



Society Position Statement

Canadian Cardiovascular Society/Canadian Heart Rhythm Society Joint Position Statement on the Cardiovascular Screening of Competitive Athletes

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ABSTRACT

Sudden cardiac death (SCD), especially in a young seemingly healthy individual, is a tragic and highly publicized event, which is often followed by a strong emotional reaction from the public and medical community." Although rare, SCD in the young is devastating to families and communities, underpinning our society's desire to avoid any

RÉSUMÉ

La mort subite d'origine cardiaque (MSOC), en particulier chez une personne jeune et qui semblait être en bonne santé, est un événement tragique et hautement médiatisé qui engendre souvent de la part du public ou du milieu médical un « appel à l'action ». La MSOC chez les jeunes, si elle est rare, n'en a pas moins des conséquences

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The disclosure information of the authors and reviewers is available from the CCS on their guidelines library at www.ccs.ca.

This statement was developed following a thorough consideration of medical literature and the best available evidence and clinical experience. It represents the consensus of a Canadian panel comprised of multidisciplinary experts on this topic with a mandate to formulate disease-specific recommendations. These recommendations are aimed to provide a reasonable and practical approach to care for specialists and allied health professionals obliged with the duty of bestowing optimal care to patients and families, and can be subject to change as scientific knowledge and technology advance and as practice patterns evolve. The statement is not intended to be a substitute for physicians using their individual judgement in managing clinical care in consultation with the patient, with appropriate regard to all the individual circumstances of the patient, diagnostic and treatment options available and available resources. Adherence to these recommendations will not necessarily produce successful outcomes in every case.

The Canadian Cardiovascular Society (CCS) Guidelines Committee identified the need for a Position Statement addressing cardiovascular (CV) screening of competitive athletes with particular attention to the 12-lead electrocardiogram (ECG). Currently, European and American recommendations exist, however the lack of a national position has led to tremendous variation of practice in Canada.¹ This statement provides appropriate, evidence-based recommendations for Canadian sporting organizations and institutions with a focus on the role of routine ECG screening in preventing sudden cardiac death (SCD).

Methods and Terminology

The CCS Guidelines Committee appointed co-chairs, and a primary and secondary panel to develop this document. The primary panel established its scope, identified topics, reviewed literature, prepared and voted on the recommendations on the

circumstances predisposing to the loss of human life during exertion. The Canadian Cardiovascular Society Position Statement on the cardiovascular screening of athletes provides evidence-based recommendations for Canadian sporting organizations and institutions with a focus on the role of routine electrocardiogram (ECG) screening in preventing SCD. We recommend that the cardiac screening and care of athletes within the Canadian health care model comprise a sequential (tiered) approach to the identification of cardiac risk, emphasizing the limitations of screening, the importance of shared decision-making when cardiac conditions are diagnosed, and the creation of policies and procedures for the management of emergencies in sport settings. Thus, we recommend against the routine (first-line or blanket mass performance of ECG) performance of a 12-lead ECG for the initial cardiovascular screening of competitive athletes. Organization/athlete-centred cardiovascular screening and care of athletes program is recommended. Such screening should occur in the context of a consistent, systematic approach to cardiovascular screening and care that provides: assessment, appropriate investigations, interpretation, management, counselling, and follow-up. The recommendations presented comprise a tiered framework that allows institutions some choice as to program creation.

basis of the Grading of Recommendations Assessment, Development and Evaluation system. In this system, the panel must consider not only the quality of the scientific evidence but also values, preferences, and practicality in forming recommendations. These factors included the current Canadian health care model, good clinical practice, cost, infrastructure, and the feasibility of screening components. The secondary panel peer-reviewed the manuscript; the final document was submitted to the CCS Council for approval.

The competitive athlete is defined as “one who participates in an organized team or individual sport; is engaged in regular, systematic, and often intense training with high CV demands; participates in competition against others; and places a premium on excellence and achievement.”² The distinction between competitive and recreational athletes often lies in the ability and freedom afforded by the participant to judge when it is prudent to reduce or stop exertion.^{3,4} Competitive athletes may also be defined as those engaged in training and competition on a regular basis; ≥ 10 hours weekly.⁵ We acknowledge that our scope neglects younger, less competitive, or older athletes who collectively represent a population in which a much larger number of CV events can occur.⁶ “Red flags” refer to a symptom, sign, history, or abnormality for which further investigation is strongly recommended by existing contemporary guidelines. In this statement, we refer to and contextualize the utility of these tools rather than list each possible “red flag.” Potential or emerging bedside screening tools (ie, ultrasound and molecular diagnostics) were not considered in the present scope. CV screening is usually undertaken specifically to assess the risk of SCD during or

