Cardiac Evaluation of the Adolescent
W. Reid Thompson, M.D.

The Helen B. Taussig Children's Heart Center
Johns Hopkins University School of Medicine

Goals for talk

- By the end of the session you should know:
  - Indications for ordering ECGs and ECHOs
  - Common abnormal ECG findings in pediatrics
  - Preparticipation cardiac evaluation in the athlete
  - Update for office cardiology:
    - Cardiac considerations for use of psychotropic medications
    - SBE prophylaxis update

Indications for ordering an ECG

- Evaluation of syncope, near syncope, palpitations
  - Look for long QT, WPW, frequent PVCs or PACs
  - If occurs with exercise, consider referral to cardiologist
- Chest pain
  - R/s-T abnormalities, LVH
  - If occurs with exercise, consider referral to cardiologist
- Prior to beginning and during titration of certain medications
- For selected patients as part of pre sports participation evaluation

What the pediatrician should look for on an ECG

- Is the patient in sinus rhythm (P wave axis 0-90°) with normal heart rate for age?
- Are there frequent extrasystolic beats?
- Is there a delta wave?
- Is the QRS axis normal for age?
- Is there normal voltages or obvious RVH (more specific) or LVH (less specific)?
- Is the QTc interval normal for age?
- Is there evidence of ischemia?

Normal ECG

- P-wave
- PR-interval
- QRS-complex
- ST-segment
- T-wave
- J-point
14 year old adolescent with no cardiac symptoms

13 yo with palpitations

Wolff-Parkinson-White syndrome (WPW)

- Delta wave (upsloping wave from the P wave to the QRS, with resulting short P-R interval)
  - Check in all leads
  - May be intermittent
  - Results in abnormal repolarization (abn S-T)
- Predisposes to SVT and sudden death
- Radiofrequency ablation may be indicated

Indications for ordering an echocardiogram based on an abnormal cardiac examination

When should you order an echo?

- Pathologic murmur or other abnormal heart sounds (clicks, abnormal S2, rubs or gallops)
  - If not sure whether pathologic or innocent, probably more cost-effective to refer to cardiologist before echo
- Evaluation of possible connective tissue syndrome (eg, Marfan's, Loeys-Dietz, Ehlers-Danlos) or neuromuscular disease (eg, Duchenne)
- Suspected Kawasaki disease
- Other systemic diseases affecting the heart (eg, SLE, renal hypertension, chemotherapy, pulmonary hypertension, SS)
- Preop evaluation before scoliosis surgery
- Evaluation of embolic stroke

Heart murmurs and echocardiography

ACC/AHA 2006 Guidelines for the Management of Patients With Valvular Heart Disease
Preparticipation cardiac evaluation in the athlete

Sudden death in 158 young athletes

Cardiac causes of sudden death

Sudden Death in 387 Young Athletes (2003)

Results of pre participation evaluations in young athletes that had sudden death
**Previous cardiac symptoms**

- Present in 18%
- Syncope (in 9%), chest pain, SOB
  - AOLCA, other coronary anomalies
  - Myocarditis
  - HCM
- Of athletes with AOLCA and HCM, 31% and 21%, respectively, had had preceding signs or symptoms of disease

**Most common activities engaged in at collapse**

- Basketball and football accounted for 68%
- 90% collapsed either during training or during competition
- 10% died while relatively sedentary (including 4/6 with aortic dissection)

**Difficulties with pre participation screening**

- Large numbers of participants
  - ~ 4 million high school aged athletes
  - ~0.5 million collegiate athletes (300,000 NCAA)
  - ~ 5000 professional athletes
- Low prevalence of athletic field deaths
  - ~ 1 : 100,000-300,000 high school aged males
  - ~ 1.5 : 100,000 collegiate males
- Low cost-efficiency of detection
  - HCM occurs ~ 1 : 500 (at ~ $500/echo, would cost $250,000 per new case identified)

**AHA 1996 Recommendation**

- Pre participation evaluation should include complete history and physical before high school and college
- Continued participation in subsequent years should include yearly interim history and BP check with complete physical every 2 years (for high school participants*)
- Routine screening EKGs, echos, or stress tests not currently justifiable.

*For collegiate athletes, the American Heart Association recommends that a comprehensive personal and family history be obtained and that a physical examination be performed by a qualified examiner in the first year upon entering the institution and before beginning training and competition. In each of the subsequent 1 to 4 years, an interim history and a blood pressure measurement should be obtained. Important changes in medical status or abnormalities detected during interim annual histories may warrant evidence that another upper extremity examination and possible further testing should be performed. Circulation. 1996;97:2294

**Pre participation evaluation: symptoms?**

- Prior occurrence of exertional chest pain/discomfort or syncope/near-syncope?
  - Requires cardiology evaluation to exclude life-threatening conditions
- Excessive, unexpected, and unexplained shortness of breath or fatigue associated with exercise?
  - May be only symptom in myocarditis or cardiomyopathy
- Past detection of a heart murmur or increased systemic blood pressure?
- Should question patient and parents (separately)

**Pre participation evaluation: family history?**

- Family history of premature death (sudden or otherwise)?
- Significant disability from cardiovascular disease in close relative(s) younger than 50 years old?
- Specific knowledge of the occurrence of certain conditions:
  - hypertrophic cardiomyopathy?
  - dilated cardiomyopathy?
  - arrhythmogenic right ventricular dysplasia?
  - aortic dissection?
  - long QT syndrome?
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Pre participation evaluation: murmur?

