



# Sports cardiology: current updates and new directions

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## INTRODUCTION

In 1901, Dr W Collier<sup>1</sup> submitted a paper to the *British Medical Journal* entitled, 'The effects of severe muscular exertion, sudden and prolonged, in young adolescents'. This early article demonstrated the predicament faced by physicians when dealing with athletes suspected of, or diagnosed with, a cardiovascular disease. Collier describes the case of an Oxford University mile runner who was performing poorly and presented for medical consultation. Physical examination at rest was normal, but upon mild exercise, the athlete demonstrated a very distinct systolic murmur. Rightly or wrongly, Collier stated that he 'had no doubt that it was over-dilation of the right ventricle' and disqualified the athlete from competition. He even sent the athlete on a sea voyage, where the temptation to exercise was effectively removed. Despite much medical, academic and technological advancement in the 100 years after Collier's initial insights, many sports medicine physicians who undertake cardiovascular preparticipation screening may argue that following the diagnosis of an inherited cardiac disease, the limited ability to adequately risk stratify and provide evidence-based disqualification criteria for athletes indicates our management remains just as inadequate and imprecise.

Athletes are perceived as the epitome of health, owing to their unique lifestyle and physical achievements. However, a small proportion of athletes die suddenly from a pathological heart condition; so-called sudden cardiac death (SCD). Most of the deaths in athletes under 35 years, are attributed to inherited or congenital disorders of the heart that predispose to malignant ventricular arrhythmias. Due to the steady trickle of SCD's in young athletes, several major sport governing bodies, including the International Olympic Committee and Fédération Internationale de Football

Association have 'recommended' the implementation of systematic cardiac screening programmes—a trend increasingly being adopted by national and international sport governing bodies worldwide. Despite differences in screening methodology, both the American College of Cardiology/American Heart Association and the European Cardiology Society agree that compelling justification for cardiovascular preparticipation screening exists based on medical, ethical and legal grounds.<sup>2 3</sup>

## EVIDENCE-BASED SPORTS CARDIOLOGY?

The purpose of preparticipation cardiovascular screening appears to be well intentioned, that is to provide medical clearance for participation in sport through the systematic evaluation of athletes aimed at identifying pre-existing cardiovascular abnormalities and thereby reducing the potential for adverse events and sudden death. However, athletes who exhibit an abnormal finding on their screening may face a barrage of complex medical, psychological, ethical, financial and legal conundrums. In turn, the attending sports medicine physician faces an equally challenging management situation, for which little evidence-based guidance is offered. As more sporting federations promote cardiovascular preparticipation screening, it is a statistical inevitability that (1) an increased number of high-level athletes will be diagnosed with a cardiac disease associated with SCD and (2) an even higher number of athletes will be evaluated and monitored for suspicion of having an inherited cardiac disease.

If one assumes the 12-lead ECG to be part of the standard screening process, what constitutes appropriate management following the emergence of a particularly abnormal or bizarre ECG in an otherwise healthy asymptomatic athlete? The problem facing cardiologists and sports physicians is that the risk stratification of patients harbouring the most common diseases associated with SCD in sport is poorly described. Our limited understanding suggests that risk is exacerbated when intense training and competition is imposed on a disease carrier. Guidelines from both the American College of

Cardiology's 36th Bethesda Conference and the European Society of Cardiology recommend that athletes with 'unequivocal' or 'probable' cardiomyopathy abstain from competitive sport and vigorous training with the exception of low-intensity activities.<sup>4 5</sup> Yet, the precise risk of SCD related to continued sports participation for an athlete with an inherited cardiac disease is not clearly established.

