

AHA/ACC SCIENTIFIC STATEMENT

Eligibility and Disqualification Recommendations for Competitive Athletes With Cardiovascular Abnormalities: Task Force 13: Commotio Cordis



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

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Commotio cordis is defined as sudden cardiac death triggered by a relatively innocent blow to the precordium (1). Although initially thought to be extremely rare, it is now increasingly reported in the United States and worldwide (2,3). Enhanced recognition of commotio cordis, rather than an increase in event frequency, likely accounts for the greater visibility of those events. Commotio cordis is one of the most common causes of sudden cardiac death in recreational and competitive sports, instantaneously resulting in a potentially fatal arrhythmia (4). Commotio cordis is distinct from cardiac contusion, in which structural damage to the heart with resultant

arrhythmias develops within 24 hours after severe chest impact (5).

RISK FACTORS FOR COMMOTIO CORDIS

Risk factors for a commotio cordis have been defined by a Commotio Cordis Registry of clinical events and an experimental swine model. Human cases occur largely in adolescent males (95% of cases), with a mean age of 14 years (2). Impacts occur over the left chest wall and are generally sustained with a hard spherical object such as a baseball, hockey puck, lacrosse ball, or softball. Collapse is instantaneous or

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within a few seconds; when a defibrillator is used rapidly, the arrhythmia is typically ventricular fibrillation (VF).

An experimental model of commotio cordis has confirmed the arrhythmia induced by a chest blow is VF (6). Impact must occur over the cardiac silhouette, and harder balls are more likely to induce VF (6-8). In addition, this model has demonstrated the critical importance of timing in that only those blows that occur during a narrow time segment of the T-wave upstroke reliably produce VF (6). These laboratory experiments have also shown the importance of size and shape of the object (9). Blows must occur directly perpendicular to the chest wall to produce VF, and impact velocities optimal to produce commotio cordis are those just slightly less than velocities which produce cardiac damage (in the swine model 40 mph optimal; 50 mph creates cardiac damage) (10).

RESUSCITATION

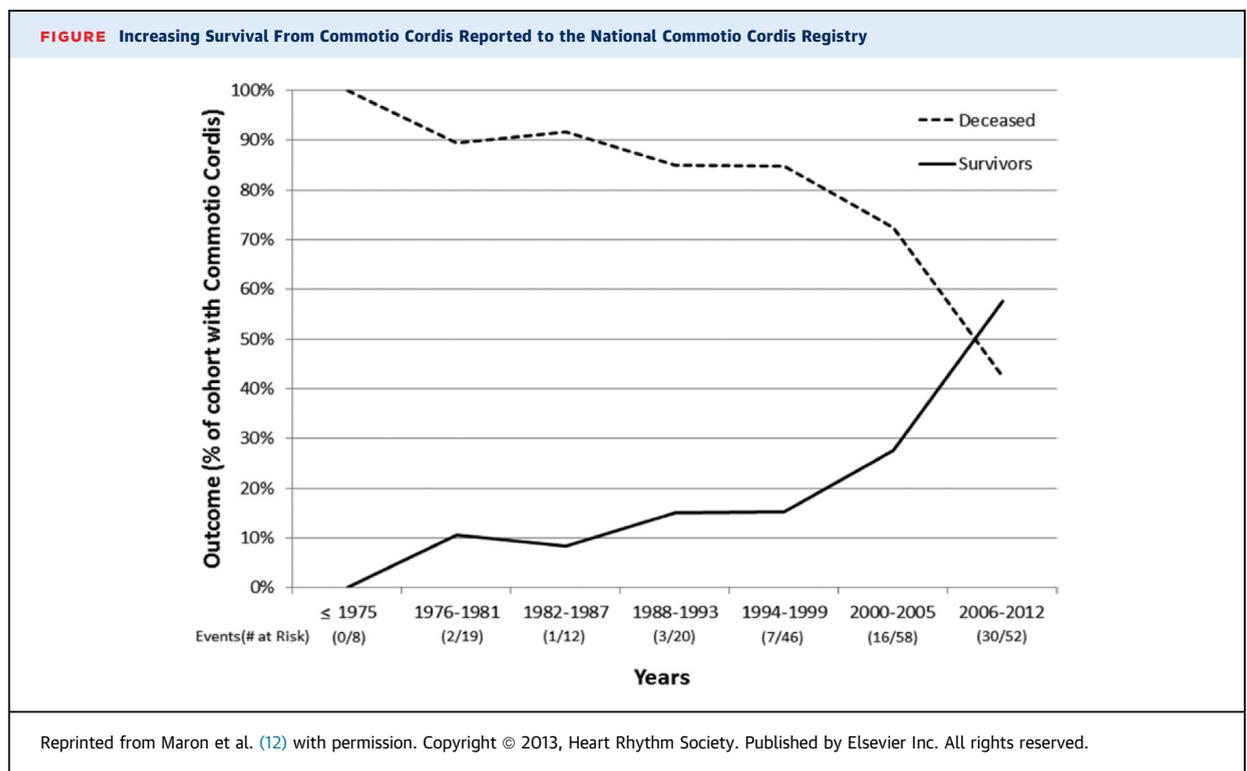
Initially, it was thought that successful resuscitation was more difficult to achieve in commotio cordis victims than in sudden cardiac death in other conditions (1). This perception was based on the poor rate of survival of commotio cordis victims reported to the Commotio Cordis Registry before 1995 (1). Registry data reported in 2002 showed that survival had increased to 15% (11). More recent data from the Commotio Cordis Registry demonstrate that the survival rate has increased steadily over

