Objectives

- Acquired Heart Disease
- Congenital Heart Disease
- What should you be on the lookout for as a practitioner?
- What needs a referral?
Acquired Heart Disease

- Myocarditis
- Cardiomyopathies
- Endocarditis
- Kawasaki
- Rheumatic Fever
- Arrhythmias
- Hypertension
- Hyperlipidemia

Congenital Heart Disease – Defining Characteristics

- Cyanotic versus Acyanotic
- Single Ventricle verses Two Ventricle
- Shunt Dependent?
- Repaired versus Palliated
- Propensity to develop congestive heart failure
- Need for future surgeries?
What to watch for/who needs a referral?

- Post-op considerations (incisions, PPS)
- Monitoring of CHF management
- SBE prophylaxis
- Activity restrictions
- Co-management of HTN/lifestyle changes
- Murmurs and arrhythmias – who needs a cardiologist?

Sudden Death

- Traumatic
  - MVA, violent deaths, recreational/occupational injury
- Nontraumatic
  - Noncardiac
    - Asthma, hyperthermia, malignancy, infection
  - Cardiac
Sudden Cardiac Death

- **Structural**
  - Coronary abnormalities: Anomalous, Kawasaki
  - Aortic root dilation: Marfan, CTD
  - Left-sided obstruction: Aortic valve stenosis, coarctation, elevated LV mass/HTN
  - MVP

- **Functional**
  - Cardiomyopathy: HCM, ARVD/RVCM, DCM, RCM
  - Myocarditis: Acute, chronic

Sudden Cardiac Death

- **Primary electrical/Heritable arrhythmias**
  - Channelopathies: LQTS, Brugada
  - WPW
  - Idiopathic VT/VF
  - Catecholamine VT
  - AV block

- **Acquired**
  - Commotio cordis, drug use, PHTN, CAD

- **Repaired/Unrepaired congenital heart disease**
  - PHTN, CHF, arrhythmia
Sudden Cardiac Death: Athletes

Cardiomyopathy

- Hypertrophic (42%, 50% hereditary)
  - Primary
  - Secondary
- Dilated (51%, 20% familial)
  - Idiopathic
  - Secondary
- Restrictive (3%)
- Arrhythmogenic right ventricular
Dilated Cardiomyopathy: Etiologies

- **Infectious**
  - Myocarditis, Kawasaki’s

- **Metabolic**
  - Carnatine deficiency, selenium deficiency, Barth’s syndrome, hypoglycemia, hypothyroid, myopathy

- **Structural**
  - LV outflow obstruction, coarctation, anom coronary, LV noncompaction

- **Arrhythmogenic**
  - SVT, VT, congenital complete AV block

- **Hereditary**
  - Familial DCM, ARVC

- **Toxicity**
  - Chemotherapy, Ipecac

**Sudden Cardiac Death**

- Mechanism believed to be arrhythmic (VF) in most cases
- Other causes: bradycardia, rupture, embolism, circulatory failure, ischemic
- 75% at rest or mild physical activity
- 10-15% during sleep
- 10-15% with physical exertion
Sudden Cardiac Death

- 0.8 to 6.2 cases/100,000 per year (vs 1/1000 adults)
- 500 SCD/year (5-24 yo 15-1100 SCD/yr)
- ~20 high school athlete
- 50% antecedent symptoms (chest pain, palpitations, syncope)
- ~80% have underlying cardiac cause at autopsy
- 70% male

Sudden Cardiac Death

- 500 SCD/year (5-25 yo)
  - ~20 high school athlete/year
  - 1,500 drowning deaths/year
  - 15,000 MVA deaths/year
  - 500 firearm deaths/year
- 10-15% with physical exertion
- 50% antecedent symptoms
- ~80% have underlying cardiac cause
- Preparticipation assessment
**Sudden Cardiac Death: Athlete**

- 4 million high school sports participants yearly
- Nearly 25 million “recreational” participants
- High school participants: Risk of sudden death 1:200,000 (M>F, older > younger)
- 15% noncardiac cause: asthma, hypothermia, trauma

**Pre-participation Sports Physicals**

- Purpose of the preparticipation examination and the cardiac screening assessment
- The athlete and sudden death
- Cardiovascular screening assessment (AHA Guidelines)
  - History
  - Physical
  - Referral
- Effectiveness and limitations of cardiac screening
- Activity restrictions (26th Bethesda Conference)
The Preparticipation Examination