## MANAGING THE 'GREY ZONE' ATHLETE APPROPRIATELY

In the absence of a definitive diagnosis, within the UK and at our institutions, our sports physicians and cardiologists adopt a conservative approach to the 'grey zone' athlete with mild cardiac abnormalities suggestive but not diagnostic of a cardiomyopathy. This approach includes cardiac symptom education, close observation and regular annual follow-up. With the athlete's permission, this management strategy is also provided to the athlete's family, coach, team medical staff and sporting organisation. We also recognise that the sporting eligibility decision is further underpinned by the athlete's family history of SCD and past or present symptoms, both of which appear to be predictors of risk. Note again that the algorithms used for this prediction of risk are not derived from a population of young, fit and otherwise healthy athletes, but rather from a diverse population of diseased cardiomyopathy patients.

In this themed issue, Aspetar (Qatar Orthopaedic and Sports Medicine Hospital) partners with the *BJSM* to present a series of peer-reviewed commissioned articles and original investigations, authored by international experts in sports cardiology and sports medicine. The issue is divided into three sections to highlight contemporary challenges and advances in sports cardiology: current updates, new directions and original investigations.

## CURRENT UPDATES

Current updates start with a debate by Professors Ben Levine and Paul Thompson versus Prof Greg Whyte and Dr Wilson and Whyte over a series of five clinical challenges commonly faced by sports physicians. At times confrontational, this well-informed debate attempts to 'cut to the chase' on difficult cardiovascular issues relevant to cardiovascular screening in athletes. Sheppard and colleagues later illustrate the role of the consultant histopathologist at the regrettable endpoint of sports cardiology; the SCD of a young athletic individual. Here the authors describe the main causes of SCD based on

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detailed autopsy data from a specialised cardiac pathology laboratory, concluding with recommendations for the appropriate management in the event of a 'negative' autopsy.

With preparticipation screening now being performed on a global scale, there is mounting evidence that an athlete's ethnicity has an important determination on the objective manifestations of cardiovascular adaptations to exercise.<sup>7 8</sup> Papadakis and colleagues provide a review that highlights the differences in cardiovascular adaptations to exercise in athletes of diverse ethnic backgrounds, and offer a practical guide for the interpretation of baseline investigations. Clearly, further work is needed for these ethnic populations who are under-represented in the sports cardiology literature, as without such knowledge the possibility of an erroneous diagnosis of cardiac disease increases.

Nevertheless, it is not just the inherited cardiac conditions that pose a diagnostic challenge to the young athlete and the attending sports physician. With such overwhelming evidence promoting the beneficial effects of regular exercise upon long-term cardiovascular health in the general population, concern has been mounting for the veteran athlete and the apparent increasing prevalence of acquired atrial and ventricular arrhythmia disturbances seen within this population. As highlighted by a recent *BJSM* editorial,<sup>6</sup> a number of studies have suggested that life-long intensive and prolonged exercise may be damaging to the myocardium. With atrial fibrillation (AF) being the most commonly cited significant cardiac arrhythmia in clinical practice, there is growing evidence that endurance exercise may exacerbate the risk of developing AF and atrial flutter. Calvo and colleagues discuss not only the prevalence of AF and atrial flutter, but also the clinical presentation, potential pathophysiological mechanisms and treatment strategies for endurance athletes suffering with AF or atrial flutter.

Ventricular arrhythmias in athletes are rare, but by their very nature may be life threatening. Accordingly, Heidbuchel and colleagues review the evidence for the link between ventricular arrhythmias and long-term endurance exercise. Here, the authors suggest that repetitive right ventricular microtrauma induced through prolonged and repeated endurance exercise may result in chronic right ventricular structural and functional changes, and proarrhythmogenicity in some endurance athletes.

## NEW DIRECTIONS

New directions utilise internationally recognised experts to provide practical solutions to five common problems facing sports cardiologists and sports physicians in the cardiovascular care of athletes: T-wave inversion ECG abnormalities, genetic testing in athletes, use of cardiac magnetic resonance during follow-up examination, cardiovascular risks associated with performance enhancing drugs and emergency cardiac care in the athletic arena.

