Defining the Process of a Cardiovascular Risk Assessment Program: Lessons Learnt From Cardiac Assessment of Elite Soccer Players in the United Kingdom

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Abstract

Objective: Retrospectively analyze the cardiac assessment process for elite soccer players, and provide team physicians with a systematic guide to managing longitudinal cardiac risk. **Design:** Descriptive Epidemiology Study. **Setting:** Cardiac assessments incorporating clinical examination, 12-lead ECG, echocardiography, and health questionnaire. **Participants:** Soccer players at 5 professional clubs in England, the United Kingdom. **Intervention:** Data was retrospectively collected, inspected, and analyzed to determine their clinical management and subsequent follow-up. **Results:** Over 2 years, 265 soccer players, aged 13 to 37 years with 66% of white European ethnicity, were included in the cohort. Eleven percent had "not-normal" assessments, of these assessments, 83% were considered gray screens, falling into three broad categories: structural cardiac features (including valvular abnormalities), functional cardiac features, and electrocardiogram changes. After cardiology consultation, all assessments were grouped into low, enhanced and high-risk categories for ongoing longitudinal risk management. Overall clear-cut pathology was identified in 2%. **Conclusions:** Cardiovascular assessment is a vital tool in identifying athletes at risk of sudden cardiac death to mitigate their risk through surveillance, intervention, or participation restriction. The decision whether a player is fit to play or not requires a robust risk assessment followed by input from a multidisciplinary team that includes both the team physician and cardiologist. This educational article proposes a clinical management pathway to aid clinicians with this process. **Clinical Relevance:** Sudden cardiac death is the important medical cause of death during exercise. The team physician should assume responsibility for the management of the longitudinal risk of their players' cardiac assessments in conjunction with sports cardiologist.

Key Words: sudden cardiac death, cardiac, assessment, cardiac screening, soccer, risk management, gray screen

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INTRODUCTION

Sudden cardiac death (SCD) often occurs on the field of play without previous symptoms. The risk of SCD is increased by a factor of 2.8 times with vigorous physical activity.[1] Young competitive athletes can be affected, where upon vigorous exercise, a silent underlying cardiovascular condition triggers cardiac arrest.[1,2] The incidence of SCD in the people aged younger than 35 years is 1.8 per 100 000 per year; this corresponds to approximately 433 deaths per year or more than 8 deaths/week in England and Wales.[3] The consequence of recent high profile cases has led to intense media scrutiny and increased the public awareness of the role of cardiac assessment in preventing SCD.[4,5]

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In practice, distinguishing between physiological adaptation of the athletic heart and potentially fatal conditions, such as hypertrophic cardiomyopathy, can be very challenging. In addition, decisions informing participation in competitive sport have become more pertinent with ever-increasing financial value of professional soccer players, the legal responsibilities of "sign off" and the consequent liability of medical professionals where events occur.

The purpose of preparticipation cardiovascular assessment is to identify potentially fatal cardiac abnormalities to mitigate the risk of SCD or disease progression through medical management, invasive interventions, or if required advice on abstinence or disqualification from competitive sport.

Current guidance within professional soccer in England is from the Football Association (FA) Cardiology Expert Panel. This national committee reviews abnormal cases, making recommendations for further investigation and decisions relating to intervention and participation restriction. All players are required to have cardiac assessment with past medical history, family history, clinical examination, 12-lead electrocardiogram (ECG) and transthoracic echocardiography at the age of 16 before signing for a club. The role of ongoing cardiac assessment during a player's competitive sporting career is unclear, with

limited evidence about the risk and natural history of cardiac conditions associated with SCD.[6] Currently, further assessment is recommended if the player transfers to another club, competes in a European cup competition, or competes at National level.

PURPOSE

The objective of this study was to retrospectively analyze the cardiac assessment process of a cohort of elite soccer players and provide team physicians with a systematic guide to managing the longitudinal risk of cardiac assessments.

METHODS

Ethical Considerations

This article utilized data from cardiovascular assessments of players mandated by their respective clubs. All subjects agreed to inclusion of their data for audit. No ethical considerations arouse from the retrospective analysis of the data.

Assessment Protocols

Cardiovascular assessment was performed in line with the recommendations of the Football Association (FA) Cardiology Committee, incorporating a health questionnaire, clinical examination, 12-lead ECG, and echocardiography.

To obtain consistent and reliable data, ECG and Echocardiograms were performed by experienced cardiac physiologists. They used a uniform ECG and echocardiographic protocol for all assessments.[7] The results of the assessments were evaluated by an experienced Consultant Cardiologist, with a professional interest in sports cardiology. ECG results were interpreted using the guidance available at the time, namely the Seattle Criteria[8] and echocardiograms using the British Society of Echocardiology Guidelines.[7] In the absence of a definitive guidance for surveillance, a consensus of sports cardiology opinion was sought for all not-normal cardiac assessments.