- To provide medical clearance for participation in competitive sports and reduce the risks associated with organized sports through routine screening
- Provide an appropriate and timely referral for more detailed evaluation as needed
- Competitive athlete: organized team or individual sport requiring systematic training and regular competition while placing a high premium on performance and achievement

Cardiovascular Preparticipation Examination

(AHA Recommendations)

- Establish national standard for medical screening
  - Standards currently set at State or Local level
  - Some states with no requirement for preparticipation assessment or no standard assessment
- Mandatory cardiovascular preparticipation screening
  - History, physical, advanced assessment
- Careful and complete personal and family history focusing on cardiovascular lesions known to cause sudden death in athletes
- Examination performed by healthcare worker with proper medical skills and background (calm, quiet location)
- Physical assessment every 2 years, medical histories updated yearly
The Cardiovascular History
(AHA Recommendations)

- Family history (performed with parent)
  - premature death
  - heart disease in those < 50 yo
  - specific cardiovascular diseases such as Marfan Syndrome, LQTS, ARVD, hypertrophic cardiomyopathy, dilated cardiomyopathy

- Personal history
  - heart murmur or congenital heart disease
  - systemic hypertension
  - excessive fatigability
  - syncope, dizziness, or lightheadedness (HCM, arrhythmias, MVP, aortic stenosis)
  - shortness of breath, chest pain, palpitations (especially with exertion)

The Cardiovascular Physical Exam
(AHA Recommendations)

- Assess brachial artery blood pressure in sitting position
  - Primary hypertension
  - Coarctation of the aorta

- Recognize the physical stigmata of Marfan syndrome
  - Long, thin fingers (Arachnodactyly)
  - Upward displacement of the lens (ectopia lentis)
  - Decreased lower body:upper body ratio

- Assess femoral pulses
  - Coarctation of the aorta
The Cardiovascular Physical Exam
(AHA Recommendations)

- Perform precordial auscultation in supine and standing positions (primarily identifies LV outflow obstruction)
  - Further evaluation for murmurs 3/6 or greater in intensity, diastolic timing, increase with valsalva, clicks, concerns
  - HCM: Murmur decreases supine or with squatting, increases with standing or valsalva
  - Assess for regularity of rhythm
<table>
<thead>
<tr>
<th>Collision contact sports</th>
<th>Limited contact sports</th>
<th>Non-contact sports</th>
</tr>
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<tbody>
<tr>
<td>Basketball</td>
<td>Baseball</td>
<td>Badminton</td>
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<tr>
<td>Diving</td>
<td>Cheerleading</td>
<td>Dance Team</td>
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<tr>
<td>Football</td>
<td>Field Events</td>
<td>Field discus</td>
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<tr>
<td>Ice Hockey</td>
<td>high jump</td>
<td>shot put</td>
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<tr>
<td>Soccer</td>
<td>pole vault</td>
<td>Golf</td>
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<td>Wrestling</td>
<td>Floor Hockey</td>
<td>Running</td>
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<td></td>
<td>Gymnastics</td>
<td>Swimming</td>
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<td></td>
<td>Nordic Ski Racing</td>
<td>Tennis</td>
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<td></td>
<td>Alpine Skiing</td>
<td>Track</td>
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<td>Softball</td>
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<td>Swimming</td>
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<td>Tennis</td>
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<td></td>
<td>Volleyball</td>
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<table>
<thead>
<tr>
<th>Sport classification based on intensity and stimulus</th>
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<tbody>
<tr>
<td>High intensity</td>
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<tr>
<td>Cross Country Running</td>
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<tr>
<td>Nordic Ski Racing</td>
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<tr>
<td>Alpine Skiing</td>
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<td>Football</td>
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<td>Wrestling</td>
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<td>Low intensity</td>
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<td>Low dynamic</td>
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<td>High to moderate dynamic</td>
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<tr>
<td>Low intensity</td>
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<tr>
<td>Low static</td>
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<table>
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<tr>
<th>Low dynamic</th>
<th>Moderate dynamic</th>
<th>High dynamic</th>
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<tr>
<td>Billiards</td>
<td>Baseball</td>
<td>Racquetball</td>
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<tr>
<td>Bowls</td>
<td>Softball</td>
<td>Cross-country skiing (classic technique)</td>
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<tr>
<td>Cricket</td>
<td>Table tennis</td>
<td>Field hockey*</td>
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<tr>
<td>Curling</td>
<td>Tennis (doubles)</td>
<td>Cross-country skiing (slalom technique)</td>
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<tr>
<td>Golf</td>
<td>Volleyball</td>
<td>Football (Australian rules) *</td>
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<tr>
<td>Squash</td>
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<td>Lacrosse</td>
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<td>Tennis (singles)</td>
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<td>Running (middle distance)</td>
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<td>Archery</td>
<td>Fencing</td>
<td>Swimming</td>
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<tr>
<td>Auto racing *</td>
<td>Field events (jumping)</td>
<td>Team handball</td>
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<tr>
<td>Diving *</td>
<td>Figure skating *</td>
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<tr>
<td>Biathlon</td>
<td>Football (American) *</td>
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<tr>
<td>Motorcycling *</td>
<td>Rugby *</td>
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<td>Running (sprint)</td>
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<td></td>
<td>Synchronized swimming *</td>
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<tr>
<td>High static</td>
<td>Body building *</td>
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<tr>
<td>Field events (classic)</td>
<td>Downhill skiing *</td>
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<tr>
<td>Gymnastics *</td>
<td>Rowing *</td>
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<tr>
<td>Karate / judo *</td>
<td>Cycling *</td>
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<tr>
<td>Long *</td>
<td>Decathlon</td>
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<tr>
<td>Sailing</td>
<td>Bowing</td>
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<tr>
<td>Rock climbing *</td>
<td>Speed skating</td>
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<tr>
<td>Water-skiing *</td>
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<tr>
<td>Weight lifting *</td>
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<tr>
<td>windsurfing *</td>
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Sudden Cardiac Death

