ECG Screening and Risk Stratification in Competitive Athletes

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If Hippocrates Saw Pheidippides

Pheidippides’ ECG?
**Magnitude of SCD in the US**

- **Stroke**: 167,366
- **Lung Cancer**: 157,400
- **Breast Cancer**: 40,600
- **AIDS**: 42,155

SCD claims more lives each year than these other diseases combined.

450,000

SCD is #1 Killer in the U.S.

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**Causes of SCD (Age>35)**

- **Uncommon causes**
  - Arrhythmias
  - Cardiomyopathy

- **Risk factors for common atrial fibrillation**
  - Older age
  - Hypertension
  - Diabetes

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**SCD due to CAD: Darryl Kile**

Huikuri et al. NEJM 2001 (adapted from Myerburg)
Causes of SCD (age<35)
• #1: Hypertrophic CM
  - 1 in 500
  - Scarred and disordered myocardium
  - Confirmed HCM in 26.4% of SCDs
  - Probable HCM in 7.5% additional cases of SCD
  - Diagnosis
    - PE
    - ECG
    - Echo

ECG in Hypertrophic CM

Causes of SCD (age<35)
• #2: Commotio Cordis
  - Blunt blow to the chest 15-30ms before T-wave peak (vulnerable phase of repolarization)
  - Mean age 13 years old
    - Compliant chest wall
  - 19.9% of SCDs
  - Structural normal heart
  - Normal ECG
Causes of SCD (age<35)

• #3: Congenital Coronary Artery Anomalies
  – Artery arises from wrong aortic sinus
  – Classic presentation: CP or syncope with exercise
  – 13.7% of SCDs
  – Diagnosis:
    ◦ Stress test
    ◦ Echo
    ◦ MRI
    ◦ CT
    ◦ Cath
  – Normal ECG
Athlete’s Heart

- **Triggers**
  - Endurance sports (rowing, cross country skiing, swimming)
  - Isometric sports (weightlifting, wrestling)

- **Cardiac changes**
  - Heart size and chamber enlargement
  - Increased LV wall thickness
  - Increased LA
  - Preservation of systolic and diastolic function

- Associated with abnormal ECG patterns
- Considered a benign adaptation to training

17 year old Swimmer

- Referred for Abnormal ECG
- Sees you for evaluation
  - No syncope
  - No symptoms of cardiac disease
  - No FH of SCD
  - Appears to be extremely physically fit
  - Rest of exam benign except for a soft systolic murmur
17 year old Swimmer

- **Echo**
  - Significant concentric LVH with maximal wall thickness of 14 mm (normal <12 mm)
  - Normal LV cavity of 48 mm
  - Normal systolic and diastolic function
  - Normal valves
- **MRI** normal except for wall thickening
- **ETT** normal
- **24 hour holter normal**
- **Now what?**


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**After 8 week of Deconditioning**

LVH regressed from 14 mm to 11 mm


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Detraining in 40 Elite Athletes


Automatic External Defibrillator (AED)

ICD Size

ICDs and Exercise

Physician recommendations regarding avoidance of activities

- All more vigorous than golf or bowling
- All vigorous sports
- Contact sports
- Competitive sports
- Sports with risk injury
- No restrictions

Percent of respondents

0 10 20 30 40 50 60 70 80 90 100

Lempert et al. JCE 2006

Pre-participation Screening in Italy

Corrado et al. JAMA 2006
AHA Recommendation

The American Heart Association (AHA) recommends for the prevention and detection of cardiovascular disease in young athletes.

- If age >35, add ETT if RF for CAD
- If age >65, add ETT

Conclusions
A large population-based screening initiative for athletes that translates a 12-lead ECG, such as that already proposed by the ESC and IOC, is probably impractical and would require considerable resources that do not currently exist, as well as substantial long-term federal government investments.

AHA Cost Analysis for U.S.

- 10M middle school and high school athletes
- Initial Screen
  - $25 for H&P
  - $50 for ECG
- Follow-up Screen
  - $100 for H&P
  - $400 for Echo
- Administrative Cost: 500M
- Total Cost: $2B
- $330,000 for every relevant disease diagnosed
Other Cost Effectiveness Analysis

Cost effectiveness of pre-participation screening for prevention of sudden cardiac death in young athletes

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Annals of Internal Medicine 2010

Cost and yield of adding electrocardiography to history and physical in screening Division I intercollegiate athletes: A 5-year experience

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HRS 2011

AHA Recommendation

If age >35, add ETT if RF for CAD
If age >65, add ETT

Maron et al. Circulation 2007

Conclusions

A large population-proportionate screening initiative for US athletes that mirrors a 13-nodal 12-lead ECG, such as that proposed by the AHA and ACC, is probably impractical and would require considerable resources that do not currently exist, as well as substantial long-term federal government subsidies. Although such a complex initiative would have benefits in terms of detecting larger numbers of athletes with important heart diseases, it is unlikely that the current formulation of such a national program could serve because of the numerous (unaddressed) barriers. Paradoxically, such screening could also be potentially harmful to many athletes by virtue of false-positive test results that could lead to unnecessary further evaluations and testing, anxiety, and possibly to myocardial infarctions. Although the 12-lead ECG remains the gold standard, it is not currently feasible to implement such a screening program into the US medical system and environment. On the other hand, the recent move of some experts to consider the use of 12-lead ECG as part of a comprehensive testing plan, formalized relatively on a case-by-case basis, is local communication if it is designed and properly implemented.
Pre-participation Screening at UCSF

- 80 total volunteers
  - Half were RNs and MDs
- 40 volunteers for cardiac screening
  - 7 ECG machines
    - 10 ECGs per hour per machine
  - 2 Echo machines
    - 1.5 Echo’s per hour per machine

ECG Screening at UCSF

- By the Numbers
  - 2009: 155 athletes
  - 2010: 349 athletes
  - 2011: 327 athletes
  - 2012: 540 athletes
- 1371 total screened
- 1216 unique athletes
- 52 (4.28%) with abnormal ECG leading to Echo
- 8 (0.7%) not approved for sports and need further work-up by their own MDs
Findings

- 8 non-approved athletes
  - 2 WPW
  - 2 Long QT
  - 1 RVE with ASD
  - 1 LVH with syncope
  - 1 Bicuspid AV and PFO
  - 1 Orthopedic injury

Conclusions

- Most SCDs occur in otherwise healthy individuals
- Main cause of SCD
  - Over 35: CAD
  - Under 35: HCM, Commmotio Cordis, Coronary Anomalies
- ICDs can be life-saving but will limit physical activity
- Young athletes screening:
  - H&P
  - ECG?
- Master athletes (age >35) screening:
  - H&P
  - ETT (if RFs for CAD or age>65)
- Community based programs can find new disease and save lives

Resuscitation Success vs. Time*

- Chance of success reduced 7 - 10% each minute