TABLE 1. Baseline Characteristics of Study Population

Demographic	All, Mean (SD) [Range]
Age, yrs	21.3 (5.5) [13-37]
Height, cm	181.6 (6.9) [156-203]
Weight, kg	78.2 (9.5) [59.5-110]
Body mass index, kg/m^2	23.7 (2.0) [18.5-31.5]
Body surface area, m^2	2.0 (0.2) [1.7-2.4]

Data Collection

Data were collected prospectively at the time of mandatory cardiac assessment (FA guidance recommends at the age of 16 years on signing for a club) or initial assessment at the time of transfer or loan. Consent was taken for use in audit and research. Inclusion criteria were male professional soccer players assessed between March 2012 and October 2014. Exclusion criteria were serial or repeat cardiac assessments, female players, cardiovascular assessments out with the period of the study and nonplaying members of staff.

Data were inspected independently before entry into excel spreadsheets. Attention was paid to identifying individuals who required follow-up assessment. The ECG, echocardiogram report, and clinical letters were retrospectively analyzed to determine the reason for follow-up and subsequent clinical management.

RESULTS

Study Population

Two hundred sixty-five players from 5 professional soccer clubs across the Midlands region of England were included in the cohort. There was an age range of 13 to 37 years. The mean height of the study population was 181.6 cm (SD 6.9); mean weight was 78.2 kg (SD 9.5); mean body surface area was 2.0 m^2 (SD 0.2); and mean body mass index was 23.7 kg/m^2 (SD 2.0). Baseline characteristics are shown in Figure 1 and Table 1.

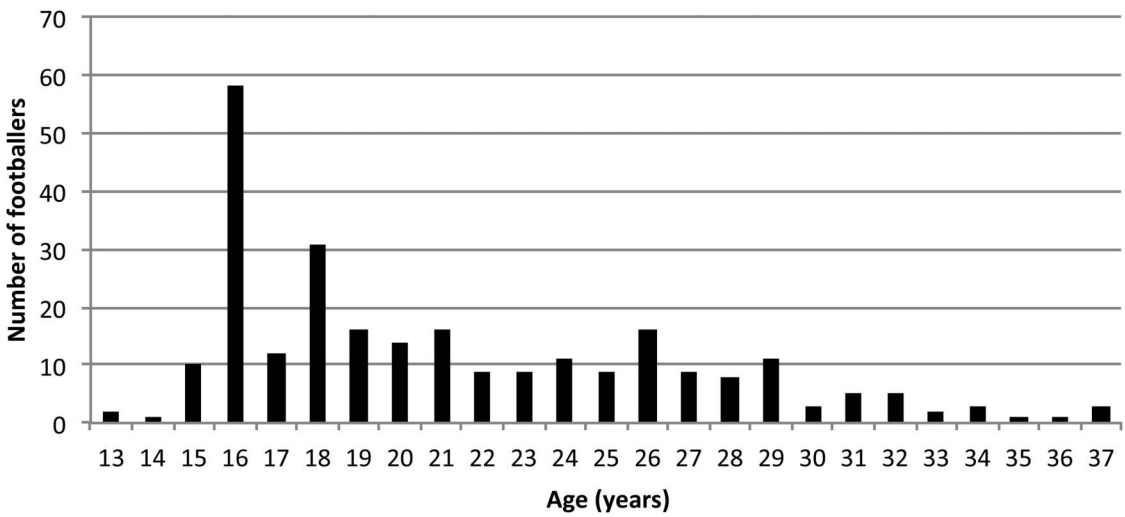

Figure 1. Age range of study population.

