Prevention of Sudden Cardiac Death in Athletes

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Sudden cardiac death (SCD)

‘Natural death due to cardiac causes, heralded by abrupt loss of consciousness within 1 h of the onset of acute symptoms; pre-existing heart disease may have been known to be present, but the time and mode of death are unexpected’

Myerberg, 1997 A Textbook of Cardiovascular Medicine
Sudden cardiac death: An epidemic

Comparison of public-access defibrillation studies

<table>
<thead>
<tr>
<th></th>
<th>Casinos¹⁰</th>
<th>Airlines⁹</th>
<th>Airports⁷</th>
<th>NCAA Division I Universities¹¹</th>
<th>US High Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases of SCA, n</td>
<td>148</td>
<td>36</td>
<td>21</td>
<td>35</td>
<td>36</td>
</tr>
<tr>
<td>Immediate resuscitation rate, % (n/N)</td>
<td>48 (71/148)</td>
<td>36 (13/36)</td>
<td>52 (11/21)</td>
<td>54 (19/35)</td>
<td>64 (23/36)</td>
</tr>
<tr>
<td>Cases of VF/VT, n</td>
<td>105</td>
<td>15</td>
<td>18</td>
<td>21*</td>
<td>30*</td>
</tr>
<tr>
<td>Resuscitation rate if shock deployed, % (n/N)</td>
<td>63 (66/105)</td>
<td>87 (13/15)</td>
<td>61 (11/18)</td>
<td>71 (15/21)</td>
<td>67 (20/30)</td>
</tr>
</tbody>
</table>

Survival to discharge: 61% to 87%
Case

- 44 y.o. male Caucasian marathon runner
- Cardiac RFs: nil
- PMH: nil
- Meds: nil
- Non-drinker, non-smoker, vegetarian; machinist
- No family history of cardiac disease
- Completed multiple marathons, including the Boston Marathon
- Runs a minimum of 50 miles per week for 5 years
Case: HPI

- Running a marathon
- At mile 24 of 26, he suddenly collapses
- Found to be pulseless and apneic by a physician spectator; CPR initiated

- On arrival to hospital
  - Intubated, in ventricular fibrillation → cardioverted
  - 110/80, P = 100 irregular, T = 38.6
  - JVP not elevated, lungs clear, S4 noted
  - Cardiac markers, transaminases elevated
  - CXR: Normal
  - Swan-Ganz catheter inserted; PCWP = 6
Case (cont’d)

- Stay complicated by significant ventricular ectopy requiring lidocaine and procainamide
- Suffered significant anoxic brain injury
- Died on Day 50 from *Pseudomonas* pneumonia
- Autopsy
  - Transmural myocardial infarction involving the anterior, septal, and lateral left ventricle
  - Left coronary artery system was large in diameter and was "widely patent" throughout its entirety
  - Right coronary artery had mild atherosclerosis
Fatal Myocardial Infarction in Marathon Racing

LAURENCE H. GREEN, M.D.; STAFFORD I. COHEN, M.D., F.A.C.P.; and GEORGE KURLAND, M.D.; Boston, Massachusetts

We believe that our study is the first documentation of a myocardial infarction in a trained athlete while running a marathon. In the presence of normal coronary arteries, the relation between exertion and infarction is unclear. Advocates of long-distance running for prevention or rehabilitation of ischemic heart disease should be aware of this potential complication.
‘The unexpected demise of an athlete is always a tragic event, which has a tremendous impact on the media, because it strikes down apparently healthy individuals…everyone wonders what intervention might have prevented sudden death.’

Dr. Domenico Corrado, Cardiologist
University of Padua, Italy

Corrado, ESC, Paris 2011
Phidippides (530 BC - 490 BC)

Athenian herald: Professional-running courier

Ran 40km from Marathon to Athens to announce Greek victory over Persia

‘Nikomen’ – We have won

Collapses and dies

Luc-Olivier Merson, 1869
Alexander Dale Oen, age 26
Piermario Morosini, age 25
Nemanja Nesic, age 24
Claire Squires, age 30
Fabrice Muamba, age 23

Brett Maclean, age 23
Objectives

- Does exercise increase the risk of SCD and what etiologies account for SCD in athletes?

- Can we prevent sudden cardiac death in athletes?

- What restrictions should be placed upon individuals with cardiovascular disease?
SCD and exercise: Mechanisms

- Majority of deaths: Ventricular tachycardia (VT) or ventricular fibrillation (VF)

- Two mechanisms:
  
  - Prolonged physical training induces changes in cardiac structure (eg, chamber dilation and physiologic hypertrophy) that may create arrhythmic substrate
  
  - Immediate physiologic demands of intense athletics may trigger malignant arrhythmias and SCD in susceptible individuals with underlying cardiac abnormalities
Physiologic changes of exercise and potential sequelae

Thompson, Circulation. 2007 May 1;115(17):2358-68.
Risk of SCD: Age, Sport, Etiology

Kevin Durant, 23 y.o.
NBA scoring title x 3

Etiology of SCD:
Congenital heart disease

Bill Clinton, 66 y.o.
CABG x 4, DES x 2

Etiology of SCD:
Coronary heart disease

Competitive sport
Recreational sport
Classification of SCD by age and etiology

Athlete

- Young
  - 18 to 35 yo (Congenital heart disease)

- ‘Masters’
  - > 35 yo (Coronary heart disease)
Classification of sports

Billiards
Bowling
Cricket
Curling
Golf
Riflery
Higher physical fitness associated with decreased all-cause mortality

Does exercise increase the risk of SCD in athletes?