- Cardiac arrest is reversible in most cases if treated within a few minutes
- Survival is reduced by 7-10% each minute delay without defibrillation
- 340,000 Americans die yearly from a sudden cardiac event without ever reaching the hospital
- 500-1000 students/year suffer sudden cardiac arrest: 15-30 in North Carolina

The Case for AEDs in Schools

- Community gathering place (NY State law)
- Employer of high risk adults
- Children often resist notifying parents of risk symptoms (chest pain, syncope)
- Site of athletic events
- Student deaths emotional, tragic
Public Access Defibrillation

- AHA first challenges industry to develop PAD devices
- First report of most desirable public sites for PAD devices
- Project ADAM initiated by Children’s Hospital of Wisconsin
- All 50 states provide some level of legal immunity for lay users of AEDs
- Federal ADAM Act passed but not funded
- AHA Scientific Statement: Medical Emergency Response Plans for Schools recommends AED availability
- Out-of-hospital survival of SCD <5%
- First report of effectiveness of AED’s by lay personnel on airliners
- With AED’s, out-of-hospital survival: 40-53%

March 16, 2006

“Mr. President, today I am introducing the reauthorization of the Automated Defibrillators in Adam’s Memory Act, or the ADAM Act. This bill is modeled after the successful Project ADAM that originally began in Wisconsin and will reauthorize a program to establish a national clearing house to provide schools with the “how to” and technical advice to set up a public access defibrillation program.

Mr. President, every two minutes, someone in America falls into sudden cardiac arrest. By improving access to AEDs, we can improve the survival rates of cardiac arrest in our communities…”

Senator Russell Feingold
Project ADAM

• Not-for-profit program collaboration with Children’s Hospital of Wisconsin
• Started in 1999 after a series of student athlete deaths
• Mission is “to serve children and adolescents through education and deployment of life-saving programs that help prevent sudden cardiac death.”
• Carried-out primarily, but not exclusively, through school systems.

