ΑΝΑΚΟΠΗ ΚΑΙ ΚΑΡΠΑ ΣΕ ΕΙΔΙΚΟΥΣ ΧΩΡΟΥΣ

Ανακοπή και ετοιμότητα για ΚΑΡΠΑ σε αθλητικούς χώρους / αγωνίσματα

Μαρία Δρακοπούλου
A’ Πανεπιστημιακή Καρδιολογική Κλινική
Ιπποκράτειο Νοσοκομείο
Outline

- Magnitude of the problem in Athletes- causes of SCA
  - Pre-sport heart screening
  - CPR
  - Summary
Sudden Cardiac Arrest

- Abrupt interruption of circulation and ventilation that leads to inadequate perfusion of vital organs

  At 4 min  ➞ cerebral injury

  At 10 min ➞ cerebral death

SCA is often the first symptom
General Population

Who is at risk for SCA?

- **Athletes**

- Selected Child and Adolescent Population
  - Known *congenital heart disease*
  - Undiagnosed cardiac conditions
  - Exposure to *drugs, medications, toxins, infectious agents*

- Infants or Neonates
Athletes

Relative risk of SCD

Corrado D JACC 2003
### Incidence of sudden cardiac death in athletes: a state-of-the-art review

Kimberly G Harmon, Jonathan A Drezner, Mathew G Wilson, et al.

*Br J Sports Med* published online June 24, 2014
doi: 10.1136/bjsports-2014-093872

<table>
<thead>
<tr>
<th>POPULATION</th>
<th>AGE</th>
<th>DURATION</th>
<th>INCIDENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organised high school and college athletes</td>
<td>13-17</td>
<td>12 years</td>
<td>0.5/100,000/yr</td>
</tr>
<tr>
<td>Competitive athletes</td>
<td>14-35</td>
<td>25 years</td>
<td>2/100,000/yr</td>
</tr>
<tr>
<td>Marathon (London)</td>
<td>Mean 42</td>
<td>26 years</td>
<td>2.2/100,000 runs</td>
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</table>
Substrate for SCA in Athletes

- Abnormality either in heart’s **structure** or in the **electrical system** of the heart.

- Many of these conditions **are inherited, so it is important for family members** to be aware of their family history.
Triggers of SCD

- Dehydration
- Adrenergic surges
- Electrolyte imbalance
- Acid/base disturbance
Causes of SCD in Athletic Population

- HCM
- Myocarditis
- Tunneled LAD
- DCM
- Ion Channelopathies
- Indeterminant LVH
- ARVC
- Coronary Artery Disease
- Sarcoidosis
- Other Congenital Disease
- Coronary Artery Anomalies
- Mitral Valve Prolapse
- Aortic Stenosis
- Aortic Rupture
- Other

37%
18%
9%
6%
4%
4%
3%
3%
3%
3%
2%
2%
2%
1%
Sudden Cardiac Death in Senior Athletes

- CAD: 80%
- SAD: 5%
- MVP: 5%
- Valves: 5%
- HCM: 5%
Outline

- Magnitude of the problem in Athletes - causes of SCA
- Pre-sport heart screening
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YOUNG COMPETITIVE ATHLETE

FAMILY & PERSONAL HISTORY, PHYSICAL EXAMINATION, 12 LEAD ECG

NEGATIVE FINDINGS

ELIGIBLE FOR COMPETITION

No evidence of cardiovascular disease

POSITIVE FINDINGS

FURTHER EXAMINATIONS (echo, stress test, 24hr Holter, Cardiac MRI, angio/EMB, EPS)

Diagnosis of cardiovascular disease

MANAGEMENT ACCORDING TO ESTABLISHED PROTOCOLS
Evaluation of an athlete: tools available

› History and physical examination
› ECG
› Echo (transthoracic)
› +/- Stress echo/MIBI
› ? Cardiac CT
› +/- Cardiac MRI
› +/- Holter/Event monitor/Implantable loop recorder
› +/- Electrophysiology studies
› +/- Genetic testing
Historical Overview

1899: Initial observations by Henschen and Darling
   - Cardiac enlargement by physical exam