dévastatrices sur les familles et les communautés, ce qui explique le désir de notre société d'éviter toute circonstance prédisposant à la perte d'une vie humaine durant un effort physique. L'énoncé de position de la Société canadienne de cardiologie sur le dépistage des troubles cardiovasculaires chez les athlètes présente, à l'intention des organisations et des institutions sportives canadiennes, des recommandations fondées sur des données probantes insistant plus particulièrement sur le rôle du dépistage par électrocardiogramme (ECG) de routine dans la prévention de la MSOC. Nous préconisons, pour le dépistage et les soins des troubles cardiovasculaires des athlètes au sein du modèle canadien de soins de santé, une approche séquentielle (par paliers) d'évaluation du risque cardiaque, tout en soulignant les limites du dépistage et l'importance de la prise de décision partagée lors du diagnostic d'une cardiopathie et l'élaboration de politiques et de procédures applicables à la gestion des situations d'urgence dans un contexte d'activité sportive. Par conséquent, nous déconseillons le recours à un ECG à 12 dérivations de routine (utilisation en première ligne ou généralisée) pour le dépistage initial des troubles cardiovasculaires chez les athlètes de compétition. Un programme de dépistage et de soins des troubles cardiovasculaires des athlètes axé sur l'institution et l'athlète est recommandé. Un tel dépistage devrait s'inscrire dans une approche uniforme et systématique du dépistage et du traitement des troubles cardiovasculaires comprenant les volets suivants : évaluation, examens appropriés, interprétation, prise en charge, counseling et suivi. Les recommandations présentées incluent un cadre à plusieurs paliers qui donne aux institutions une certaine latitude pour l'élaboration du programme.

related to sport. The reported incidence of SCD in athletes varies greatly according to age, geography, level of competition, method of case ascertainment (numerator), and the defined number of athletes at risk (the denominator). In one region of Canada (Toronto, Ontario), the risk of death during competitive sport in a sample aged 12-45 years, derived from 5 years of Emergency Medical System registry data, was 0.76 cases per 100,000 athlete-years⁷ which is consistent with the estimate from a meta-analysis of a diverse population and geography (0.72 cases per 100,000).^{7,8}

“CV screening” is used throughout this document in place of “preparticipation screening” (PPS) because most Canadian collegiate and other competitive athletes have typically been previously participating in high volume/intensity training and competition. Screening in this context is defined as a systematic evaluation of all participants in a defined subset of athletes; it is differentiated from “case finding”; the appropriate investigation of a disease serendipitously identified by other means (eg, as part of routine clinical care). Recommendations were formed after consideration of: (1) frequency and nature of the disease identified; (2) “lives expected to be saved” as a result of screening; and (3) risks associated with false-positive testing. In addition to these factors, recommendations reflect sensitivity to resource limitations and a nonpaternalistic approach. Finally, it is critical to note that these recommendations occur in context of a universal health care system (Canada Health Act, 1984). Most athletes (and nonathletes) have had medical contact or “well-checks” within a system underpinned by family physicians or primary care providers before, during, and after entering competition.

Elements of CV Screening

The history and physical examination

PPS, with a standardized questionnaire, a medical history, and physical examination has been recommended in all major guidelines.⁹⁻¹¹ However, high quality, outcomes-based evidence supporting the use of mass PPS with history and physical examination is limited. Presently within Canada, there is no widely accepted systematic screening process to identify athletes at risk. A PPS medical questionnaire may be administered by an athlete's organization. Questionnaires are ideally standardized, performed and interpreted by a physician, or other qualified health professional with relevant expertise. Preferably, questionnaires are followed by a physical examination, permitting an opportunity to review responses of concern. The diagnostic yield of a questionnaire or medical history used for mass CV screening of athletes is poor.^{12,13} Several prospective, observational studies have compared the results of a medical history and physical examination.¹³⁻¹⁵ A meta-analysis of 15 studies reported a pooled sensitivity of 20% for history and 9% for physical examination in identifying disease¹³ and subsequent studies have reported similar results.¹⁴⁻¹⁶ However, these studies did not have a "gold standard" comparator, because denominators were created from total positive screening results.¹³ Therefore, false-negative rates and negative predictive values cannot be accurately assessed, supporting the view that such approaches should be considered poor for identifying disease but might assist in identifying athletes at risk of a CV event. It has been reported that 72% of SCD victims were described by their parents to have at least 1 CV symptom before SCD¹⁷ in contrast to a larger autopsy study in which most of the athletes were deemed asymptomatic.¹⁸

Several studies have included athletes who screened "positive" for conditions associated with no additional risk of SCD (ie, isolated bicuspid aortic valve) and were subsequently cleared for participation.^{15,19,20} The reported low sensitivity of history/questionnaire is not surprising because 70%-80% of SCD occurs as the first manifestation of an underlying cardiac disease.^{18,21,22} Furthermore, although an important small percentage of the causes of SCD in young athletes are heritable, a positive family history is reported in some cases (8%-40%).^{17,18} Thus, the low positive predictive value of history and physical examination in 47,137 athletes (a total of 160 potentially lethal CV conditions detectable using ECG; a rate of 0.3%), means that a positive result translates to only a small increase in the likelihood of disease.¹³ Nonspecific symptoms, such as fatigue might be common; however, the diagnostic utility of this symptom, although uncertain,¹⁶ might not be trivial because fatigue (44%) and near-syncope/light-headedness (30%) have been reported to be the 2 most common symptoms before sudden cardiac arrest (SCA).¹⁷ An athlete's interpretation of what entails a positive response to personal and family history on medical questionnaires is variable. High rates of "positive" responses (up to 68%) have been reported to occur, before review by a physician or health care professional.^{15,23} The high false-positive rate, low level of sensitivity, and the presence of nonspecific symptoms, in populations at varying risk, combine to limit the diagnostic accuracy of questionnaires.

