Disclosures

“I have no relevant financial relationships with the manufacturer(s) of any commercial product(s) and/or provider(s) of commercial services discussed in this CME activity.”
Additional Disclosures

I am the mother of two teenage athletes

Neither have had a baseline ECG or echocardiogram

They both have had a baseline lipid panel!
Task Force 2: Preparticipation Screening for Cardiovascular Disease in Competitive Athletes

“Mandatory and universal mass screening with 12-lead ECGs in large general populations of young healthy people 12 to 25 years of age (including on a national basis in the United States) to identify genetic/congenital and other cardiovascular abnormalities is not recommended for athletes and nonathletes alike (Class III, no evidence of benefit; Level of Evidence C)”.
Pre-participating ECG Screening

- Remains a controversial topic
- The incidence of sudden death of young athletes due to genetic or congenital heart diseases is low in the general population
- Sudden death from these diseases are more common in the general population than just those competing in competitive sports.
Distribution of cardiovascular causes of sudden death in 1435 young competitive athletes.

Incidence and Causes of Sudden Death in U.S. College Athletes

Barry J. Maron et al. JACC 2014;63:1636-1643
Some of the arguments against…. 

- The risk of sudden death in the athlete is low
- No evidence athletes are at a higher risk than general population
  - Heighted awareness because of the media
- Why not ALL children….
- Routine screening leads to more false positive and false negative diagnoses
- Suicide, drug overdoses pose a much greater risk to students than SCD
More arguments against…. 

- Some cardiac conditions present no abnormalities on 12-lead ECG 
  - i.e. coronary anomalies, bicuspid aortic valve, dilated ascending aorta, hyperlipidemia

- Cardiac arrest due to non-penetrating chest injury (commotio cordis) cannot be prevented by screening
Another Controversial Issue

- Not all kids playing sports need clearance
  - Town Youth leagues
  - Tournament teams
- Aren’t these children at risk?
- Is the 16 year old on the tournament less at risk than the 16 year old on the varsity high school team?
- AEDs availability?
Italian Sport Law

- **Certificato Sportivo Agonistico** (competitive sport certificate).
- All athletes interested in participating in a competitive sport must provide a medical certificate that validates their level of physical fitness SPECIFIC TO the desired sport.
- A certificato sportivo agonistico can only be issued by a sports medicine doctor.
- Most certificates have a validity of one year.
- The athlete will have their blood pressure checked, undergo a stress test with ECG and submit a urine sample.
From: Cardiovascular pre-participation screening of young competitive athletes for prevention of sudden death: proposal for a common European protocol. Consensus Statement of the Study Group of Sport Cardiology of the Working Group of Cardiac Rehabilitation and Exercise Physiology and the Working Group of Myocardial and Pericardial Diseases of the European Society of Cardiology
Italian Sport Law

- March 24, 2012. Italian volleyball Olympian Vigor Bovolenta died after suffering a heart attack during a professional match. He was 37.

- April 14, 2012, Piermario Morosini, a 25-year-old midfielder, collapsed while playing soccer for Livorno. The team was playing against Pescara. Though he was rushed to the hospital, nothing could be done and he died shortly after. He had suffered from a heart attack
Other Professional Athletes with Sudden Cardiac Death

- 26-year-old Norwegian swimmer Alexander Dale-Owen – heart attack (Familial hypercholesterolemia)

- 32-year-old Claire Squires collapsed in sudden cardiac arrest during the London Marathon

- Soccer star Fabrice Muamba, who arrested but miraculously survived

- 24-year-old Serbian rower Nemanja Nesic. Nesic had regular medical checkups - the most recent five weeks before his death. There was no indication that anything was wrong with his health.
The 14-Element AHA Recommendations for Pre-Participation Cardiovascular Screening of Competitive Athletes
Personal History

- Chest pain or discomfort *related to exertion*
- *Unexplained* syncope or near syncope
- Excessive or unexplained dyspnea/ fatigue/ or palpitations *associated with exercise*
- Heart Murmur *
- Elevated Blood Pressure
- Prior Restriction from sports participation
- Prior cardiac testing
Family History

- Premature Death
  - Sudden and unexpected
  - Under age of 50 years in first degree relative
- Disability from heart disease in a close relative under age 50 years
- Cardiac Genetic Disorders
  - Hypertrophic or dilated cardiomyopathy
  - Long QT syndrome or other channelopathies
  - Marfan Syndrome
  - Clinically significant arrhythmias
  - Familial Hyperlipidemia
Physical Exam

- Heart Murmur
- Femoral Pulses
- Physical Stigmata of Marfan’s
- Brachial artery blood Pressure (Sitting)
- Lower extremity blood pressures*
  - New Blood Pressure Guidelines
  - Pediatrics 2017
Determination of proper BP cuff size.

Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents

Joseph T. Flynn et al.
PEDIATRICS Volume 140, number 3, Sept 2017
Athletes and Hypertension

- The AAP policy statement “Athletic Participation by Children and Adolescents Who Have Systemic Hypertension”

- Children with stage 2 HTN should be restricted from high-static sports (classes IIIA to IIIC) until their BP is in the normal range.

- Recommended that athletes be promptly referred and evaluated by a qualified pediatric medical subspecialist within 1 week if they are asymptomatic or immediately if they are symptomatic. *Pediatrics* 2010;125(6)
Case 1

- 15 year old presents for evaluation of hypertension
- Otherwise healthy, no complaints.
- Left hand pitcher – parents anticipate he will get a college scholarship and be a major league pitcher one day.
EXAM

- BP 140/95
- Could not get lower extremity BP
- Alert, well developed, well nourished.
- Cardiac exam:
  - RRR. 1-2/6 systolic murmur LUSB. Did not radiate to back. No clicks or gallops.
- Pedal pulses difficult to appreciated.
- Femoral pulses felt but not strong.
Testing

- ECG: Sinus arrhythmia. No LVH noted.
- ECHO:
  - Coarctation suspected from the abdominal Doppler
  - Unable to image the descending aorta from the suprasternal notch well
    BUT Small transverse arch. Small aortic isthmus
- Cardiac MRI - unsuccessful
- Exercising Test
  - Patient's resting right blood pressure was 168/95 with a large adult cuff.
    His left arm BP was 167/80 with a large adult BP cuff.
  - Unable to measure a blood pressure in his right or left leg at rest or at
    peak exercise.
  - Peak blood pressure was 256/90 in the right arm.
  - Blood pressure returned to 172/82 in recovery.
- Parents declined cardiac catherization offered the day after exercise testing

- Family decided to wait until after the summer tournament/ college recruiting season despite potential risks which included a intracranial aneurysm with rupture or stroke.
Cardiac Cath (4 months later…) 

- Severe discrete aortic coarctation.
- Large mediastinal and intercostal aortic collaterals
- Stenosis diameter 3.0 mm
  - transverse arch 16.5 mm
  - distal arch 12.4 mm
  - adjacent desc.AO 13 mm
  - desc.AO 17 mm)
4 months later – Second case!

- 17 year old presents to ER from PCP office with hypertension
- BP – 170/110
ECG changes in Athletes

- ECG changes in athletes are common

- Usually reflect the electrical and structural remodeling or autonomic nervous system adaptations that occur as a consequence of regular and sustained physical activity (ie, athlete's heart).
Common ECG Changes in Athlete’s

- Sinus bradycardia
- Sinus Arrhythmia
- Junctional escape beats
- Early repolarization
- Increased QRS forces (LVH)
- 1st degree AV block
- 2nd degree AV block type 1
- Negative T waves (precordium)
- Incomplete RBBB

More common
- Male athletes
- African/ Caribbean descent
- High endurance sports
  - (cycling, rowing, long distance running)

PELLICIA A, et al., 2002; Corrado D, et al 2010
Sinus bradycardia

- Defined as HR <60 beats/min
- Can be seen in up to 80% of highly trained athletes.
- Heart rates ≥30 beats/min is considered normal in highly trained athletes.
- Sinus arrhythmia is also common, particularly in younger athletes.
Other ECG Findings

- Early repolarization is also commonly seen in up to 45% of Caucasian athletes and 63–91% of black athletes.
- Black athletes also commonly T wave preceded by ST segment elevation in leads V1–V4.
- A junctional (nodal) rhythm or wandering atrial pacemaker may be observed in up to 8% of all athletes on a resting ECG.
- First-degree AV block and Mobitz type I second-degree AV block (Wenkenback) can also seen in athletes and a result of increased vagal tone.
Incomplete RBBB

- Normal finding in healthy teens and athletes
- Complete RBBB can be seen in up to 3% of athletes.
- Clinically significance unknown, may be due to remodeling
T wave inversion in Lateral leads