Project ADAM

• Provides program materials to schools/organizations to plan, fund and develop their program, including planning templates, a comprehensive planning manual, form letters
• Outline the importance of:
  – Identify PAD coordinator
  – AED/CPR training (who, how many, how often)
  – Emergency response plan
  – Collaboration with medical “director”/team
  – Maintenance of devices
Project ADAM

- $600 training grants
- Consultation/support
- Affiliate sites in other states use Project ADAM to advance the mission to provide comprehensive public access defibrillation (PAD) programming in schools across the country.
- Florida, Philadelphia, Atlanta

Project ADAM

- School-based strategy
  - Identify PAD coordinator
  - Site assessment; budget
  - Identify medical director (EMS or hospital)
  - AED purchase process
  - Policies & procedures
  - Apply for training grant (and renewal funds)
  - Create response team (8-40/school); plan training
  - Local publicity and school awareness
  - Submit policies/procedures to medical director
  - Ongoing training, equipment maintenance
PAD Liability

• No successful lawsuits against schools that have used AEDs
• Increasing number of lawsuits brought due to unavailability of AED
• Most states offer legal protection for lay users of AEDs
• ? as expectations and standards change

Considerations for NC

• Role of State legislature
  – Mandate
  – Funding
• Role of NC Schools
  – State agencies (Board of Ed, DPI, DPH)
  – Local systems
  – Individual schools
• Role of medical organizations/services
• Role of community/students/parents
• Expansion to “true” PAD
Other acquired heart disease

- Arrhythmias
  - Inherent
  - Post op
- Hypertension
- High cholesterol

- Endocarditis
- Kawasaki Disease
- Rheumatic Heart Disease

Arrhythmias/Autonomic Dysfunction

- Long QT
- SVT
- Atrial Arrhythmias
- Ventricular Tachycardia
- POTS
- Syncope
Antiarrythmics

- Any antiarrythmic is pro-arrythmic
- Risk is exponential with multi-drug therapy
- Special precautions with certain medications
- Stress with parents need for correct dosing

Pacemakers and ICDs

- What are they
- What do they do
- What do I need to know
Hypertension/Hypercholesterolemia

Measurement

- Korotkoff sounds
  - SBP – K1
  - DBP – K5 (versus K4)
- 3 separate measurements
- Arm at level of heart
- Oscillometric vs. manual (>90% - confirm)
- Ambulatory BP measurement
Etiology

- Primary (essential)
- Secondary, definable cause
- Vary with age

Secondary HTN

Causes of Secondary Hypertension in Children and Adolescents

- Renal disease
  - Pyelonephritis
  - Renal parenchymal disease
  - Congenital anomalies
  - Nephrotic syndrome
  - Acute glomerulonephritis
  - Nephroblastos tumors
  - Renal trauma
  - Hydronephrosis
  - Nephrologic syndromes
  - Renal stones
  - Nephrotic syndrome
  - Wilms tumor
  - Neoplastic kidney
  - Polyarteritis nodosa

- Endocrine disease
  - Hypothyroidism
  - Congenital adrenal hyperplasia
  - Cushing syndrome
  - Primary aldosteronism
  - Primary hyperparathyroidism
  - Diabetes mellitus
  - Hypercalcemia
  - Thyrotoxicosis

- Neurologic causes
  - Increased intracranial pressure
  - Guillain-Barré syndrome

- Psychologic causes
  - Anorexia
  - Pharmacologic causes
  - Sympathomimetics
  - Corticosteroids
  - Alcohol
  - Waaler syndrome
  - Anabolic steroids
  - Diabetes
  - Pheochromocytoma (PCh)
  - Licorice
  - Cocaine
  - Caffeine

Vascular disease
- Renal artery abnormalities
- Arterial hypertension
- Hypertensive crisis
- Hypertensive nephropathy
- Pheochromocytoma

Other causes
- Neurologic causes
- Thyrotoxicosis
- Cocaine
- Anorexia
- Diabetes

- Nephrotic syndrome

### History

#### History in the Child or Adolescent with Elevated Blood Pressure

<table>
<thead>
<tr>
<th>History</th>
<th>Possible cause of hypertension</th>
<th>Elevated intraocular pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>GMS: <em>Headache (separated, persistent), visual disturbance, malaise, tremor</em></td>
<td>Elevated intraocular pressure</td>
<td></td>
</tr>
<tr>
<td>Hearing: <em>Hearing loss</em></td>
<td>Elevated intraocular pressure</td>
<td></td>
</tr>
<tr>
<td>Cardiovascular: <em>Palpitations, irregular pulse</em></td>
<td>Elevated intraocular pressure</td>
<td></td>
</tr>
<tr>
<td>Renal: <em>History of UTI or unexplained</em></td>
<td>Elevated intraocular pressure</td>
<td></td>
</tr>
<tr>
<td>Family History: <em>Hypertension, early death, diabetes, stroke</em></td>
<td>Elevated intraocular pressure</td>
<td></td>
</tr>
<tr>
<td>Social History: <em>Stress factors at home and school</em></td>
<td>Elevated intraocular pressure</td>
<td></td>
</tr>
</tbody>
</table>