Further compromising diagnostic accuracy is the marked variability of the guideline-recommended questionnaires used by institutions. An analysis of the questionnaires used by U-SPORTS institutions in Canada revealed that only 10% strictly follow guideline-endorsed questions and less than half (43%) contain at least 75% of the recommended items.¹

The 12-lead ECG

International guidelines differ in their recommendations addressing ECG screening of competitive athletes.²⁴ The resting 12-lead ECG is superior to the history and physical examination in the detection of disease associated with SCD.¹³ Factors considered in recommending ECGs are: (1) detection of subclinical asymptomatic electrophysiological disease such as Wolff-Parkinson-White, some channelopathies, and occult cardiomyopathies such as hypertrophic cardiomyopathy and arrhythmogenic right ventricular cardiomyopathy (ARVC)²⁴; (2) the fact that most athletes who succumb to SCD are asymptomatic; and (3) the low percentage of deaths that are readily identifiable using physical examination.^{13,18} The utility of an ECG to improve detection is influenced by the underlying prevalence of disease predisposing to SCD specifically during sport (which is very challenging to determine), the sensitivity of the ECG in young athletes, and the experience of its reader. Indeed, the ECG as a tool is not without limitations, including: (1) low positive likelihood to predict SCD; (2) high costs of secondary evaluations required to evaluate an "abnormal" ECG; (3) variability of accurate athlete-specific ECG interpretation; (4) logistics of implementing screening programs; and (5) false reassurance of a normal ECG in athletes with disease. Continued study of what is "normal" for an athlete, and refinement of ECG interpretation criteria for young athletes, has led to a marked decrease in the number of false-positive results from 21.8% with the 2010 European Society of Cardiology criteria to 3%^{25,26} with the 2017 international recommendations.²⁷ Whether ECG-inclusive PPS significantly reduces SCD in competitive athletes remains uncertain. However, it is clear that the risk of SCD during sport is low.⁸ To date, only the Italian ECG-inclusive PPS experience in Veneto, Italy (where there is a pronounced increase in the prevalence of ARVC) has suggested a reduction in the incidence of death after introducing mandatory ECG screening.²⁸ The low incidence of SCD in athletes, and the major limitations of historical controls as a standard for assessing effectiveness of screening, are cited as reasons against including ECG as part of PPS; as is the small absolute reduction in SCD that might be gained by consequent restriction of sport. On the basis of the Italian data, an argument has been made that the restriction of activity might reduce disease progression and death; however, most presumed cardiac deaths in young participants occur during sleep or at rest.^{18,29,30} One might argue that PPS might lead to a diagnosis of heart disease, and the provision of advice regarding vigorous physical activity that might reduce the future risk of SCD. Nevertheless, there is a paucity of evidence that such an approach will protect an individual from cardiac events.

Because of the weak evidence for the benefit of ECG screening to reduce SCD weighed against potential harms including inappropriate restriction, psychologic and career

