Pediatric Cardiology for Dentists

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Topics for Today:

• Introduction to Congenital Heart Disease
• Acquired Heart Disease in Pediatric Patients
• Strategies for Safe and Effective Dental Care for the Patient with Congenital Heart Disease
• Antibiotic Prophylaxis for Dental Procedures

Despite these advances:

- CHD
  - Leading congenital cause of infant mortality
  - Incidence is increasing
- Long term sequelae
  - Chronic illness
  - Developmental delays
- Costs are high
  In 1997, MDH estimated $17 million needed to care for 65 children with complex CHD

Epidemiology Of Congenital Heart Disease (CHD)

- CHD effects 8/1000 live born infants
  - 30,000 infants per year in the US
  - 25,000 will require surgical repair or palliation
- CHD is the most common birth defect
- In 2000, over 1 million survivors of CHD
- As of 2005, there are more adults with CHD than Children

Genetics of CHD

- Risk in any pregnancy -1%
- Risk with an affected relative - 3% (+)
- Associated with common chromosomal abnormalities (7%)
  - Trisomy 21, Turner Syndrome, DiGeorge Syndrome (22q11 deletion), Marfan Syndrome
- Most CHD occurs sporadically in otherwise healthy children

Human Heart Formation

<table>
<thead>
<tr>
<th>Specification of the precardiac mesoderm</th>
<th>Week</th>
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</thead>
<tbody>
<tr>
<td>Form and fusion of the heart tube</td>
<td>3</td>
</tr>
<tr>
<td>Cardiac looping</td>
<td>4</td>
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<tr>
<td>Septation</td>
<td>5/6</td>
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<tr>
<td>A-V valve formation</td>
<td>7/8</td>
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<tr>
<td>Outflow tract formation</td>
<td>9/10</td>
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<tr>
<td>Semilunar valve formation</td>
<td></td>
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</tbody>
</table>

Weeks:
3, 4, 5/6, 7/8, 9/10
Normal Cardiac Anatomy

Classification of Cardiac Defects

- Septal Defects - L/R Shunts
- Valve/Obstructive Lesions
- Cyanotic CHD
- Single Ventricles
- Complex Congenital Heart Disease

Septal Defects

- Atrial Septal Defect (ASD) - 10%
- Ventricular Septal Defect (VSD) - 30%
- Atrioventricular Septal Defects (AV canal)

Patent Ductus Arteriosus (PDA)

- Systemic to Pulmonary Arterial Level Shunt
- Common
- Associated with other forms of CHD
- Amenable to Surgical or Device Closure

Physiology of Septal Defects

- Increased pulmonary blood flow
- +/- increased pulmonary artery pressure
- Chamber enlargement
- Congestive heart failure
  - Failure to thrive
  - Difficulty feeding
  - Sweaty, pale
Repair of Septal Defects
- Surgery
- Device closure
- Long term outcome
  - ASD, VSD, PDA - normal life expectancy
  - AV Canal - based on associated lesions

Device Closure of Septal Defects

Valve/Obstructive Lesions
“Left-sided”
- Bicuspid Aortic Valve
- Aortic Stenosis (AS)
- Subaortic Membrane
- Mitral valve
  - Stenosis
  - Prolapse/insufficiency

“Right-sided”
- Pulmonary Valve Stenosis (PS)
- Supravalvar Pulmonary stenosis
- Peripheral Pulmonary Stenosis (PPS)
- Ebstein’s anomaly of the tricuspid valve

Aortic Coarctation
- 6% CHD
- High reoccurrence rates
- Chronic Hypertension
- CHF

Valve/Obstructive Lesions - Physiology
- Limitation of cardiac output - obstruction
  - Exercise intolerance
  - Syncope
  - Myocardial hypertrophy/infarction
  - Myocardial failure due to pressure load
- Limitation of cardiac output - insufficiency
  - Chamber enlargement
  - Myocardial failure due to volume load
Valve/Obstructive Lesions - Repair

- Surgical Valvulotomy
- Balloon Valvulotomy
- Arterioplasty (Surgical widening of the artery)
- Valve Replacement
- There are generally residual lesions!!!

Cyanotic Congenital Heart Disease

- Tetralogy of Fallot (TOF)
- Transposition of the Great Arteries (TGA /TGV/d-TGA)
- Truncus Arteriosus (Truncus)
- Tricuspid Atresia
- Total Anomalous Pulmonary Venous Return (TAPVR)

Tetralogy of Fallot

- 11% of CHD
  - VSD
  - Overriding aorta
  - Pulmonary artery obstruction
  - right ventricular hypertrophy
- Variable pulmonary artery anatomy

Transposition of the Great Vessels

- 7-8% of all CHD
- Historically treated with an atrial switch procedure in childhood

Transposition of the Great Vessels - Arterial Switch Procedure

- Undergo arterial switch as a neonate
- Outcome dependent on residual lesions and ventricular function
Other Cyanotic Lesions - Repairs

- Tricuspid atresia - Fontan (single ventricle circulation)
- Truncus arteriosus - neonatal repair requiring reconstruction of the main pulmonary artery
  - High mortality
- Total anomalous pulmonary venous return
  - Neonatal repair/pulmonary hypertension

Hypoplastic Left Heart Syndrome

- 4-5% CHD
- High mortality
- Single ventricle repair (Fontan)
- Limited exercise tolerance
- +/- Mild cyanosis
- Developmental Delay

Single Ventricle Repair-
Staged Glenn and Fontan Procedures

Hybrid Procedure for HLHS

- Done in specialized cath lab by interventional cardiologists/surgeons
- Initial palliation of circulation without bypass or major surgery (PA bands/PDA stent)
- Short, easy newborn hospitalization
- Norwood and Glenn together at 6 months of age
- Goals: Improved survival, better developmental outcomes, fewer medical complications