100+ years of scientific study:
Athletes' Heart
Electrical and Structural adaptation

**ELECTRICAL**
- Bradycardia
- Repolarisation anomalies
- Voltage criteria for chamber enlargement

**FUNCTIONAL**
- Enhanced diastolic filling
- Augmentation of stroke volume

**STRUCTURAL**
- Increased wall thickness
- Increased cavity size
Overlap with Disease

- Long standing endurance athlete
- Anabolic drug abuse
- Black athletes
- Juvenile EKG pattern
- Repolarisation changes and increased heart size
- Cardiomyopathy

Cardiac Risk in the Young Centre for Sports Cardiology
Cardiac Remodeling

Hemodynamic Stress of Sport

Pathophysiology of Disease
Cardiac Remodeling: Exercise

**Endurance Activities (Isotonic)**
- Sustained $\uparrow$ CO
  - 4 to 5 times rest
  - $\uparrow \uparrow \uparrow$ HR & $\uparrow$ SV
  - Vasodilation

**Volume Challenge**

**Strength Activities (Isometric)**
- Repetitive $\uparrow$ SBP
  - Systolic BP > 200 mmHg
  - Skeletal Muscle Contraction
  - Vasoconstriction

**Pressure Challenge**
Cardiac Remodeling: Physiology

Characteristic Features
- Eccentric LVH and RV dilation
- Biastral enlargement
- Normal to slightly reduced resting LVEF
- Normal or enhanced early diastolic function

Characteristic Features
- Concentric LVH
- Enlarged left atrium
- Hyperdynamic resting LVEF
- Reduced early diastolic function
- Altered LV mechanics

LV non-compaction

Restrictive cardiomyopathy

Normal heart

DCM

HCM

ARVC
Gray Area of overlap between ‘Athlete’s Heart’ and cardiomyopathies

- LV cavity: 56-70 mm
- Frequent or complex ventricular arrhythmias
- Dilated cardiomyopathy
- Myocarditis
- HCM; ARVC
- Distinctly abnormal ECG
- LV wall thickness: 13-15 mm
- Athlete’s Heart
- Gray-area
- Cardiomyopathy

HCM
Evaluation ‘Tool Kit’

Structural changes
When left-sided parameters fall outside normal range

**Structural changes**

- **Absolute wall thickness**
  - Any 1 of the 8 measurements > 12mm (or 14mm in male and 13mm in female patients of black ethnicity)

- **Left ventricular diameter**
  - Male (LVDd > 59mm or > \(3.1\text{mm/m}^2\))
  - Female (LVDd > 53mm or \(3.2\text{mm/m}^2\))

- **Left atrial size**
  - Male (LAd > 40mm and LA vol index > 28ml/m\(^2\))
  - Female (LAd > 38mm and LA vol index > 28ml/m\(^2\))

**Assess LV systolic function**
- > 55%
  - EF Simpsons Biplane
  - Pulsed Wave TDI S’ – average of septum and lateral wall

**Assess LV diastolic function**
- < 55%
  - E/A > 1
  - Standard trans-mitral Doppler
  - Pulsed Wave TDI E’ – average of septum and lateral wall

**Consider Physiology**
- Correlate with clinical data (ECG, symptoms, demographics, FH)

**Consider Pathology**
- E/A < 1
  - Refer to BSE algorithms
  - Correlate with clinical data

**Physiological adaptation more likely**

**Pathological adaptation more likely**
When right-sided parameters fall outside normal range

**Structural changes**

- RVOT1 $> 35\text{mm}$ or $> 21\text{mm/m}^2$ OR
- RVD1 $> 42\text{mm}$ OR
- RV:LV ratio $> 0.66$

**Assess RV systolic Function**

- TAPSE
  - $> 16 \text{ mm}$
  - $> 33\%$
  - $S' > 10 \text{ cm/s}$

- Right Ventricular Fractional Area Change
  - $< 16 \text{ mm}$
  - $< 33\%$
  - $S' < 10 \text{ cm/s}$