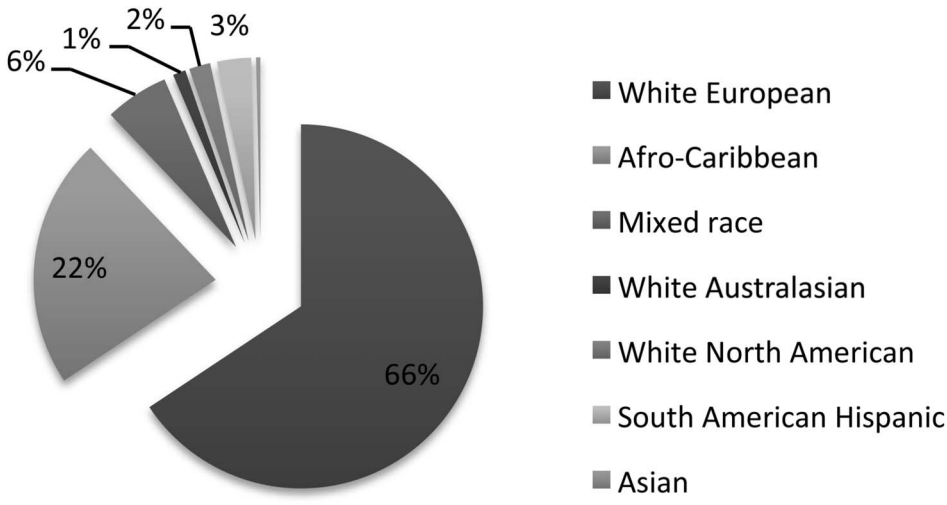

Figure 2. Study population by ethnic origin.

Most of the study population were of white European ethnicity, 174 (66%) with others from the following ethnic groups; Afro-Caribbean 59 (22%); mixed race 15 (6%); South American 8 (3%); white North American 5 (2%); white Australasian 3(1%); and Asian 1 (<1%) (Figure 2). Definitions and terminology used are shown in Table 3.

Cardiac Assessment Overview

Of the study population, 235 (88.7%) had normal cardiac assessments; 30 (11.3%) had assessments that were not normal (Figure 3), of which 25 (9.4%) were considered gray screens requiring further investigation or surveillance, and 5 (1.9%) were identified to have a clear-cut pathology.

Five players had clear-cut pathology; a patent foreman ovale (PFO), hypertensive left ventricular hypertrophy (LVH), bicuspid aortic valve, moderate aortic regurgitation, and moderate mitral regurgitation. Twenty-five players were considered to have gray screens requiring further investigation or surveillance (Table 2). These were grouped into 3 categories; ECG changes (eg, repolarization abnormalities, t-wave abnormalities, corrected QT (QTc) interval abnormalities, and atrioventricular node conduction abnormalities), structural cardiac features (eg, valvular regurgitation less than moderate severity, right ventricular enlargement, and atrial septal aneurysm), and functional cardiac features (eg, left ventricular ejection fraction less than 55% and pulmonary hypertension).

Management of Not-Normal Assessments

All athletes with clear-cut pathology continued to play during further investigation or follow-up; the player with a PFO underwent annual surveillance; the player with hypertensive LVH who underwent computed tomography of the aorta was commenced on antihypertensive medication and annual surveillance; the player with a bicuspid aortic valve also underwent cardiac magnetic resonance imaging (MRI); the rest underwent annual surveillance.

Surveillance screening or further investigations were justified on the grounds of either a consensus of cardiology opinion or to provide further reassurance to both player and club physician in the presence of an ECG or echocardiogram that was not normal. Of the gray screens, 21 (84%) underwent surveillance at 12 months, at which point 11 players were discharged to their team physicians for ongoing routine assessment and 10 players continued annual surveillance. Two (8%) players also underwent cardiac MRI and 2 (8%) players also underwent exercise ECG assessment.

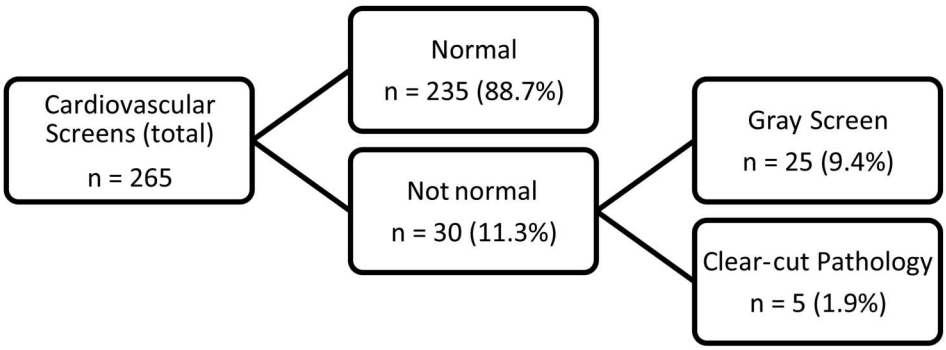

Figure 3. Overview of the cardiac assessment results.

