment	Research Grant	Other Research Support	Speakers Bureau/Honoraria	Expert Witness	Ownership Interest	Consultant/ Advisory Board	Other
Michelle A. Grenier	University of Mississippi	None	None	None	None	None	None	None
Pranav Kansara	Christiana Care Health System	None	None	None	None	None	None	None
Mark S. Kindy	Medical University of South Carolina	None	None	None	None	None	None	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.

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