**Consider Pathology**

- Correlate with clinical data
- Refer to BSE algorithms

**Subjective Assessment**

- Evidence of dyskinesis, akinesis or aneurysm

**Physiological Adaptation**

- More Likely

**Pathological Adaptation**

- More Likely

**Consider Physiology**

- Correlate with clinical data (ECG, symptoms, demographics, FH)

- No evidence of dyskinesis, akinesis or aneurysm
Other areas of study

- **Atria**
  - LA dilation: endurance > strength athletes
    
  - LA function: atrial strain and contraction

- **Aorta**
  - Sinus of Valsalva: 3.2 mm greater in athletes
    
Future Directions

- Myocardial mechanics
  - LV strain, twist (regional function)
- Cardiac MRI

ECG changes

ECG; history

1998
Screening for HCM in young athletes.
NEJM. 339(6)
Initial presentation of formal ECG criteria for differentiation of pathology from normality in athletes

2005
“ESC 2005”
Eur Heart J. 26(5)
First consensus document presenting quantitative ECG criteria for use in athletes

Key Advances
First published ECG criteria designed to detect occult structural disease in athletes

2010
“ESC 2010”
Eur Heart J. 31(2)
Criteria update aimed at acknowledging the difference between “common/training related” ECG patterns and “uncommon/training unrelated” ECG patterns

Key Advances
Segregated athlete ECG patterns into “Group 1” (training related) and “Group 2” (training unrelated)

2012
“Seattle Criteria”
Br J Sports Med 47(3)
Criteria update aimed at refining the ESC 2010 criteria with an emphasis on the development of training modules for sports medicine practitioners.

Key Advances
Provided refined quantitative definitions for numerous ECG patterns to increase specificity for the detection of occult disease

2014
“Revised Criteria”
Circulation. 129(16)
Criteria focused on further improving the specificity of athlete ECG interpretation by using primary data derived from sizeable multi-ethnic athlete cohorts.

Key Advances
Reclassified several common isolated ECG patterns as benign including axis deviation, atrial enlargement, and right ventricular hypertrophy

2017
“International Criteria”
Eur Heart J. 2017
## ESC Classification of ECG abnormalities in Athletes

<table>
<thead>
<tr>
<th>Group 1 (training-related)</th>
<th>Group 2 (training-unrelated)</th>
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<tbody>
<tr>
<td>Sinus Bradycardia</td>
<td>T-wave inversions</td>
</tr>
<tr>
<td>First degree AV Block</td>
<td>ST-segment depression</td>
</tr>
<tr>
<td>Incomplete RBBB</td>
<td>Pathological Q-waves</td>
</tr>
<tr>
<td>Early Repolarisation</td>
<td>Left Atrial Enlargement</td>
</tr>
<tr>
<td>Isolated QRS voltage criteria for LVH</td>
<td>Left axis deviation / left anterior hemiblock</td>
</tr>
<tr>
<td></td>
<td>Right axis deviation / left posterior hemiblock</td>
</tr>
<tr>
<td></td>
<td>Right Ventricular Hypertrophy</td>
</tr>
<tr>
<td></td>
<td>Ventricular pre-excitation</td>
</tr>
<tr>
<td></td>
<td>Complete LBBB or RBBB</td>
</tr>
<tr>
<td></td>
<td>Long QT or short QT interval</td>
</tr>
<tr>
<td></td>
<td>Brugada-like early repolarisation</td>
</tr>
</tbody>
</table>
29-y male asymptomatic athlete

Bradycardia, early repolarization I, II, avF, V4-V6, voltage criteria for LVH (S-V1 + R-V5>35mm), tall, peaked T waves
Incomplete RBBB is a common and normal finding in athletes and does not require additional evaluation.
**ECG from a black athlete**

Voltage criteria for LVH, J-point elevation and convex (‘domed’) ST segment elevation followed by TWI in (V1-V4). This is a normal repolarization in black athletes.
ECG changes

Figure 1  International consensus standards for ECG interpretation in athletes. AV, atrioventricular; LBBB, left bundle branch block; LVH, left ventricular hypertrophy; PVC, premature ventricular contraction; RBBB, right bundle branch block; RVH, right ventricular hypertrophy; SCD, sudden cardiac death.

