Management of sudden cardiac death

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Abstract

Every medical graduate will encounter a case of sudden cardiac death (SCD) during their medical training and face the unpleasant task of disclosing the tragic news to the victim's family. Although most such deaths affect middle-aged and older individuals, young and apparently healthy people occasionally fall victim to SCD, making the experience even more poignant. Most SCDs and arrests in the young are secondary to previously quiescent, inherited cardiac diseases, galvanizing discussions relating to primary and secondary prevention strategies to avert such catastrophes. It is essential that all clinicians have a basic understanding of conditions predisposing to SCD in the young, as the impact of a missed opportunity to save a young life cannot be overestimated. This article provides an overview of the epidemiology of SCD and potential prevention strategies. Most importantly, it outlines the management of surviving first-degree relatives, as SCD in a young individual is the beginning of a long, arduous road for the grieving family.

Keywords Arrhythmogenic right ventricular cardiomyopathy; Brugada syndrome; defibrillation; hypertrophic cardiomyopathy; long QT syndrome; MRCP; post-mortem molecular autopsy; pre-participation screening; sudden arrhythmic death syndrome; sudden cardiac death

Key points

- The sudden cardiac death (SCD) of a young individual commonly results from quiescent inherited cardiac diseases, offering potential for primary and secondary prevention strategies to avert such catastrophes
- All young SCD victims should undergo detailed post-mortem examination by an expert cardiac pathologist, and consent should be sought to retain blood or tissue for molecular autopsy
- The presence of a potentially inherited cardiac condition, but also a normal post-mortem (sudden arrhythmic death syndrome) or autopsy findings of uncertain significance, should trigger referral of first-degree relatives for comprehensive cardiac evaluation by an expert in inherited cardiac diseases

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Epidemiology and causes of sudden cardiac death (SCD)

SCD accounts for 50% of all cardiovascular mortality, with 100,000–120,000 deaths annually in the UK. Most SCDs are secondary to atherosclerotic coronary artery disease and heart failure, and affect individuals in their fifth decade and onwards. The epidemiology of SCD in young individuals (≤35 years) is less well established. Estimates range from 0.5 per 100,000 in teenage American athletes to 13 per 100,000 recruit–years in US military recruits. A review of UK Office of National Statistics data reported an incidence of 1.8 per 100,000 per year in individuals aged 1–34 years. There is a male predominance, with a male-to-female ratio of 3:1 in the general population and 9:1 in young athletes. In contrast with older individuals, hereditary and congenital cardiac pathologies, including cardiomyopathies, ion channel diseases and accessory pathways, predominate in the young.[1]

Prevention of sudden cardiac death

Identifying individuals at risk of SCD is crucial considering that interventions ranging from lifestyle modification advice to the implantation of an internal cardioverter-defibrillator are effective in preventing such deaths. Widely accepted preventive strategies include targeted screening of high-risk individuals, such as first-degree relatives of victims of SCD, cardiovascular evaluation of young individuals with symptoms suggestive of cardiac disease or family history of an inherited cardiac condition, and availability of automated external defibrillators in athletic and public venues.

Evaluation of high-risk individuals

Increased awareness among physicians of these disease processes, including their genetic nature and modes of presentation,

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is imperative to ensure early recognition of susceptible young people. SCD can be preceded by warning symptoms, including syncope, which are occasionally misdiagnosed as simple faints or mislabeled as epileptic seizures. Ventricular arrhythmias can also account for unexplained drownings and road traffic accidents.

Evaluation of families affected by sudden cardiac death

The hereditary nature of most conditions predisposing to SCD in young individuals highlights the importance of performing comprehensive evaluation of the index case and offering cardiovascular assessments to all first-degree relatives. In the aftermath of an SCD, the family's journey encompasses delicate interactions with a number of public and health services, and adequate steps should be instigated to provide support. Support networks in the UK, such as the charitable organization Cardiac Risk in the Young (CRY), offer guidance to the family, bereavement support and an expert cardiac pathology service integrated with a dedicated inherited cardiac diseases clinic.