#### Past Medical History
- **Preterm**: Premature, congenital anomalies
- **Medications**: Hypertensive agents, OCPs
- **Substance Use**: Caffeine, phenylpropanolamine, alcohol, tobacco, caffeine
- **Family History**: Hypertension, early death, diabetes, stroke
- **Social History**: Stress factors at home and school

#### Management

#### Measure BP and Height and Calculate BMI
- **Determine BP category for age, sex, and height**
- **Prehypertensive**
  - **Stage 1 Hypertension**
    - Repeat BP Over 3 visits
    - 90–95% or 120/80 mmHg
    - **Stage 2 Hypertension**
      - 95–100% or 130/90 mmHg

#### Consider Diagnostic Workup and Evaluation for Target-Organ Damage
- **Secondary Hypertension**
  - Overweight
    - **Drug Rx**
    - **Weight Reduction**
  - Normal BMI
    - **Drug Rx**
  - Overweight
    - **Weight Reduction and Drug Rx**

#### Therapeutic Lifestyle Changes
- **Weight Reduction**
- **Drug Rx**
- **Weight Loss**
- **Drug Rx**
- **Weight Loss**
- **Drug Rx**

#### Consider Diagnostic Workup and Evaluation for Target-Organ Damage
- **Secondary Hypertension**
  - Overweight
    - **Drug Rx**
    - **Weight Reduction**
  - Normal BMI
    - **Drug Rx**
  - Overweight
    - **Weight Loss**
  - Normal BMI
    - **Weight Loss**
  - Overweight
    - **Weight Loss**
  - Normal BMI
    - **Weight Loss**
  - Overweight
    - **Weight Loss**

#### Therapeutic Lifestyle Changes
- **Weight Loss**
- **Drug Rx**
- **Weight Loss**
- **Drug Rx**
- **Weight Loss**
- **Drug Rx**
- **Weight Loss**
- **Drug Rx**

#### Monitor Q & O Mo

#### Education on Healthy Lifestyle
- **For the Family**
  - **Prohypertensive**
    - **Stage 1 Hypertension**
      - Repeat BP Over 3 visits
      - 90–95% or 120/80 mmHg
    - **Stage 2 Hypertension**
      - 95–100% or 130/90 mmHg
  - **Prehypertensive**
    - **Stage 1 Hypertension**
      - Repeat BP Over 3 visits
      - 90–95% or 120/80 mmHg
    - **Stage 2 Hypertension**
      - 95–100% or 130/90 mmHg
Goals of therapy

• Reduce BP <95%
• <90% if assoc. with comorbid conditions or end-organ damage noted
• “Minimalist” approach to drug therapy
• Duration of therapy?

NCEP Screening Guidelines

• Screening recommended (in children >2 yrs) if:
  – A parent/grandparent suffered a heart attack or had other signs of atherosclerosis at or before age 55.
  – A parent has a total blood cholesterol level over 240.

• Estimated that half of 15 million children needing testing would need further treatment
Public Policy Strategies

- Increase awareness about lifestyle and nutritional choices
- Population-wide primary prevention of unfavorable cholesterol and blood pressure levels
- Awareness about the risks of cigarette smoking and obesity
- Promote benefits of regular exercise

CHEST PAIN IN CHILDHOOD
Heart Disease in Childhood
CHEST PAIN

• Facts:
  – Common in childhood
  – Rarely comes from the heart
  – Musculoskeletal and respiratory aetiologies most common
  – Exception: Association with exercise, preceded by palpitations or in association with known heart disease

Heart Disease in Childhood
CHEST PAIN-Types

• Idiopathic
  – Precordial catch
  – Occurs at rest and exercise
  – Located at the apex or sternal edge
  – Described as sharp stabbing pain of short duration
  – Common in adolescent girls
  – Varies from every now and then to several times a day
  – EKGs are normal
  – Gets better with sympathy, time and reassurance
Heart Disease in Childhood
CHEST PAIN-Types

• Musculoskeletal
  – Sharp pain
  – Related to trauma and movement
  – Well localized and is reproduced by pressure on the affected area or springing the ribs
  – Usually acute and subsides over several days
  – Tietzes syndrome = costo-chondritis of the 2nd - 5th rib junctions

