

Contents

Foreword: Sports Cardiology: Put Your Heart into It	xiii
Mark D. Miller	
Preface: The Offense and Defense of Sports Cardiology	xv
Peter N. Dean	
The Importance of Surrounding the Athlete's Heart with a Team	357
Peter N. Dean, Kelli Pugh, Siobhan M. Statuta, and John M. MacKnight	
<p>Providing medical care for an athlete can be challenging in many aspects. One specific aspect is the athlete's cardiovascular system. Athletic training and physical activity certainly can improve cardiovascular health, but it can also cause cardiac adaptations and place athletes at risk for sudden cardiac arrest. When an athlete has cardiac symptoms, a concerning family history, abnormal cardiac testing, or an underlying cardiac condition, a wide range of professionals are needed to appropriately care for the athlete under evaluation.</p>	
Incidence and Causes of Sudden Cardiac Death in Athletes	369
Kimberly G. Harmon	
<p>Sudden cardiac death (SCD) is the leading cause of medical death in athletes; however, many studies are significantly flawed making an accurate estimation of risk difficult. Incidence studies need to have accurate case ascertainment, a defined study population, and should be stratified by both sex and age. The risk of SCA/d in college-aged males is 1 in 35,000 person-years, black males 1 in 18,000 person-years, and higher-risk sports include men's basketball, men's soccer, and American football. Inherited cardiomyopathies and electrical conditions account for ~ 2/3 of off SCA/d and can be detected with an ECG. More research is needed to provide more granular estimates.</p>	
Non-Cardiac Conditions that Mimic Cardiac Symptoms in Athletes	389
Siobhan M. Statuta, Erin S. Barnes, and John M. MacKnight	
<p>When considering the variety of complaints an athlete can present with, chest pain is arguably the most concerning given the potential for catastrophic outcomes. Luckily, these do not comprise the majority of cases, and indeed, are quite rare. The bulk of presentations of athletes with chest pain are due to musculoskeletal, gastrointestinal, and pulmonary causes. Each and every healthcare provider who works closely with athletes must have a thorough understanding of contributing conditions that present as chest pain. Here, we explore some of the more prevalent causes of non-cardiac chest pain, classic presentations, and management considerations.</p>	

Wearables in Sports Cardiology 405

David L. Beavers and Eugene H. Chung

The expanding array and adoption of consumer health wearables is creating a new dynamic to the patient–health-care provider relationship. Providers are increasingly tasked with integrating the biometric data collected from their patients into clinical care. Further, a growing body of evidence is supporting the provider-driven utility of wearables in the screening, diagnosis, and monitoring of cardiovascular disease. Here we highlight existing and emerging wearable health technologies and the potential applications for use within sports cardiology. We additionally highlight how wearables can advance the remote cardiovascular care of patients within the context of the COVID-19 pandemic. Finally, despite these promising advances, we acknowledge some of the significant challenges that remain before wearables can be routinely incorporated into clinical care.

Differentiating Physiology from Pathology: The Gray Zones of the Athlete’s Heart 425

Alfred Danielian and Ankit B. Shah

Routine vigorous exercise can lead to electrical, structural, and functional adaptations that can enhance exercise performance. There are several factors that determine the type and magnitude of exercise-induced cardiac remodeling (EICR) in trained athletes. In some athletes with pronounced cardiac remodeling, there can be an overlap in morphologic features with mild forms of cardiomyopathy creating gray zone scenarios whereby distinguishing health from disease can be difficult. An integrated clinical approach that factors athlete-specific characteristics (sex, size, sport, ethnicity, and training history) and findings from multimodality imaging are essential to help make this distinction.

Exercise Stress Testing in Athletes 441

Gary Parizher and Michael S. Emery

Exercise stress testing (EST) is indicated for diagnostic and prognostic purposes in the general population. In athletes, stress tests can also be useful to inform the risk of high-intensity training and competition, to assess athletic conditioning, and to refine training regimens. Many specific indications for EST are unique to athletes. Treadmill and cycle ergometer protocols each have their strengths and disadvantages; extensive protocol customization may be necessary to answer the clinical question at hand. A comprehensive understanding of the available tools for exercise testing, their strengths, and their limitations is crucial to providing cardiovascular care to athletic individuals.