Expert cardiac pathologist review

Examination of the heart by a highly experienced cardiac pathologist is crucial to ensure accurate interpretation of autopsy findings. The need for a cardiac pathologist is underscored by the fact that erroneous interpretation of macroscopic or microscopic findings can misguide familial evaluation, offer false reassurance to surviving relatives or dissuade physicians from initiating familial screening. Interpreting the results is complex as many disorders are rare or exhibit subtle autopsy findings. In addition, uncertainty can exist regarding the causal relationship between the pathological findings and the sudden death.[2] A UK study demonstrated a 40% disparity in reporting the cause of sudden death between an expert cardiac pathologist and general pathologists: the latter were more likely to attribute the death to structural heart disease, guiding familial evaluation towards an inherited cardiomyopathy, than to report a normal heart or inconclusive findings.

Evaluation of first-degree family relatives

Family evaluation should include a comprehensive cardiological assessment of all first-degree relatives. Specific investigations are guided by clinical suspicion and autopsy findings (Figure 1). It is imperative to emphasize that, in a significant proportion of SCDs, an obvious cause of death cannot be identified despite detailed histopathological and toxicological evaluation. Such deaths are classified as sudden arrhythmic death syndrome (SADS). Contemporary literature suggests that approximately 40% of families with a SADS death demonstrate evidence on clinical assessment of an inherited cardiac condition (Figure 1), with ion channel disorders such as long QT and Brugada syndromes being the predominantly identified conditions.[3] Most importantly, 20% of SADS relatives are diagnosed with a previously unsuspected inherited cardiac condition, highlighting the need to refer such families to an expert centre for specialist assessment.[3] Interventions ranging from simple lifestyle modification advice to implantation of a prophylactic implantable cardioverter-defibrillator can significantly reduce the risk of further fatalities within a family unit.

Emergency medical care provisions

The benefits of early cardiopulmonary resuscitation and defibrillation have encouraged public health programmes to train lay individuals in basic life support and increase the availability of automated external defibrillators in public areas. Exercise occasionally triggers malignant arrhythmias in predisposed individuals, and prompt defibrillation (within 5 minutes) has been associated with survival rates >60% in athletes. Mass events in sports arenas pose particular challenges, and a comprehensive medical action plan is essential to ensure the best possible outcome for both young athletes and spectators.

Pre-participation cardiac screening

Different preventive strategies complement each other. Widely accepted strategies such as targeted screening and the use of external defibrillators, however, prevent only a minority of SCDs in young individuals; this is because SCD is usually the first presentation and commonly occurs at rest or during sleep. In addition, outside the context of an athletic arena or public place, the efficacy of external defibrillators is limited by availability and prompt application. Pre-participation cardiovascular screening of young competitive athletes with a 12-lead electrocardiogram (ECG) has been a contentious issue in the UK. Data from the Italian national screening programme in athletes report a 90% reduction in SCD with screening; however, there are concerns relating to false-positive tests that could result in unnecessary investigations or erroneous disqualification from competitive sport, and ensuing costs. Recent studies in large cohorts of young athletic individuals have resulted in refinement of the ECG criteria, with considerable improvements in ECG specificity and the cost per serious disease detected.[4]

The role of genetic testing

The use of genetic testing is governed by the likelihood of a positive result for the suspected condition (sensitivity), certainty of the result (established causality) and associated clinical impact and costs. In current clinical practice, genetic testing is largely performed in individuals with a clinical phenotype of an inherited cardiac condition in order to facilitate cascade screening of family members. In certain conditions, such as long QT syndrome and dilated cardiomyopathy, genetic testing can provide invaluable information regarding risk stratification and guide therapy.

Targeted post-mortem genetic testing is known as molecular autopsy. After consent, a blood sample and splenic tissue from the deceased should be retained for future analysis in all cases where an inherited cardiac condition is confirmed or suspected. Identification of a causative mutation can reinforce the pathologist's findings when cardiomyopathy is suspected, or provide a plausible cause of death in SADS. Most importantly, a causative mutation facilitates cascade screening of living relatives. The yield of molecular autopsy is determined by the particular

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