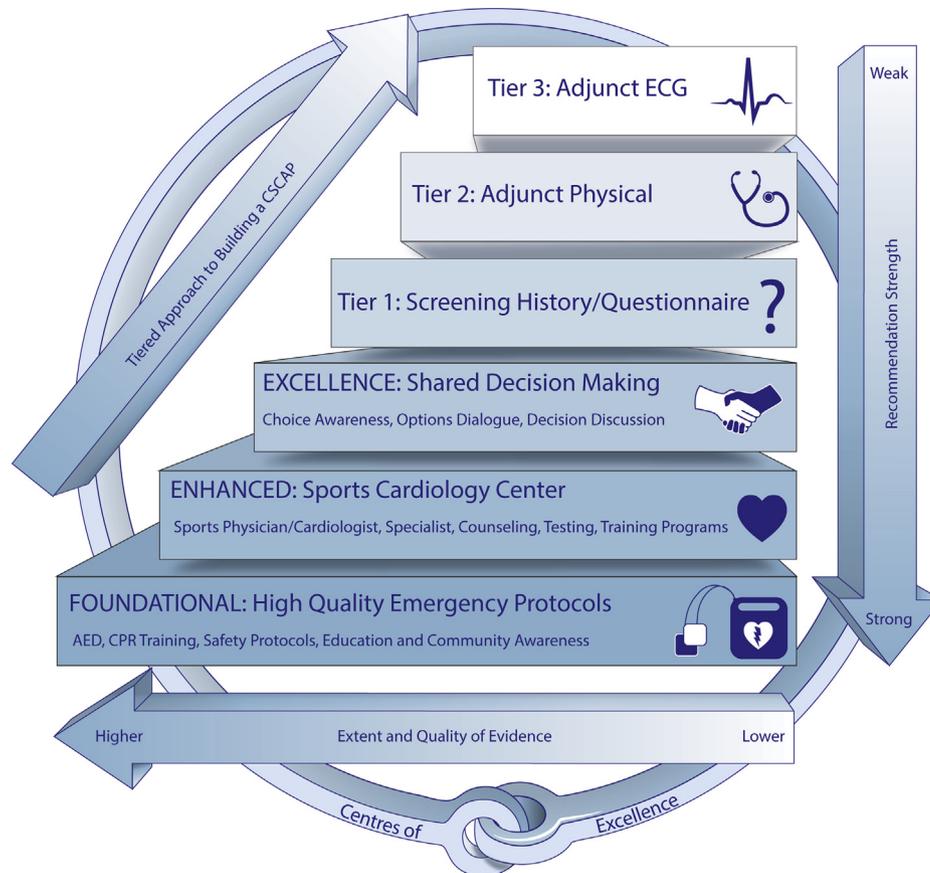


Figure 1. Cardiovascular screening and care of the athlete program (CSCAP): the tiered approach. The illustration suggests an evidence-based approach encouraging organizations to direct resources to ensure a stepwise approach to the performance of processes and resource utilization. This program operates within a broader health care model supported by family physicians and primary care providers. Each organization should consider linking to other centres to allow a national approach to gathering and enhancing the quality of evidence as part of a proposed network. It is critical to note that the ordering of tiers is not on the basis of test characteristics alone (sensitivity for detecting sudden cardiac death). It is recognized that tier 1 and 2 have poorer test characteristics for detecting sudden cardiac death compared with electrocardiogram (ECG; tier 3) but represent good clinical practice and reflect achievability as defined by expert consensus. AED, automated external defibrillator; CPR, cardiopulmonary resuscitation.

impact, the potential for unnecessary testing, and real-world limitations in resources depending on the environment of the organization, we have recommended an institution-centred or regionalized approach to CV screening of athletes. In the “tiered” approach, we define minimal requirements before beginning a screening program, and then describe which components of screening should be considered next in a stepwise or incremental fashion. The ordering of the tiers is not only on the basis of the test characteristics of each action; in other words, the Panel does not believe that the history and physical examination are superior to ECG as components of screening, but because they are part of good clinical practice, and achievable, should be performed before contemplation of adding ECG testing to screening. This expert-derived consensus upon the ordering of tiers considers the Canadian health care model, where virtually all athletes have had some contact with primary care networks before collegiate-level sports participation. The tiered approach allows institutions some choice as to how to build up to a cardiovascular screening and care of athletes program (CSCAP), which could include qualified ECG performance, on the basis of their environment

and resources. The tiers in this approach are ordered on the basis of the recommendation intensity, which considers not only evidence, but also achievability, values, and good clinical practices. The starting foundational component related to automated external defibrillator (AED) and emergency protocol has the greatest recommendation intensity, and ECG for routine screening has the lowest recommendation intensity (visually depicted in Fig. 1).

In summary, the history and physical examination components are a reasonable initial aspect of screening in a stepwise program or incremental approach (tier 1 and 2). Abnormal findings on history and physical exam require further investigation, such as with ECG (tier 3) to ascertain diagnosis as per standard of care. Standard follow-up investigations of abnormal history, physical examination, and ECG findings are well described. Certain initial abnormal ECG findings require further cardiac evaluation (Table 1). Interdisciplinary collaboration to appropriately guide follow-up investigations becomes important to prevent false-positive interpretations, unnecessary investigations, and inappropriate sport restriction. Abnormal screening findings

RECOMMENDATION

1. We recommend an incremental (tiered) approach to CV screening of competitive athletes as part of a broad, organization/athlete-centred CSCAP. Such screening should occur in the context of a consistent, systematic approach to CV screening and care that provides assessment, appropriate investigations, interpretation, management, counselling, follow-up.

Strong Recommendation, Low-Quality Evidence

2. We recommend that a history/questionnaire should constitute the initial CV screening (tier 1), provided it is:

- Standardized according to at least 1 of the American Heart Association, European Society of Cardiology, fourth-edition Preparticipation Physical Evaluation, or SportsCardiologyBC tools or equivalent;
- Accurately interpreted by an appropriately qualified professional experienced in the care of athletes; and
- Is followed with appropriate investigations as “clinically warranted.” “Clinically warranted” findings are those deemed by the interpreter as requiring further assessment, for example using: physical examination; investigations such as ECG testing, imaging, or stress testing; and/or consultation with a specialist.