TABLE 2. Summary of Gray Screen Results

Category of Gray Screen	Number	Follow-up
ECG changes	n = 8 (32%)	Cardiac MRI (n = 2, 25%)
		Exercise test (n = 2, 25%)
		Surveillance screen 12 mo (n = 4, 50%)
Structural cardiac features	n = 14 (56%)	Surveillance screen 12 mo (n = 14, 100%)
Functional cardiac features	n = 3 (12%)	Surveillance screen 12 mo (n = 3, 100%)

Adverse Events

During the 31-month study period from March 2012 and October 2014, there were no reported SCDs or aborted SCDs among our study population. One player had an episode of transient pericarditis. No players were disqualified from competitive sport as a result of assessment.

DISCUSSION

This study highlights some of the challenges facing team physicians when considering the cardiac assessment of elite soccer players. The results are highly likely transferable to soccer players at all levels of the game. We found that cardiac assessments can be classified into 2 broad categories; normal and not normal. Not-normal cardiac assessments can be further classified into those that have clear-cut pathology and the rest which fall into a gray screen cohort (Table 3).

Most of the not-normal cardiac assessments were considered gray screens, falling into 3 broad categories; ECG changes, structural cardiac features, and functional cardiac features (Table 2). Most not-normal cardiac assessments in this cohort of players resulted primarily from echocardiogram data (70%). The addition of echocardiography was useful within this cohort, as it enabled the diagnosis of 4 clear-cut pathologies and most of the structural and functional gray screens that required additional investigation, specific treatment, or follow-up. These problems had not been detected by medical history, physical examination, or 12-lead ECG. We recognize that at this time, most expert groups and professional sporting organizations do not recommend the use of echocardiogram as a screening tool. However, the well-rewarded English soccer program gives access to echocardiogram as part of a cardiac assessment program, which can strengthen decisions on diagnosis, investigation and surveillance, as well as provide the reassurance to a player and physician that a normal echocardiogram confers.

For the practicing Sports Physician, managing players within their soccer club with normal cardiac assessments or clear-cut pathology should follow a defined clinical pathway with guidance determined by a robust evidence base. There must be consultation with a suitably qualified cardiologist throughout the process.

The cardiac gray screen can be much more challenging to manage. Often there are minimal case-matched studies in the medical literature and hence a lack of relevant cardiology guidelines to support the team physician's decision making. These gray screen changes may be considered trivial; however, their progression in elite athletes undergoing intensive training regimes is completely unknown.[9] Because of these challenges, making the decision whether a player is fit to play or not requires a robust risk assessment followed by input from a multidisciplinary team that includes both the team physician and cardiologist. The team physician should assume responsibility for the management of the longitudinal risk of their players' cardiac assessments in conjunction with a sports cardiologist. This screening program demonstrates how the integration of sports cardiologist(s) within a screening program can add value, allowing for a consensus of sports cardiology opinion in the absence of a definitive guidance for management or surveillance of not-normal assessments. We propose a clinical management pathway to help support this process (Figure 4).

This study has defined examples of gray cases and clear-cut pathology in our cohort of athletes, and although not exhaustive of all possible cardiac abnormalities, demonstrates the variety of pathology and physiological adaptations that can be found in athletes.

A high proportion of players (11.3% in this cohort) have cardiac assessments that were not normal, the majority falling into the category of a gray screen. Whether these findings have a clinical consequence, that is that they put the athlete at risk of a life-threatening cardiac event, is not fully understood at present. Team physician's need is to be aware of managing the ongoing risk with these players and ensure suitable follow-up and assessment on a regular basis to mitigate this. Decisions on the nature of investigation, intervention, and subsequent follow-up should be made with consultation with a cardiologist.

Decisions regarding longitudinal risk management in sport, including restriction from participation and follow-up care

TABLE 3. Definitions

Definitions	
Normal cardiovascular assessment	A normal assessment with no need for enhanced risk monitoring, investigation, or intervention. Low risk routine screening advised.
Not-normal cardiovascular assessment	Require enhanced risk ongoing surveillance, further investigation, or intervention. This includes clear-cut pathology and gray screens.
Clear-cut pathology	Pathology identified on cardiovascular assessment with widely accepted published guidance on further management or clear-cut clinical symptoms in the presence of known disease.
Gray screen	Cardiovascular assessment findings for which there is currently no widely accepted guidance on management or where there are challenges in distinguishing between physiological adaptations often seen in the athlete's heart and potentially fatal conditions.