- Small absolute increase in relative risk of SCD during exercise

- In the long-run, physical activity is protective
Etiology of SCD in young athletes

- Structural
  - Hypertrophic cardiomyopathy
  - Arrhythmogenic right ventricular cardiomyopathy or dysplasia
  - Premature coronary atherosclerosis
  - Congenital anomalies of coronary arteries

- Myocarditis

- Aortic rupture

- Valvular disease

- Pre-excitation syndromes and conduction diseases

- Ion channel diseases
  - Brugada
  - Long QT syndrome
  - Catecholaminergic Polymorphic Ventricular Tachycardia
Etiologies of SCD

Hypertrophic cardiomyopathy

Arrhythmogenic right ventricular Dysplasia/Cardiomyopathy
Etiology of SCD in young athletes: American experience

- **HCM (36%)**
- Indeterminate LVH - possible HCM (8%)
- Coronary artery anomalies (17%)
- Myocarditis (6%)
- ARVC (4%)
- MVP (4%)
- Tunneled LAD (3%)
- CAD (3%)
- AS (3%)
- Aortic rupture (2%)
- Sarcoidosis (1%)
- Dilated C-M (2%)
- Ion channelopathies (3%)
- Other congenital HD (2%)
- Other (3%)
- Normal heart (3%)

Maron, Circulation. 2007;115(12):1643.
Etiology of SCD in young athletes: Italian experience

<table>
<thead>
<tr>
<th>Cause</th>
<th>Athletes (N=49)</th>
<th>Nonathletes (N=220)</th>
<th>Total (N=269)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrhythmogenic right ventricular cardiomyopathy</td>
<td>11 (22.4)</td>
<td>18 (8.2)*</td>
<td>29 (10.8)</td>
</tr>
<tr>
<td>Atherosclerotic coronary artery disease</td>
<td>9 (18.4)</td>
<td>36 (16.4)</td>
<td>45 (16.7)</td>
</tr>
<tr>
<td>Anomalous origin of coronary artery</td>
<td>6 (12.2)</td>
<td>1 (0.5)†</td>
<td>7 (2.6)</td>
</tr>
<tr>
<td>Disease of conduction system</td>
<td>4 (8.2)</td>
<td>20 (9.1)</td>
<td>24 (8.9)</td>
</tr>
<tr>
<td>Mitral-valve prolapse</td>
<td>5 (10.2)</td>
<td>21 (9.5)</td>
<td>26 (9.7)</td>
</tr>
<tr>
<td>Hypertrophic cardiomyopathy</td>
<td>1 (2.0)</td>
<td>16 (7.3)</td>
<td>17 (6.3)</td>
</tr>
<tr>
<td>Myocarditis</td>
<td>3 (6.1)</td>
<td>19 (8.6)</td>
<td>22 (8.2)</td>
</tr>
<tr>
<td>Myocardial bridge</td>
<td>2 (4.1)</td>
<td>5 (2.3)</td>
<td>7 (2.6)</td>
</tr>
<tr>
<td>Pulmonary thromboembolism</td>
<td>1 (2.0)</td>
<td>3 (1.4)</td>
<td>4 (1.5)</td>
</tr>
<tr>
<td>Dissecting aortic aneurysm</td>
<td>1 (2.0)</td>
<td>11 (5.0)</td>
<td>12 (4.5)</td>
</tr>
<tr>
<td>Dilated cardiomyopathy</td>
<td>1 (2.0)</td>
<td>9 (4.1)</td>
<td>10 (3.7)</td>
</tr>
<tr>
<td>Other</td>
<td>5 (10.2)</td>
<td>61 (27.7)</td>
<td>66 (24.5)</td>
</tr>
</tbody>
</table>

*P = 0.008 for the comparison with the athletes.
†P < 0.001 for the comparison with the athletes.
Differing etiologies of SCD in young American and Italian athletes

USA
- Coronary anomalies: 36
- Cardiac mass: 19
- CAD: 10
- MVP: 5
- ARVC: 4
- Other: 3

ITALY
- Coronary anomalies: 22.4%
- Cardiac mass: 18.4%
- CAD: 10.2%
- MVP: 10.2%
- ARVC: 8.2%
- Other: 6.1%

Etiology of SCD in ‘Masters’ athletes: CAD
HCM vs. Athlete's Heart

- Unusual patterns of LV hypertrophy
- LV cavity <45 mm
- LV cavity >55 mm
- Left atrial enlargement
- Bizarre ECG patterns
- Abnormal LV filling
- Female gender
- Thickness with deconditioning
- Family history of HCM
- Max. VO₂ >45 ml/kg/min >110% predicted

"Gray zone" of LV wall thickness (13–15 mm)
What restrictions should be placed upon individuals with cardiac disease?
Restriction from competitive sports: What do the experts agree upon?