Strong Recommendation, Low-Quality Evidence

3. We recommend that a physical examination should be considered as an adjunct component of CV screening of competitive athletes (tier 2) provided it is:

- Performed by an appropriately qualified professional involved in the care of athletes; and
- Followed-up as clinically warranted.

Strong Recommendation, Low-Quality Evidence

4. We recommend against the “routine” performance of a 12-lead ECG for the initial CV screening of competitive athletes. “Routine” in this context is defined as “first-line” or blanket mass performance of ECG not occurring in context of an integrated program as described in Recommendation 5.

Strong Recommendation, Low-Quality Evidence

5. We recommend that a 12-lead ECG should be performed for screening of competitive athletes only when indicated according to history/questionnaire and/or physical examination (targeted screening, tier 3) and provided it is:

- Of “adequate” quality. In this context “adequate” is defined as technically sufficient and of the highest possible quality;
- Interpreted by those with “appropriate expertise” (“appropriate expertise” is defined as training and skills in ECG interpretation specific to athletes and persons with disorders associated with arrhythmias) and with consideration of sport history, sex, ethnicity, age, family history, relevant clinical findings, “regional” (“regional” refers to geographic areas

with a relatively high incidence of certain relevant cardiac conditions) occurrence of disease; and

- Accompanied by appropriate investigations and expert referral if clinically warranted.

Strong Recommendation, Low-Quality Evidence

Values and preferences. We disclose that there was an important disagreement between the primary writing panel (composed of Canadian experts) and the secondary international review panel (composed of American and European experts) with respect to Recommendations 4 and 5. The international experts on the secondary panel emphasize that SCD in athletes occurs in the absence of warning symptoms. Performance of targeted screening will miss these occurrences. In rebuttal, the primary panel clarified our position that these recommendations do not prohibit organizations from performing ECG screening, but suggest a tiered approach that can be tailored to regional needs, resources, and values. The benefit of mass ECG screening to prevent SCD in asymptomatic athletes is challenging to assess. As further detailed, our current position is that any ECG performance, whether it is targeted or not, occur in context of an expert-led, integrated program to ensure accuracy, minimization of false-positive results, prioritization of safety protocols in the case of SCA, and follow-up of abnormal findings.

require a shared decision-making (SDM) approach to guide next steps.

SDM

“Red flags” or abnormalities during the screening process necessitate an SDM approach toward further management. This process of deliberation and exchange between clinicians and patients ensures decisions are informed by the best available evidence.²⁷ SDM is highly appropriate for the CV care of athletes because it acknowledges the uncertainties surrounding screening, diagnosis, and the risk of CV events during sport. SDM involves ensuring that all involved become fully informed of: (1) degree of uncertainty surrounding the association of a particular diagnosis and actual SCD risk; (2) harms and benefits of the diagnostic cascade and intervention (restriction of competition); and (3) alternative approaches, if any, to management.³¹ Practically, SDM should consist of 3 steps: (1) choice awareness; (2) an options dialogue; and (3) a decision discussion²⁷ (Fig. 2).

Choice awareness

Athletes, physicians, and sport organizations should understand the limitations and implications of a CV screening program and the need for careful, informed interpretation of ‘abnormal’ findings potentially suggestive of CV disease.³²⁻³⁴ Athletes should be provided a choice to participate in screening and provide informed consent. There are understandable expectations that a sport organization will act to safeguard the health and well-being of participants and other competitors, and show specific self-interest in seeking to reduce the possibility of tragic deaths in their programs. Thus, it is

Table 1. ECG findings in an athlete

Normal ECG findings	Borderline ECG findings	Abnormal ECG findings
<ul style="list-style-type: none"> • Increased QRS voltage for LVH or RVH • Incomplete RBBB • Early repolarization/ST-segment elevation • ST elevation followed by T-wave inversion V₁-V₄ in black athletes • T-wave inversion V₁-V₃ in age ≤ 16 years • Sinus bradycardia or arrhythmia • Ectopic atrial or junctional rhythm • 1° AV block • Mobitz type I 2° AV block 	<ul style="list-style-type: none"> • Left axis deviation • Left atrial enlargement • Right axis deviation • Right atrial enlargement • Complete RBBB 	<ul style="list-style-type: none"> • T-wave inversion • ST-segment depression • Pathologic Q waves • Complete LBBB • QRS ≥ 140 ms duration • Epsilon wave • Ventricular pre-excitation • Prolonged QT interval • Brugada type 1 pattern • Profound sinus bradycardia < 30 bpm • PR interval ≥ 400 ms • Mobitz type II 2° AV block • 3° AV block • ≥ 2 PVCs • Atrial tachyarrhythmias • Ventricular arrhythmias
No further evaluation required in asymptomatic athletes with no family history or inherited cardiac disease or SCD	In isolation, no further evaluation required in asymptomatic athletes with no family history or inherited cardiac disease or SCD; If ≥ 2, further evaluation required to investigate for pathologic cardiovascular disorders associated with SCD in athletes	Further evaluation required to investigate for pathologic cardiovascular disorders associated with SCD in athletes

AV, atrioventricular; bpm, beats per minute; ECG, electrocardiogram; LBBB, left bundle branch block; LVH, left ventricular hypertrophy; PVC, premature ventricular complex; RBBB, right bundle branch block; RVH, right ventricular hypertrophy; SCD, sudden cardiac death.