Eur Heart J 2017
SCD with a normal Heart

LQTS

Brugada

WPW
Arguments for and against screening

**For**
- Highly visible events
- Loss of numerous years of life
- Association between exercise and sudden death
- Acceptable interventions to prevent fatalities

**Against**
- Sudden deaths in athletes uncommon; 1 in 50,000
- Rare disorders. Diverse pathology
- Elaborate screening programmes not cost effective
- Risk of false positives
Deaths Despite Screening with ECG

False Negatives

- Anomalous coronary arteries
- Premature atherosclerotic coronary disease
- Incomplete expressions of cardiomyopathy and ion channel disease

Acquired conditions

- Commotio cordis
- Myocarditis
- Electrolyte disorders
Outline

• Magnitude of the problem in Athletes-Causes of SCA

• Pre-sport heart screening

• CPR

• Summary
• **Chain of Survival**

The chain of survival refers to five events that must occur quickly to optimize a person's chance of surviving a cardiac arrest. The five links of the chain:

1. Immediate recognition of cardiac arrest and activation of the emergency response system.
2. Early CPR with emphasis on chest compressions.
3. Rapid defibrillation to establish a normal heart rhythm to a person suffering a cardiac arrest. It is most effective when it is performed in the first few minutes of a cardiac arrest.
4. Effective advanced life support.
5. Integrated post-cardiac arrest care.
Unresponsive and not breathing normally

Call Emergency Services

Give 30 chest compressions

Give 2 rescue breaths

Continue CPR 30:2

As soon as AED arrives: switch it on and follow instructions
External defibrillators
Cardiac Arrest during Long-Distance Running Races

Survivor 29%

Death 71%

Kim et al NEJM 2012

CPR

Time taken for Emergency Arrival (mins)

VF

HCM

100%

3.3

88%

0%

40%

7.7

35%

66%

Causes of SCA among Non-survivors and Survivors

- Nonischemic ventricular tachycardia: 7%
- Unknown: 3%
- Hyperthermia: 3%
- Cardiomyopathy: 3%
- Hyponatremia: 7%
- No autopsy: 7%
- Presumed dysrhythmia: 7%
- PHCM+: 13%
- PHCM: 10%
- HCM: 10%
- HCM+: 16%
- Myocardial ischemia: 16%

Quick CPR saves runner, who finds his ‘angels’ using social media

By AMERICAN HEART ASSOCIATION NEWS

The crowd cheered as Bill Amirault neared the finish line of the Key West Half Marathon in Florida. Suddenly, he felt faint and had tunnel vision, so he slowed to walk. Then he collapsed.

Fellow runners and bystanders rushed to him. Luckily, the first three people [...]

Marathon offers CPR training to runners
posted on December 20, 2017 12:30

By Deborah Kotz GLOBE STAFF JANUARY 12, 2012

At least 1,000 runners and family members will be trained in CPR the weekend before this year’s Boston Marathon, after local researchers found that immediate use of the procedure could have saved many of the runners who have died from cardiac arrest during a marathon or half-marathon.

The Massachusetts General Hospital study, published yesterday in the New England Journal of Medicine, examined 59 runners whose hearts stopped during races over the past decade in the United States. Among 31 cases with complete clinical data, the researchers found that all eight who survived had received cardiopulmonary resuscitation from a bystander. In comparison, just 10 of the 23 who died received CPR.

“The number-one predictor of survival of cardiac arrest during a race was whether a runner had access to bystander CPR,” said study leader Dr. Aaron Baggish, associate director of the cardiovascular performance program at Mass. General. Teaching basic chest compressions to marathon participants and race observers - a form of CPR that doesn’t involve mouth-to-mouth resuscitation - might lead to fewer deaths in the future, he added.

Bob Pohl’s life was saved by a bystander who performed CPR last October after he collapsed in full cardiac arrest about 200 feet from the finish line of the Baltimore half-marathon. “I was very fortunate,” said the 55-year-old from Marriottsville, Md., a longtime runner who had no previous heart problems. “If I had the attack at home, I probably would have died.”