the past 15 years (Figure) (12), and survival in the most recent years is now >50%. The reasons for improved survival are multifactorial, including greater recognition of commotio cordis, which leads to a shorter time interval after collapse to cardiopulmonary resuscitation and defibrillation; more dissemination of automated external defibrillators in the community; and a greater number of people who have been trained and are willing to perform cardiopulmonary resuscitation and defibrillation.

Barriers remain to a successful outcome for victims of commotio cordis. In the Registry, blacks had a much lower survival rate than whites, and events that occur at home or during recreational sports are associated with lower survival than those in the setting of competitive sports, likely because of more rapid response times.

PREVENTION

Data from the Commotio Cordis Registry show that commotio cordis events can occur despite the use of safety baseballs and chest protectors (13). Although most baseball events have occurred with a standard baseball, there have been a small number that occurred with safety baseballs (11). Without knowing the relative number of chest impacts with standard versus safety baseballs, it is not possible to assess from these data whether safety baseballs are protective. In an



experimental model, the risk for commotio cordis decreased incrementally with softer balls (age-dependent safety baseballs), but safety baseballs were not absolutely protective against commotio cordis (6,8). This decrease was observed with chest wall impacts at both 30 and 40 mph.

Of the commotio cordis events that occurred in competitive sports, chest protectors were worn in 37% (12). Despite the use of these chest barriers, commotio cordis still occurs; in some sports, such as hockey, the chest protector can be raised with lifting of the arms, thereby uncovering the precordium and thus failing to provide protection. However, in other sports, such as baseball and lacrosse, the chest protectors have remained over the heart, and impact occurred through the barrier. Again, without knowing the relative number of impacts with or without chest protectors, these data cannot be interpreted with regard to risk. However, it is apparent that even with chest protection, prevention of commotio cordis is not absolute. In the swine model, commercial chest protectors for lacrosse and baseball did not lower the risk of commotio cordis (14). At impact velocities of 40 mph, the incidence of VF was similar among chest protectors and control impacts in which no chest protector was worn.

RETURN TO PLAY

Commotio cordis victims must undergo a complete cardiac workup to rule out structural heart disease. This includes but is not restricted to ECGs, echocardiograms, magnetic resonance imaging, ambulatory ECG monitoring, and stress testing. Pharmacological testing for Brugada and long-QT syndromes should also be considered in the presence of typical electrocardiographic features. Age-based electrocardiographic criteria should be applied, because T-wave abnormalities and QT intervals may be greater in the young (15). In those instances in which long-QT syndrome is a persistent concern, genetic testing could be considered. If underlying cardiac disease is absent, implantable cardioverter defibrillators are not recommended for survivors of commotio cordis.

Return-to-play decisions are largely dictated by the presence versus absence of underlying cardiac disease.

Given the large number of variables necessary to be confluent to trigger commotio cordis, a randomly occurring second event would be unlikely. Still, given some animal data for individual susceptibility to commotio cordis (16), it would be prudent to avoid sports that involve chest wall impact. Maturation of the chest wall with age also should lower the risk of recurrent commotio cordis.

CONCLUSIONS

Commotio cordis is an unusual event but still an important cause of morbidity and mortality in youth sports, as well as in many other circumstances. Absolute prevention will likely never be completely attainable, and thus, the most reasonable focus should be on recognition and resuscitation, including timely cardiopulmonary resuscitation and defibrillation.

Recommendations

- 1. Measures should be taken to ensure successful resuscitation of commotio cordis victims, including training of coaches, staff, and others to ensure prompt recognition, notification of emergency medical services, and institution of cardiopulmonary resuscitation and defibrillation (2,12,17) (Class I; Level of Evidence B).**
- 2. A comprehensive evaluation for underlying cardiac pathology and susceptibility to arrhythmias should be performed in survivors of commotio cordis (2,4) (Class I; Level of Evidence B).**
- 3. It is reasonable to use age appropriate safety baseballs to reduce the risk of injury and commotio cordis (6,8) (Class IIa; Level of Evidence B).**
- 4. Rules governing athletics and coaching techniques to reduce chest blows can be useful to decrease the probability of commotio cordis (Class IIa; Level of Evidence C).**
- 5. If no underlying cardiac abnormality is identified, then individuals can safely resume training and competition after resuscitation from commotio cordis (Class IIa; Level of Evidence C).**

DISCLOSURES

Writing Group Disclosures

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