Modified from Sharma et al.⁶² with permission.

recognized that a sports organization might wish to restrict certain athletes from training and competing, for example, if they do not participate in a screening process (Fig. 2).

Options dialogue

The second stage in the SDM approach is to convey the meaning of positive findings on the questionnaire/history, physical examination, or ECG. Conveying the concept of false-positive results and their rate allows the athlete to make an informed decision. If disease is identified, consideration of the specific disorder, and the probability of SCD or disease progression as a consequence of continued athletic activity, should be weighed against the risks associated with a more sedentary or restricted lifestyle. The SDM process might require more than 1 clinical contact and involve discussions pertaining to further diagnostic testing, and the potential benefits or harms during the options dialogue (Fig. 2). For athletes with CV findings, further dialogue, with other experts might be appropriate. Patient athletes or relatives are supported to explore “what matters most to them,” so that they can participate in the selection of the best course of action.³⁵

The decision discussion and participation restriction

There is a lack of data to suggest that restricting athletes from sport results in a reduction of SCD from most of the predisposing conditions that can be identified, except for ARVC, when genotypic or phenotypic ARVC has been diagnosed as per established criteria.³⁶ Furthermore, there is a marked disparity between the prevalence of disease and the incidence of SCD; most athletes with underlying CV disease will never experience SCD during exercise.^{7,18,29} Conversely, SCD might occur in the absence of abnormal findings during screening and most cases do not occur during vigorous exercise.^{18,29,30} Although it is believed that vigorous exercise is a potential trigger for SCD, an examination of deaths of young

persons in the United Kingdom and Australia/New Zealand showed that most deaths occurred at rest^{18,29,30}; which brings into question the efficacy of restriction. Even among high-risk athletes with implantable cardioverter-defibrillators who continued to participate in sport, registry data showed no tachyarrhythmic deaths nor externally resuscitated tachyarrhythmia during or after sport.⁴ Athletes in this population experienced appropriate implantable cardioverter-defibrillator shocks (for ventricular tachycardia/fibrillation) during competition or practice at a rate of 3 per 100 person-years but this should clearly be individualized.^{37,38} Offsetting a possible benefit of reducing SCD by restricting an athlete is the potential harm of denying a young person the benefits of physical activity such as: improved physical and psychological well-being, and decreased depression, obesity, and illicit drug use,³⁹ as well as implications for scholarship and career opportunities. It is recognized that there are situations (such as a high-risk case of hypertrophic cardiomyopathy⁴⁰) in which there is a higher risk of SCD with competition and the physician might strongly advise against participation. It is also recognized that some individuals might decide not to follow such advice and attempt to continue to participate irrespective of the personal risk communicated to them.^{41,42} In this setting, an array of legal, financial, and ethical issues might emerge as a consequence of a physician's advice to restrict further opportunity for sport participation.⁴³

Secondary Prevention of SCD and CV Emergencies

Basic requirements

Sport organizations must recognize the need to ensure that appropriate approaches and equipment are available to address emergencies involving spectators, officials, staff, and competitors.⁴⁴⁻⁴⁶ Training in cardiopulmonary resuscitation

RECOMMENDATION

6. We recommend that after the identification and confirmation of any predisposing condition using screening, the probability of “SCD” (“SCD” in this context includes the probability of SCA; it is recognized that for some conditions it might be very difficult to define such probability) be estimated to facilitate a SDM process regarding sport participation involving the athlete (and parent/guardian if appropriate), caregiver, and sport organization.

Strong Recommendation, Low-Quality Evidence

7. We recommend that sport restriction be considered and discussed in the following conditions: ARVC, exercise-induced significant ventricular arrhythmias (if arrhythmogenic risk cannot be mitigated), catecholaminergic polymorphic ventricular tachycardia, exercise-induced heart block, hypertrophic cardiomyopathy with sustained ventricular tachycardia or multiple risk factors, dilated cardiomyopathy unrelated to an athlete’s heart, left ventricular noncompaction with left ventricular dysfunction and or ventricular arrhythmia, Marfan syndrome with aortic dilatation, significant aortic dilatation, coronary artery aneurysm with ischemia, oral anti-coagulation treatment in an athlete competing in sports with a high risk of injury causing bleeding, pulmonary hypertension, and cyanotic congenital heart disease.