- Reported in up to 6% of healthy black athletes and 2% of white
- Also seen in up to 80% black patients with HCM.
- ST depression however only seen in 0.4% of black athletes.
- Significance in isolation remains unknown
- Reasonable to rule out pathology
Uncommon ECG Changes in Athlete’s

- Deep Q waves (II, III, aVF, V₆)
- ST segment depression
- Long or Short QT interval
- LAE/RAE
- Abnormal R progression
- Left or Right Bundle Branch Block
- Right Ventricular hypertrophy

PELLICIA A, et al., 2002
Corrado D, et al 2010
ST depression

- Rare finding in athletes (0.7%) and should be evaluated.
- Common in cardiomyopathies, especially HCM - Seen in up to 50%
- ST depression on resting ECG of HCM patient predicts exercise induced subendocardial ischemia.
- In lateral leads – I, AVL, it could mean increased risk of sudden death
Hypertrophic Cardiomyopathy

- Reported to be the most common cause of sudden death in athletes in the US.
- Hyperdynamic precordium
- Murmur varies with maneuvers
  - Softer with Hand-grip/ Louder with release
  - Standing increases murmur /Squatting decreases murmur
- History of syncope or chest pain WITH exertion
- Family history of sudden death in a young relative
Anomalous origin of a coronary artery

- Second leading cause of sudden cardiac death in young athletes in the United States.
- Single coronary artery is a rare variant with a reported incidence of 0.024-0.05%.
- More common in females
Anomalous Coronary Artery

- Both false-positive and false-negative results limit the value of stress testing.
- Normal exercise testing prior to sudden cardiac death has been well documented. *The absence of ischemia during stress testing cannot be viewed as reassuring.*
- The risk of sudden cardiac death appears highest in young individuals, particularly during or following a period of strenuous exertion, and particularly in those with interarterial ALCA.
Commotio Cordis

- Accounts for 3% of athletic deaths
- Mean age is 14 years

- Most common causes;
  - Hockey pucks
  - Baseballs
  - Karate strike to chest
- Incidence unknown; “may be a more common cause of sudden death than many of the cardiovascular diseases known to cause these catastrophes”
- 93% have shockable rhythm
- Only 16% survival without prompt defibrillation

NEJM 349;11 September 2003
Commotio Cordis

Commotio Cordis - Barry J. Maron, N.A. Mark Estes, III
AEDs

May 17, 2011 10:09 AM CBS news
Early AED use saves young athletes' lives

Idaho Teen Athlete Saved by CPR and AED
... the football player collapsed while running wind sprints

On February 2, 2010, collapsed three-fourths of the way through his high school basketball game – no family history. Saved by AED

Survival rates decrease approximately 10% for each minute defibrillation is delayed
Use of AED in Sudden Cardiac Events

- 2149 high schools participated in a prospective observational study between August 2009 through July 2011.
- Cases of SCA were reviewed to confirm the details of the resuscitation. The primary outcome was survival to hospital discharge.
- **RESULTS:**
  - School-based AED programs were present in 87% of participating schools and in all but one of the schools reporting a case of SCA.
  - Fifty nine cases of SCA were confirmed during the study period
    - 26 (44%) cases in students and 33 (56%) in adults;
    - 39 (66%) cases occurred at an athletic facility during training or competition;
    - 55 (93%) cases were witnessed
    - 54 (92%) received prompt cardiopulmonary resuscitation.
    - A defibrillator was applied in 50 (85%) cases and a shock delivered onsite in 39 (66%).
  - Overall, 42 of 59 (71%) SCA victims survived to hospital discharge
    - 22 of 26 (85%) students and 20 of 33 (61%) adults.
    - Of 18 student-athletes 16 (89%) and 8 of 9 (89%) adults who arrested during physical activity survived to hospital discharge.

Conclusion

- A detailed family history, past medical history and physical exam remains the best tool
- ECG, if done, should be read by a physician with knowledge of the typical changes seen in healthy teens and in athletes
- Secondary prevention is key!
  - AED should be available at every venue
- CPR training – parents, coaches, athletes
References

- Assessment of the 12 lead ECG as a screening test for the detection of CV disease in Healthy General Populations of Young People (12-25 years of age). *JACC Vol 64 Issue 14 October 2014*

- Cardiovascular Preparticipation Screening of Competitive Athletes. A Statement for Health Professionals From the Sudden Death Committee (Clinical Cardiology) and Congenital Cardiac Defects Committee (Cardiovascular Disease in the Young), American Heart Association. *Circulation*. 1996;94:850-856


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