Wilson and colleagues examine the prevalence of T-wave inversion in athletes and their relationship to structural heart disease. T-wave inversion is an important ECG abnormality, as these alterations are a recognised manifestation of hypertrophic cardiomyopathy, arrhythmogenic right ventricular cardiomyopathy and Brugada syndrome. Accordingly, the authors propose clinical management pathways (including genetic testing) for asymptomatic athletes demonstrating significant T-wave inversion but with structurally normal hearts on cardiac imaging. As the authors allude, genetic testing is increasingly being sought in the follow-up cascade of athletes suspected of harbouring an inherited cardiac disease. At present, screening is based on phenotype not genotype; but what should be done for the athlete who is gene positive yet phenotype negative? Richard and colleagues examine the role of genetic testing within the diagnostic algorithm of preparticipation screening. The authors provide the sports medicine physician with the latest genetic information for the main inherited cardiac conditions known to cause SCD, and scrutinise its impact upon the challenges of sport eligibility and disqualification decisions.

With further articles from Waterhouse and colleagues evaluating the use of cardiac magnetic resonance for imaging focal and interstitial fibrosis in athletes with left ventricular hypertrophy, and Angell and colleagues exploring current knowledge, controversies and emerging evidence in relation to the cardiovascular health risks of athletes taking performance enhancing drugs, readers are provided with modern perspectives to these challenging diagnostic quandaries.

Finally, regardless of whether a sports physician believes in the clinical utility of cardiovascular screening, it is evident from the recent number of televised high-profile cardiac arrests (and unfortunately in some cases, deaths), the sports community must be prepared to respond to these potentially catastrophic events should they occur.

Toresdahl and colleagues present their experience of dealing with and planning for emergency cardiac care in the athletic setting, with special considerations discussed for schools, large sporting venues, mass events and the Olympics.

## ORIGINAL INVESTIGATIONS

In this concluding section, the sports physician and cardiologist are provided with articles that may have a direct impact upon the management of athletes during the preparticipation screening process. The ability to properly identify an abnormal ECG suggestive of an inherited cardiac disease is based upon a sound working knowledge of ECG normality within the athletic population. Previously published in *BJSM* April 2012 issue, Drezner<sup>9</sup> demonstrated the successful impact of using a standardised ECG criteria tool upon the accuracy of ECG interpretation in competitive athletes. In this issue, Drezner<sup>9</sup> reproduces a two-page ECG practical tool from their original paper, to assist a physician's ability to differentiate common, training-related ECG adaptations from uncommon ECG manifestations suggestive of a cardiac pathology.

Finally, differentiating physiological cardiac hypertrophy from pathology is especially challenging when the athlete presents with extreme anthropometry. While upper normal limits exist for maximal left ventricular (LV) wall thickness and LV internal diameter in diastole, Riding and colleagues address whether these established limits are applicable in professional male athletes with extreme anthropometry ( $\geq 2.3 \text{ m}^2$ ) who routinely play in high-level competitive sports such as rugby, basketball and American football.

## CONCLUSION

Whether Collier<sup>1</sup> in 1901 was right to disqualify his Oxford University mile runner due to apparent over-dilation of the right ventricle, and imposing a sea voyage on the athlete in an attempt to limit exercise, is not for debate. What is for discussion is that Collier reached his diagnosis by identifying abnormal signs, symptoms and cardiovascular features, which in his view is based on the existing literature of his era, suggested that in order to prevent an adverse cardiac event disqualification from competitive exercise was the appropriate course of action. As highlighted in this themed issue of *BJSM*, there are a large number of academic, clinical and ethical challenges that remain within sports cardiology. It is anticipated that with our

evolving understanding of inherited cardiac diseases and their potential risk for adverse cardiac events associated with intensive sport, the sports cardiology community will be able to reduce the number of athletes entering the 'grey zone' conundrum, and more effectively mitigate the risk of SCD in athletes with confirmed pathological cardiac disorders through improved risk stratification, targeted management and evidence-driven disqualification and activity recommendations.

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