Strong Recommendation, Low-Quality Evidence

(CPR), the availability of AEDs in key activity (competition and training) spaces, and the creation of emergency management protocols should be standard.^{47,48} These are the bedrock of a CSCAP; Fig. 1).

AEDs

Increased public awareness and advocacy has led to a wide availability of AEDs in public and private sporting venues. They provide a means of early defibrillation not only for athletes, but for spectators and other attendees in the rare event of SCD.^{46,47,49,50} Recent data⁵¹ suggest that AED use has improved the SCA resuscitation success rates among athletes, thereby conferring a survival benefit. Limited data from the United States National Registry for AED use in sports suggests that AEDs in high schools, although more commonly used on nonathlete adults, have yielded a high success rate (to hospital discharge) between 50% and exceeding 85% in young athletes.^{7,51} Most college and high schools in the United States do in fact have AEDs in place,^{44,51-53} yet the provision of AEDs in some settings might be limited by financial resources.⁴⁵ European and American authorities recommend AEDs be placed at high school and college sporting venues.^{54,55} Regarding older individuals practicing sport, a recent report showed that the presence of on-site AEDs in amateur sports centres was associated with neurologically intact survival after an exercise-related SCA. Indeed, neurologically intact survival rates were 93% in centres with on-site AEDs and 9% in centres without ($P < 0.001$).⁵⁶

RECOMMENDATION

8. We recommend the creation of specific policies and protocols for the delivery of MAPs specific to cardiac emergencies in all competitive sport settings and as the foundation of a CSCAP.

Strong Recommendation, High-Quality Evidence

9. We recommend that all educational and recreational facilities with athletic or sports programs must have AEDs located to ensure rapid access and initiation of defibrillation in < 3 minutes. These should be placed within close proximity to, if not within, all physical activity spaces used by athletes.

Strong Recommendation, Moderate-Quality Evidence

10. We recommend that because athletes, team staff, and referees are mostly likely to initially witness and attend a collapsed athlete, that at a minimum, team staff and referees be trained in CPR and be familiar with the use of AEDs, rehearse the MAP at their own facility, and be familiar with MAPs at other sporting facilities. Despite the low incidence of SCD in athletes, it is recommended that SCA be considered the likely cause of an athlete’s nontraumatic collapse during sport.

Strong Recommendation, Moderate-Quality Evidence

Education of personnel and medical action plans

The regular rehearsal of an effective medical action plan (MAP) is as critical as the provision of AEDs.⁵¹ Key components of an effective MAP include: (1) knowledge of AED location; (2) protocols to alert first responders and AED retrieval; and (3) training of personnel in CPR and AED use. Current American and European guidelines recommend that a time-to-shock using an AED should be < 3 minutes⁵²; each minute of delay reduces SCA survival by 7%-10%.⁵⁷ This is particularly important in rural communities, where in the absence of AEDs, the Emergency Medical System-dependent time-to-shock might be prolonged. Training in contemporary approaches to CPR is fundamental.⁵⁷ Current American guidelines call for CPR training of all team members, staff, and referees.⁵⁸

The Enhanced Environment of a Sports Cardiology Centre

Organizations offering a comprehensive CV screening program in an attempt to identify risk of SCD require an integrated array of resources and personnel.^{52,59,60} This writing panel recommended against the routine performance of a 12-lead ECG, meaning that it should not be the sole or first-line screening procedure without adequate good clinical practice in place (history and physical) and without adequate interpretation and follow-up. However, if a given institution/organization decides to administer a routine 12-lead ECG as part of the screening process towards tier 3 after achieving all previous steps, it must be accompanied by an interpretation by clinicians experienced in the assessment of an athlete’s