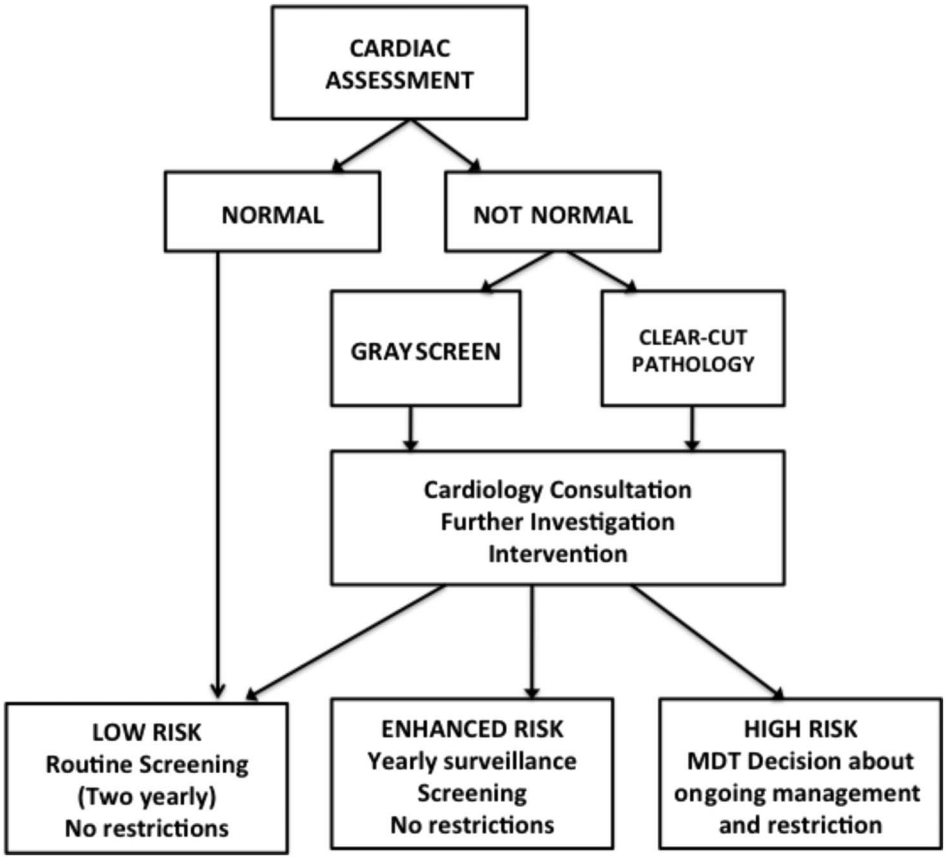

Figure 4. West Midlands cardiac risk management algorithm.

can be classified into 3 risk groups (Figure 4 and Table 4). Those at "low risk" where their cardiac assessment was normal or an intervention has succeeded in restoring the risk profile to that of a player with a normal assessment. These players should be followed up routinely with cardiac assessment every 2 years while playing competitively. Those that fall into an "enhanced risk" category are likely to fall into the gray screen cohort as described before. These players must be discussed with a cardiologist, investigated as appropriate, and undergo more regular follow-up (at least yearly) to manage the ongoing risk. The final group is high-risk players with gray screen or clear-cut pathology who after formal discussion with a cardiologist or Cardiology Committee (FA Cardiology Expert Panel) are deemed to meet current consensus guidance recommendations to restrict participation in competitive sport.[10,11] Regional referral centers across America have been proposed to provide a similar service.[6]

While there is some debate as to whether cardiac screening reduces the risk of SCD in the literature,[12] it is clear that it does not guarantee against cardiac arrest or SCD occurring. Therefore, it is imperative that soccer clubs, at all levels are able to deliver effective cardiopulmonary resuscitation and prompt defibrillation, where appropriate to those found to be in cardiac arrest.[13]

CONCLUSIONS

Sudden cardiac death is the important medical cause of death during exercise. Cardiovascular assessment is a vital tool to identify athletes at risk of sudden cardiac death to mitigate their risk through surveillance, intervention, or participation restriction. The decision whether a player is fit to play or not

TABLE 4. Cardiac Assessment Management Risk Groups

Risk Group	Definition
Low Risk	Cardiac Assessment normal or an intervention has succeeded in restoring the player to a risk profile of a player with a normal assessment.
Enhanced Risk	Cardiac assessment is not normal, often falling into the gray screen group. Decision making must involve a cardiologist, appropriate investigation, and undergo more regular follow-up (at least yearly) to reduce the ongoing risk.
High Risk	Gray screen or clear-cut pathology, which after formal discussion with a cardiologist or Cardiology Committee (FA Cardiology Expert Panel) are deemed to meet current European Society of Cardiology guidance recommendations to restrict participation in competitive sports

requires a robust risk assessment followed by input from a multidisciplinary team that includes both the team physician and cardiologist. The team physician should assume responsibility for the management of the longitudinal risk of their players' cardiac assessments in conjunction with sports cardiologist. This educational article proposes a clinical management pathway to aid clinicians with this process.

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