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Matthew W. Martinez

Preparticipation Cardiac Evaluation from the Pediatric Perspective **1**

Andrew M. Reittinger, Lanier B. Jackson, and Peter N. Dean

Each year millions of children and adolescents undergo sports preparticipation evaluations (PPEs) before participating in organized sports. A primary aim of the PPE is to screen for risk factors associated with sudden cardiac death. This article is designed to summarize the current thoughts on the PPE with a specific slant toward the pediatric and early adolescent evaluation and how these evaluations may differ from those in adults.

Hypertension in Athletes: Clinical Implications and Management Strategies **15**

Jason V. Tso and Jonathan H. Kim

Hypertension is a leading cardiovascular risk factor in athletes. Sport-specific behaviors including nonsteroidal anti-inflammatory use, stimulant use, and unhealthy diets may promote hypertension among athletes. Strength-trained athletes may be more susceptible to hypertension than endurance-trained athletes, although this may, in part, be due to body size differences and the more potent antihypertensive effects of aerobic exercise. With confirmed hypertension, young athletes require secondary hypertension evaluation while older athletes require full cardiovascular risk stratification. Calcium channel blockers and renin-angiotensin-system inhibitors are often preferred pharmacotherapy agents. Further selection of antihypertensives must include consideration of potential side effects and legality in specific sports.

The Acute Impact of Endurance Exercise on Right Ventricular Structure and Function: A Systematic Review and Meta-analysis **25**

Tristan Ramcharan, Jamie Edwards, Jamie O'Driscoll, and Michael Papadakis

There have been many studies since the late 1980s investigating the effect of endurance exercise on the left ventricle. More recently, attention has shifted to the right heart, with suggestions that endurance exercise may have a detrimental effect on the right ventricle. This systematic review and meta-analysis summarizes and critiques 26 studies, including 649 athletes, examining the acute impact of endurance exercise on the right ventricle. We also present a subanalysis contrasting ultraendurance with endurance exercise. Finally, we identify areas for future research, such as the influence of sex, ethnicity, and age.

The International Criteria for Electrocardiogram Interpretation in Athletes: Common Pitfalls and Future Directions **35**

Bradley J. Petek, Jonathan A. Drezner, and Timothy W. Churchill

Preparticipation cardiovascular screening (PPCS) in young athletes is performed to detect conditions associated with sudden cardiac death. Many medical societies and sports governing bodies support the addition of a 12-lead electrocardiogram (ECG) to the history and physical to improve PPCS sensitivity. The current standard

for ECG interpretation in athletes, the International Criteria, was developed to distinguish physiologic from pathologic ECG findings in athletes. Although application of the International Criteria has reduced the PPCS false-positive rate, interpretative challenges and potential areas of improvement remain. This review provides an overview of common pitfalls and future directions for ECG interpretation in athletes.

Anomalous Coronary Arteries: A State-of-the-Art Approach **51**

Silvana Molossi, Tam Doan, and Shagun Sachdeva

Congenital coronary anomalies are not an infrequent occurrence and their clinical presentation typically occurs during early years, though may be manifested only in adulthood. In the setting of anomalous aortic origin of a coronary artery, this is particularly concerning as it inflicts sudden loss of healthy young lives. Risk stratification remains a challenge and so does the best management decision-making in these patients, particularly if asymptomatic. Standardized approach to evaluation and management, with careful data collection and collaboration among centers, will likely impact future outcomes in this patient population, thus allowing for exercise participation and healthier lives.

Cardiopulmonary Exercise Testing Interpretation in Athletes: What the Cardiologist Should Know **71**

Mustafa Husaini and Michael S. Emery

The noninvasive assessment of oxygen consumption, carbon dioxide production, and ventilation during a cardiopulmonary exercise test (CPET) provides insight into the cardiovascular, pulmonary, and metabolic system's ability to respond to exercise. Exercise physiology has been shown to be distinct for competitive athletes and highly active persons (CAHAPs), thus creating more nuanced interpretations of CPET parameters. CPET in CAHAP is an important test that can be used for both diagnosis (provoking symptoms during a truly maximal test) and performance.

Devices and Athletics: Decision-Making Around Return to Play **81**

Bradley Kay and Rachel Lampert

Until recently, implantable cardioverter defibrillators (ICDs) were considered a contraindication to competitive athletics. Recent prospective observational registry data in athletes with ICDs who participated in sports against the societal recommendations at the time have demonstrated the safety of sports participation. While athletes did receive both appropriate and inappropriate shocks, these were not more frequent during sports participation than other activity, and there were no sports-related deaths or need for external resuscitation in the 440 athlete cohort (median followup 44 months). Optimization of medical therapies, device settings and having an emergency action plan allow many athletes to safely continue athletic activity.

The Tactical Athlete: Definitions, Cardiovascular Assessment, and Management, and "Fit for Duty" Standards **93**

Jennifer Xu, Mark C. Haigney, Benjamin D. Levine, and Elizabeth H. Dineen

Tactical athletes are individuals in the military, law enforcement, and other professions whose occupations have significant physical fitness requirements coupled with the potential for exposure to life-threatening situations. Such exposures can have varied hemodynamic effects on the cardiovascular system. It is crucial that

their clinical evaluation is inclusive of specific occupational requirements. Safety protocols regarding medical clearance are relatively more stringent for this population than for competitive athletes due to the increased impact to the tactical athlete, their team, and the population they aim to serve and protect should they experience a cardiovascular event on the job.

Exercise After Acute Myocarditis: When and How to Return to Sports **107**

Robyn E. Bryde, Leslie T. Cooper Jr., DeLisa Fairweather, Damian N. Di Florio, and Matthew W. Martinez

Myocarditis is an inflammatory disease of the myocardium secondary to infectious and noninfectious insults. The most feared consequence of myocarditis is sudden cardiac death owing to electrical instability and arrhythmia. Typical presenting symptoms include chest pain, dyspnea, palpitations and/or heart failure. Diagnosis is usually made with history, electrocardiogram, biomarkers, echocardiogram, and cardiac MRI (CMR). Application of the Lake Louise criteria to CMR results can help identify cases of myocarditis. Treatment is usually supportive with medical therapy, and patients are recommended to abstain from exercise for 3 to 6 months. Exercise restrictions may be lifted after normalization on follow-up testing.