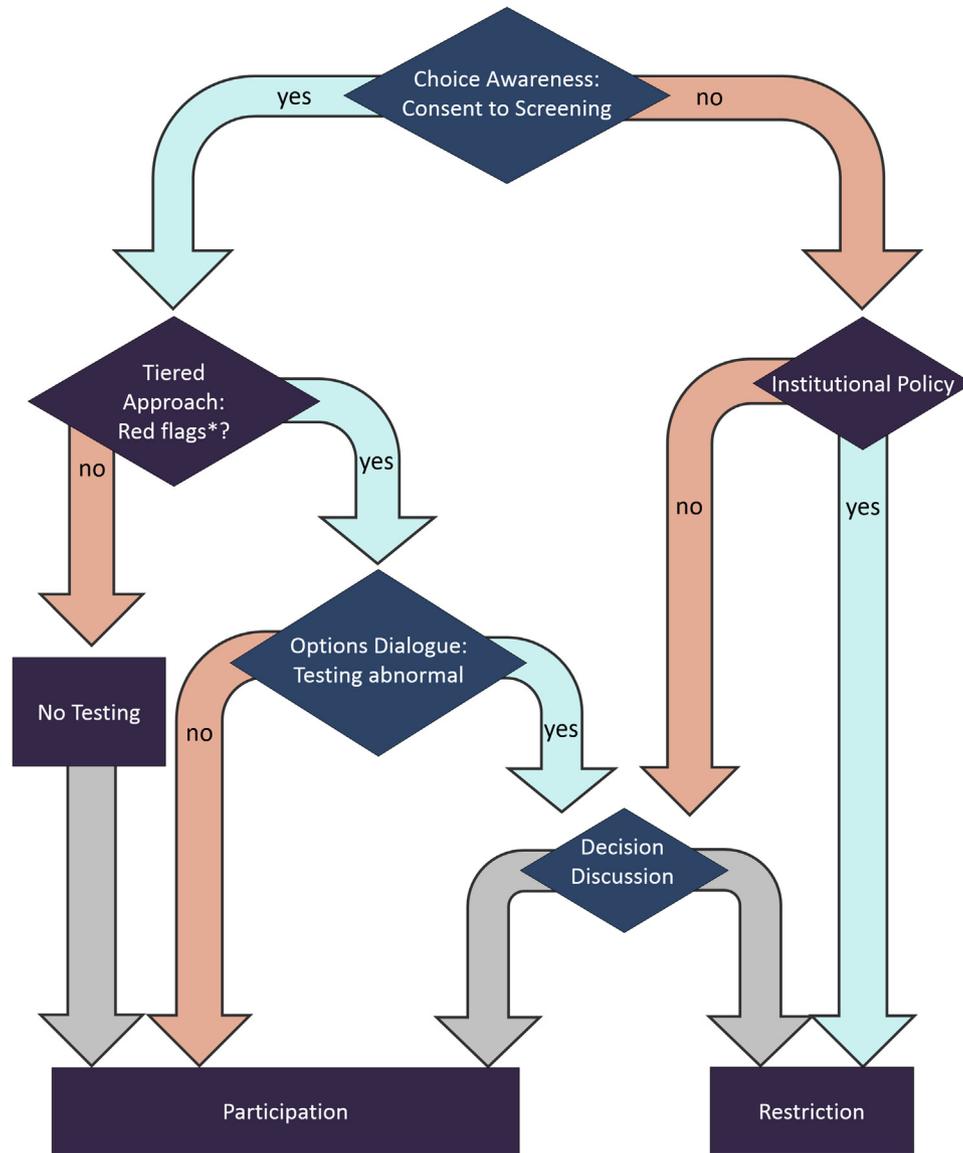


Figure 2. The cardiovascular screening and care of athletes program infers a shared decision-making approach to contextualize the screening process, understand options during recommended investigations and treatment, and ensures an informed discussion when deciding between continued participation or restriction (Recommendations 5-9). The “tiered approach” to screening is described in the text, by Recommendations 1-4, and further summarized in [Figure 1](#). A patient-oriented cardiovascular screening and care of athletes program (CSCAP) infographic was created based on this Figure and appears as [Supplemental Figure S1](#). * “Red flags” refer to a symptom, sign, family history, or abnormality for which further investigation is strongly recommended.

ECG.^{13,61-63} The limitations of such programs must be appreciated.^{19,64-70} The capacity to provide expeditious access to further cardiac investigations must be in place.⁵² In the Canadian context, this will typically involve the participation of an experienced sports medicine physician and a clearly identified cardiologist.^{52,60} It is important to ensure that oversight of screening programs is assumed by trained physicians and specialists (which includes available general cardiologists). The development of sport cardiology centres (or centres of excellence) in certain regional settings will greatly assist those with limited access to specialty services.⁵⁹ Such networks might also facilitate research into the utility of emerging bedside screening tools and consensus-building related to defining “red flags” and sport participation.

Limitations

With consideration of the assigned scope of this position statement, the writing committee was not able to comprehensively evaluate important topic areas related to CV screening in Canadian athletes. Further discussion of these topics is of paramount importance and will be eventually presented in a series of companion articles contextualized by this position statement by the CCS Sport Group. These topic areas currently in development include: prevalence of disease related to SCD in Canadian athletes, the role of imaging and point of care ultrasound in CV screening, and medico-legal aspects and the participation decision. The CCS group is proposing the creation of a network of centres of excellence to study these topic areas further because of the paucity of Canadian data.

Summary

The hallmarks of a high-quality approach to the initial cardiac screening and care of athletes within the Canadian health care model comprises a sequential (tiered) approach to the identification of cardiac risk, an appreciation of the limitations of screening, the importance of SDM when cardiac conditions are diagnosed, and the creation of policies and procedures for the management of emergencies in sport settings. The recommendations presented in this position statement comprise a tiered framework that allows institutions some choice as to program creation. The creation of a network of such regions of excellence, with the goal of further implementation, research, and standardization will enhance the safety of our athletes.

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Supplementary Material

To access the supplementary material accompanying this article, visit the online version of the *Canadian Journal of Cardiology* at www.onlinecjc.ca and at <https://doi.org/10.1016/j.cjca.2018.10.016>.