Myocarditis in the Athlete: A Focus on COVID-19 Sequelae 455

John D. Symanski, Jason V. Tso, Dermot M. Phelan, and Jonathan H. Kim

Myocarditis is a leading cause of sudden death in athletes. Early data demonstrating increased prevalence of cardiac injury in hospitalized patients with COVID-19 raised concerns for athletes recovered from COVID-19 and the possibility of underlying myocarditis. However, subsequent large registries have provided reassuring data affirming low

prevalence of myocarditis in athletes convalesced from COVID-19. Although the clinical significance of subclinical myocarditis detected by cardiac MRI remains uncertain, clinical outcomes have not demonstrated an increase in acute cardiac events in athletes throughout the pandemic. Future directions include defining mechanisms underlying “long-haul” COVID-19 and the potential impact of new viral variants.

Hypertrophic Cardiomyopathy and Exercise: Mutually Exclusive or Beneficial? 473

Matthew W. Martinez

Individuals with HCM have historically been held from participation in sports beyond mild-intensity exercise. Exercise improves functional capacity and indices of cardiac function even in those with HCM. Emerging data have demonstrated the safety of exercise in individuals with HCM. Improvement in risk stratification and a shared decision-making approach has led to a guideline endorsement for HCM providers to develop an informed plan for exercise and competitive athletics among the HCM population.

Exercise in the Genetic Arrhythmia Syndromes – A Review 485

Chinmaya Mareddy, Matthew Thomas ScM, George McDaniel, and Oliver Monfredi

Genetic arrhythmia syndromes are rare, yet harbor the potential for highly consequential, often unpredictable arrhythmias or sudden death events. There has been historical uncertainty regarding the correct advice to offer to affected patients who are reasonably wanting to participate in sporting and athletic endeavors. In some cases, this had led to abundantly cautious disqualifications, depriving individuals from participation unnecessarily. Societal guidance and expert opinion has evolved significantly over the last decade or 2, along with our understanding of the genetics and natural history of these conditions, and the emphasis has switched toward shared decision making with respect to the decision to participate or not, with patients and families becoming better informed, and willing participants in the decision making process. This review aims to give a brief update of the salient issues for the busy physician concerning these syndromes and to provide a framework for approaching their management in the otherwise aspirational or keen sports participant.

Sports Participation and Physical Activity in Individuals with Heritable Thoracic Aortic Disease and Aortopathy Conditions 511

Mary B. Sheppard and Alan C. Braverman

The evaluation and management of athletes with HTAD and aortopathy conditions requires shared decision-making encompassing the underlying condition, family history, aortic diameter, and type and intensity of sports and exercise. Mouse models of thoracic aortic disease show that low-to-moderate-level aerobic exercise can maintain aortic architecture and attenuate pathologic aortic root dilation. Although controlled trials in human are lacking, recreational physical activities performed at a low-to-moderate aerobic pace are generally low risk for most individuals with aortopathy conditions. High-intensity, competitive, and contact sports or

physical activities are generally prohibited in individuals with aortopathy conditions.

Cardiac Concerns in the Pediatric Athlete

529

Jamie N. Colombo, Christine N. Sawda, and Shelby C. White

Cardiovascular disease remains the *number one* cause of death in Americans. It is no secret that exercise mitigates this risk. Exercise and regular physical activity are beneficial for physical health including aerobic conditioning, endurance, strength, mental health, and overall improved quality of life. Unfortunately, today many children and adolescents are sedentary, lacking the recommended daily amount of physical activity, leading to higher rates of obesity, cardiovascular disease, stroke, diabetes, anxiety, and depression. Given this rising concern, the World Health Organization launched a 12-year plan to improve physical activity in children and adolescents by reducing the inactivity rate by 15% in the world. How does this apply to children and adolescents with acquired or congenital heart disease?.