- Muffled heart sounds and/or S3-S4 gallop
  - Consider myocarditis or cardiomyopathy
- Harsh systolic ejection murmur (like “clearing of the throat”)?
  - Consider aortic stenosis (esp with early systolic click at apex)
- Listen at apex and left mid sternal border in standing and squatting positions:
  - Systolic ejection murmur that intensifies with standing?
    - Consider hypertrophic cardiomyopathy (especially if family h/o sudden death)
  - Systolic regurgitant murmur or mid systolic click that moves later in systole with squatting?
    - Consider mitral valve prolapse

Pre participation evaluation: Marfan’s?

- Major skeletal findings include:
  - Pectus (carinatum or severe excavatum)
  - Reduced upper to lower segment ratio, or arm span to height ration >1.05
  - Scoliosis of >20°
  - Wrist and thumb signs
    - thumb overlaps the distal phalanx of the 5th digit when grasping the contralateral wrist
    - entire thumbnail projects beyond the ulnar border when hand is clenched
  - Pes planus
- Major ocular: ectopia lentis

Hypertrophic cardiomyopathy (HCM)

- Prevalence ~1 in 500
- Familial recurrence (autosomal dominant)
- Heterogeneous natural history
  - some patients remain asymptomatic
  - some have severe heart failure
  - some have sudden death in absence of symptoms
- Phenotype rarely develops before puberty
- Annual mortality ~3 - 4% overall; ~6% in children

HCM: pathology

- Asymmetric septal hypertrophy
  - With (~25%) or without (~75%) left ventricular outflow tract obstruction
  - mutations in some proteins associated with minimal hypertrophy
- Myofibrillar disarray and interstitial fibrosis
- Diastolic dysfunction with preserved systolic function (until end-stage)

HCM: echocardiogram
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HCM

Inverted T waves

HCM: diagnosis: echocardiography

- LV wall thickness >15 mm in adults (with equivalent relative to BSA in children)
- HCM should be considered in any trained adolescent male athlete with LVWT >12 mm (female >11 mm) and a non dilated LV*
- Tissue Doppler imaging
  - Detects changes in diastolic relaxation
  - Changes may be present even in the absence of significant hypertrophy
  - May be useful for preclinical diagnosis of HCM

* Sharma, et al JACC, 2002

HCM: risk factors for sudden death

- Family history of sudden death
- Age 14-18 years old
- Recurrent syncope
- Non sustained ventricular tachycardia (on Holter), or sustained VT on EP testing
- Abnormal BP response to exercise

Coronary anomalies

- Prevalence ~1 in 1000
- 13/134 left main coronary arising from the right sinus, coursing between the aorta and the pulmonary artery; 2/134 with RCA from left sinus; 1/134 LAD from PA.
- Slit-like or acute-angled takeoff of left main (arising from normal location)
- 3/134 with premature atherosclerotic coronary artery disease
- 6/134 with “tunneled” LAD (myocardial bridging)

14 year old boy, with sudden collapse while playing basketball

14 year old boy, with sudden collapse while playing basketball
12 yo with syncope while running at softball practice

Long Q-T syndrome

- Familial
  - Autosomal dominant (most common)
  - Autosomal recessive (Jervell-Lange-Nielsen)
  - Deafness
- Syncope, sudden death, stress often triggers event
- 15-25% may have normal QTc

Previous well child with sudden onset of lethargy and SOB

Long Q-T syndrome

- Bazett correction:
  - $Q_T = \sqrt{R-R}$
  - Average of 3 beats, including the longest
- QTc (98%tile)*
  - 0-9y: M 452, F 461
  - 10-19y: M 448, F 457
  - 20-29y: M 436, F 454
- Thus, normal QTc for patients <20 yo:
  - Male <440-450
  - Female <450-460

*J Electrocardiol 2007 Jul;40(3):228-34
Various forms of ST-segment depression

Horizontal ST-segment depression

Downsloping ST-segment depression

Upsloping ST-segment depression

Differential diagnosis of S-T elevation

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<tr>
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<th>Myocardial ischemia or infarction</th>
<th>Pericarditis</th>
<th>“Early repolarization”</th>
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<td>Q wave</td>
<td>May be present</td>
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<td>ST elevation</td>
<td>Concave and localized to area of related artery</td>
<td>Concave and widespread</td>
<td>Concave and localized (Most prominent in leads V2-4)</td>
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<td>Reciprocal ST depression</td>
<td>Inverted when ST segments are still elevated</td>
<td>Inverted after ST segments have normalized</td>
<td>Normal or prominent</td>
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<td>T wave</td>
<td>Common</td>
<td>Absent</td>
<td>Absent</td>
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<tr>
<td>AV block, ventricular arrhythmias</td>
<td>Common</td>
<td>Absent</td>
<td>Absent</td>
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ECG in a 15 year old boy with early repolarization

ECG in a 15 year old girl with pericarditis

Cardiac considerations for use of psychotropic medications
Cardiac effects of psychotropic medications

Before starting therapy:
- Careful history: palpitations, syncope, near syncope, other medication use, family history of sudden death?
- Baseline ECG if starting tricyclics (to check QT interval)

At follow-up visit:
- Ask same questions looking for new symptoms
- Check heart rate and BP
- When at steady state of TCA, recheck ECG: if HR > 130, PR > 200, QRS > 120, or QTc > 460, or if has developed symptoms, consider pediatric cardiology consultation and/or alternative therapy.

Avoid concomitant use of psychotropic drugs and other drugs that are metabolized by or inhibit the p450 system (see http://www.arizonacert.org/)

If patient has known heart disease: avoid use of amphetamines (eg., Adderal, Dexadrine); use with caution: methylphenidates (Concerta, Focalin, Ritalin), atomoxetine (Strattera)

Cardiac evaluation of children and adolescents receiving or being considered for stimulant medications

SBE Prophylaxis update

New recommendations for SBE prophylaxis