A Boston marathoner’s heart stopped a few years ago while he was passing through Kenmore Square, but he also survived after a bystander gave him CPR. Hoping that this year’s runners will be as lucky if they collapse, the Boston Athletic Association, which organizes the marathon, will offer free CPR training for participants and family members at the Boston Marathon Expo held the weekend before the April race.

While the marathon has 28 medical stations along the 26.2-mile course, roving volunteers every half-mile with portable defibrillators, and two medical tents at the finish line, runners trained in CPR can help “bridge the gap between racers and various trained medical professionals,” said Thomas Grill, executive director of the BAA.
FIRST AID MANUAL AND RELATED HEALTHCARE ISSUES FOR FOOTBALL
FOR USE BY FIRST AIDERS AND COACHES

A FLOW DIAGRAM TO FOLLOW FOR CPR ON THE FOOTBALL FIELD OF PLAY

1. Collapsed player – unresponsive
   - Shout for help
   - Open the airway – chin lift

2. Breathing or not breathing normally?
   - NO
     - Call for ambulance
     - CPR 30:2
     - Continue until signs of life or ambulance arrives
   - YES
     - Assess ABCDE
     - Call ambulance if appropriate
     - Handover to ambulance crew

Automated External Defibrillation

The automated external defibrillator (AED) allows a quick and easy way to administer an electrical shock to a patient with the minimum of fuss. Although most AEDs will vary in their shape and size, the general principles remain the same. Not all people who collapse in a cardiac arrest will have a shockable rhythm, so the AED will not shock everyone. However, the majority of initial arrhythmias are shockable which is why an AED is an essential part of your first aid equipment.

The aim of defibrillation is to stun the cardiac cells in order for the natural pacemaker of the heart to resume its natural role and allow effective cardiac contractions.

AEDs are easily stored and have a long battery life, however these should be checked on a regular basis e.g. prior to every match and training session. Please refer to the manufacturer’s guidelines for care of the defibrillator and its contents.

* If you do not wish to provide ventilations, compression-only CPR can be done until the ambulance arrives. Continuous compressions are applied in this instance.
Consensus Statement on Cardiovascular Care of College Student-Athletes

RECOGNITION AND RESPONSE TO CARDIAC ARREST, INCLUDING EMERGENCY ACTION PLANS.

1. Best practices strongly recommend a written emergency action plan (EAP) for the treatment of cardiac arrest. Online resources are available from the AHA (4). Essential aspects of the plan include:
   a. Ensuring the training of anticipated responders in cardiopulmonary resuscitation (CPR) and automated external defibrillator (AED) use. Such training should not be limited to athletic trainers and team physicians, but should rather be inclusive, including, but not limited to, strength and conditioning coaches, sport coaches, and administrative personnel with consideration in student-athletes, as resources allow.
   b. Establishing an effective emergency communication system. The communication system should be in place before the beginning of the academic year.
   c. Ensuring easy access to early defibrillation.
      • Easy access means that there should be AEDs in the immediate vicinity (within a 3-min walk) of all high-risk locations, including, but not limited to: the weight room/strength and conditioning room, basketball court(s), football/soccer/lacrosse/baseball/softball fields, track and field space, and indoor or other training facilities.
   d. Ensuring properly charged and functioning AEDs. There should be a checklist maintained for each AED that indicates the date when the AED was checked and by whom. This should be an assigned function, and the check should occur at least monthly for both the battery charge and the electrode pads. A “readiness” check by the athletic trainer or team physician before each practice or competition is encouraged. Manufacturer guidelines should be followed.
   e. Integrating on-site responder and AED programs with the local emergency medical services (EMS) system. Such integration should be developed before the beginning of the academic year, and should differentiate routine practice from competitions. For anticipated high-volume competitions (e.g., football/basketball games), the point of entry/exit for emergency medical responders/vehicles should be clearly established beforehand.
   f. Practicing and reviewing the emergency response plan at least annually.
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- Magnitude of the problem in Athletes-Causes of SCA
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Summary

- Sudden cardiac death in young athletes is rare.
- Exercise is a trigger for SCD in predisposed athletes.
- The diagnosis of cardiac pathology is challenging in some athletes.
- Pre-participation screening with ECG identifies athletes with cardiomyopathy.
- Early CPR and AEDs save lives in sport.