- **Absolute restriction:**
  - HCM
  - ARVC
  - Congenital coronary artery abnormalities (uncorrected)

- **Partial restriction:**
  - Myocarditis – for initial 6 months following diagnosis
  - MVP – class IA sports if
    - syncope/arrhythmia, family history of MVP/SCD, significant SVT or ventricular ectopy, moderate to severe MR, embolic event
  - LQTS – class IA sports
  - Brugada – class IA sports
  - CPVT – all have ICD, thus to class IA with minimal contact

- **ICD:** restrict to only recreational sports with no potential trauma allowed
Restriction from competitive sports: Striking a balance.
Can we prevent SCD in athletes?
Can we prevent SCD in athletes?

- Disagreement amongst experts in the field (ACC/AHA and ESC)
- No randomized trials comparing various screening methods
- The strongest data is from Italy, but this has not been reproducible
- Universal screening is likely not cost-effective in Canada
- History and physical examination is insensitive for the detection of cardiac abnormalities; the ECG adds sensitivity
- A significant proportion of SCD in ‘Master’s’ athletes
- Evidence for AEDs
Case for Screening

- First symptom exhibited by 60% of SCD in young athlete victims in the US is cardiac arrest
- Widespread belief that screening of young should exist - American Heart Association, International Olympic Committee, European Society of Cardiology
- Only Japan, Israel and Italy mandate screening
Two approaches to screening: American vs. Italian

**AHA/ACC**
- Cardiovascular screening q 2 to 4 years for high school/college athletes
- History and physical examination only

**ESC/IOC/FIFA**
- Systematic preparticipation screening of young competitive athletes
- History and physical examination, plus a 12-lead ECG
Canada......

- Fundamental lack of data in this area
- Screening isn’t mandated
- No official recommendation exists
- British Columbia has a very unique and ethnically diverse population
- Must develop a data set before any screening recommendations can be made
Sports Cardiology B.C. Young Athletes Study

- “Prevalence of Cardiac Disease in British Columbia for Young Competitive Athletes - Screening Using ECG, Physical Exam and Personal and Family History Questionnaire”

- Will determine prevalence in a subset of our population

- Will use recommendations of AHA and ESC and compare and contrast efficiencies of screening methods
Future Study – “Masters” Population (>35)

- Similar in nature – will conduct preliminary screening tests on large sample from across B.C.

- Goals are:
  - Determine prevalence of cardiovascular disease that can lead to cardiac events in this population
  - Determine prevalence of risk factors in this population
  - Compare and contrast efficiencies of different screening tests used
Sports Cardiology BC

Stay active, stay fit, stay safe

OUR MISSION

Clinical Assessment
With the overwhelming existing evidence of the beneficial and preventive effects of exercise, our society is becoming more and more physically active. Our goal is to assess and evaluate athletes to ensure safe participation in athletics.

Research
With an aging population and an overall increase in the participation of regular athletics and exercise in the general population, research in risk factors and warning signs for cardiovascular events must be investigated.

Advocacy
In order to educate the public on the importance of cardiovascular health and help prevent tragic cardiovascular events, Sports Cardiology B.C. will collaborate with local, national and international organizations.

Education
Through the dissemination of results from research investigation and the interpretation of clinical case studies, public education on safe participation in athletics needs to be provided.
Sports Cardiology B.C.

- Multidisciplinary medical team approach

- Goals of the program are outlined by the 4 pillars:
  - Research, Clinical Assessment, Education and Advocacy

- Clinical focus: Risk assessment and guidance in athletes with cardiac abnormalities, with a focus on Master’s athletes with CHD

- Resource for medical community to educate and provide local perspective on controversial topics

- Research: Detection, prevention and treatment of cardiovascular disease, registry formation, risk factor and disease prevalence
Team

- Dr. Saul Isserow
- Dr. Brett Heilbron
- Dr. Andrew Krahn
- Dr. Teresa Tsang
- Dr. Shubhayan Sanatani
- Dr. Jack Taunton
- Dr. Darren Warburton
- Dr. Kam Shojania
- Dr. Jimmy McKinney
- Dr. Anthony Della Siega
- Dr. Rick Leather
- Dr. Kevin Pistawka
- Dr. Mike Wilkinson
- Dr. Janet McKeown
- Dr. Rich Vandegriend
- Dr. Michael Luong
- Dr. Christopher Fordyce
- Mr. Faisal Aziz
Questions?

www.sportscardiologybc.org