• Cardiac
  – UNCOMMON
  – Arrhythmia - SVT/VT
  – Rheumatic Heart Disease
  – Congenital Heart Disease
    • ALCA
    • Pulmonary hypertension
  – Kawasaki Disease
  – HOCM
    • Rare to present with chest pain
  – Aortic Valve disease
    • ECHO diagnostic
  – Pericarditis
    • EKG is diagnostic
    • Associated with systemic disease/symptoms
Heart Disease in Childhood
CHEST PAIN-Types

• Respiratory
  – Pleurisy
  – Exercise-induced bronchospasm
• Gastro-intestinal
  – GE reflux
  – Ulcers
• Psycho-somatic

A few drugs…..
## Diuretics
- Furosemide (lasix)
- Bumetanide (bumex)
- Chlorothiazide (diuril)
- Spiranolactone (aldactone)

## Afterload reduction
- Milrinone
- Captopril (ACE inhibitor)
- Enalapril (ACE inhibitor)
### Antiarrythmics

- Digoxin (considered inotrope as well)
- Amiodarone
- Adenosine

### Sildenafil

- A potent vasodilator used in the treatment of pulmonary hypertension
- Usual dose 0.1 mg/kg/dose Q4hrs
- Only PO formulation (inhaled nitric oxide is alternative)
- When on this, will also have baseline O2 requirement (despite acceptable sats) to help with pulmonary bed vasodilation
Heart Disease in Childhood
When to refer, what to refer for?

- Cyanosis
- Congestive Heart Failure
- Murmurs
- Chest Pain
- Arrhythmias
- Other (Marfan’s HOCM, hypertension, familial hyperlipidemia, systemic illness associated cardiac disease)

Heart Disease in Childhood:
Congenital Heart Disease

- Demographics:
  - 8-10/1000 live births
  - 2/1000 live births are children with lethal or “semi-lethal” defects
  - Most defects occur in otherwise healthy, well-developed, term infants
  - Stable incidence over the past 5 decades
  - Inheritance is multifactorial
## Heart Disease in Childhood

### Presentation of Heart disease in Childhood
- Defects present in one of three ways
  - Cyanosis
  - CHF
  - Murmur
- The overwhelming majority of patients with CHD present before 2 years of age
- Serious defects present within the first 3 months of life
- Early recognition is essential to insure reasonable outcomes in CHD

### Signs Symptoms of CHF
- Subtle
- Sustained tachypnea/loss of periodic breathing
- Sustained tachycardia
- Diaphoresis with feedings/prolonged time to feed
- Hepatomegaly
- Failure to thrive
- Usually do NOT have rales or peripheral edema until end-stage CHF
- May or may not have gallop rhythm, murmur
- May be precipitated by URI/RSV
A few lesions

- ASD
- VSD
- Tetrology of Fallot
- Transposition of the great arteries
- Atrioventricular septal defect
- Hypoplastic Left heart syndrome
- DORV
- PA/IVS
- Tricuspid atresia
- TAPVR

Atrial Septal Defect – Patch Repair
Ventricular Septal Defect Repair

(Above) With Transannular Patch
(Right) With Pulmonary annulus retained

Tetralogy of Fallot Repair

(Tetralogy of Fallot Repair With Transannular Patch)

(Above) With Transannular Patch
(Right) With Pulmonary annulus retained
**Jatene Arterial Switch**

(transposition of the great arteries)

Jatene Arterial Switch Operation

(Left, in circles) Patent Ductus Arteriosus ligated, Foramen Ovale closed.

**Atrioventricular Canal Repair – Single Patch Method**

1. Atrial Septal Defect (Primum)
2. Cleft & Deformed Tricuspid Valve
3. Cleft & Deformed Mitral Valve
4. Ventricular Septal Defect (Inlet)
Atrioventricular Canal Repair – Anterior View

Normal Heart

Atrioventricular Canal Defect

Separation of mitral and tricuspid valves by suturing to patch of VSD (shown in pink)

Norwood Procedure
Bronwyn Bartle, DNP, CPNP

- Duke Children’s Heart Program
- 919-681-2343 or 919-970-2723
- Bronwyn.bartle@duke.edu

- Referrals/urgent matters – call Duke Paging Operator at 919-684-8111 and ask for pediatrics cardiologist on call