Heterotaxy Syndromes

- 2-3% of CHD
- Altered left-right asymmetry
- Disruption of all cardiac segments
- High morbidity and mortality
- Associated anomalies
  - Asplenia or polysplenia, GI abnormalities, midline abnormalities

Pediatric Heart Rate Disorders

- Normal heart rates are age-related
- Increased parasympathetic tone - increased sensitivity to vagal stimulation/gag
- Bradycardia often secondary to hypoxia
Common Pediatric Arrhythmias

- Supraventricular tachycardia (reentrant)
  - Fast (200-300 bpm)
  - Well-tolerated
  - 80% of wide rhythms are SVT in children
- Ventricular tachycardia
  - Rare
  - Assoc with CHD
  - Life threatening
- Long Q-T syndrome
- Vasovagal Syncope

Pacemakers

www.americanheart.org for guidelines

Acquired Heart Disease in Children

Infectious/Autoimmune

- Pericarditis
- Myocarditis
- Acute Rheumatic Fever
- Kawasaki Syndrome
- Lupus

Cardiomyopathies

- Muscular dystrophies - Duchenne’s
- Metabolic
- Idiopathic/Familial
  - Dilated
  - Hypertrophic
  - Congestive heart failure, LVOT obstruction
  - Arrhythmias

Hypertension/Obesity

- Increasingly common
- Medication Interactions
- CV and respiratory compromise
Strategies for Successful Care of the Patient with Congenital Heart Disease

Avoid Surprises (AKA Emergencies)
• Careful Medical History
  – Diagnosis, procedures, medications, limitations
• Consultation and review of dental treatment plan with medical consultants
  – Cardiology, Anesthesia
  – Primary Care Provider
• Observation and monitoring during and after the procedure

Monitoring
• Vital signs and general appearance
  – Age appropriate norms should be available
  – Tachycardiac, increased RR indicate distress
  – Bradycardia and decreased respiratory effort are ominous signs
• Oxygen saturation
• Blood pressure

Avoid Emergencies
hypoxemia and acidosis is the primary cause of cardiac arrest in children

Interventions
• NPO 6 hours (except for medications)
• Avoid anesthetic overdose
• Avoid or immediately treat respiratory compromise
• APLS Certification
• Early Activation of EMS

High Risk Situations
• Congestive Heart Failure/Decreased Myocardial Function
• Cyanotic CHD - hypotension can cause hypoxemia, polycythemic, sensitive to dehydration
• Prosthetic valves - Infectious risk, anticoagulation
• Pulmonary Hypertension - Risk of sudden death
Bacterial Endocarditis
Prophylaxis and Dental Procedures:

June 1, 2007

Bacterial Endocarditis
• Infection of the endothelium of the heart or great vessels
• Rare – 4.9/100,000
• 15-25% mortality with treatment
• Occurs more frequently with structural heart disease, but can occur in the normal heart
• Often associated with indwelling or central venous catheters
• Dental procedures associated with <4% of cases

Pathogenesis
• Damaged endothelium
  – congenital or acquired heart lesion
  – Thrombus formation at site of endothelial damage
• Bacteremia
  – Requires bacterial adherence
  – Dependent on duration and volume of inoculum
  – Sources include: gingival or mucosal bleeding, GU/GI tract infections, infected tissue

Clinical Presentation of Bacterial Endocarditis
• Symptoms usually occur within 2 weeks of initiating bacteremia
• Fever, anemia
• Liver and spleen enlargement, hematuria
• Night sweats, myalgias, headache, poor appetite
• Rare CHF due to valve dysfunction
• Embolic lesions- Roth spots, Janeway lesions, Osler’s nodes, splinter hemorrhages

Prevention of Bacterial Endocarditis
• Correct Hemodynamic Lesion
  – Most lesions have residual hemodynamic consequences
• Prevent Bacteremia
  – maintain good oral hygiene and prevent oral infections

Causative Organisms
• 2/3 of cases are gram positive cocci
  – Strep viridans 31%
  – Staph aureus 24%
  – Other strep/enterococci 6%
  – Coag neg staph 5%
  – HACEK 5%
  – GNB’s 5%
  – Strep pneumoniae 2%
  – Fungi 2%
  – Other 3% Negative Culture 16%
### Rationale for prophylaxis (prior to April 2007)
- High morbidity and mortality
- Longstanding practice
- Based on logical principles and animal models
- “Standard of Care”
- No controlled clinical trials available

### Risk Stratification
*Stackleberg and Wilson, 1995*

<table>
<thead>
<tr>
<th>Condition</th>
<th>Rate (per 100,000)</th>
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<tbody>
<tr>
<td>Baseline</td>
<td>4.9</td>
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<tr>
<td>Previous endocarditis</td>
<td>300-740</td>
</tr>
<tr>
<td>Prosthetic Valve</td>
<td>300-630</td>
</tr>
<tr>
<td>Rheumatic Valve</td>
<td>440</td>
</tr>
<tr>
<td>MVP with murmur</td>
<td>52</td>
</tr>
<tr>
<td>MVP no murmur</td>
<td>4.6</td>
</tr>
<tr>
<td>VSD</td>
<td>220</td>
</tr>
<tr>
<td>VSD Corrected</td>
<td>60</td>
</tr>
<tr>
<td>AS</td>
<td>180</td>
</tr>
<tr>
<td>PS</td>
<td>20</td>
</tr>
<tr>
<td>All CHD</td>
<td>120</td>
</tr>
</tbody>
</table>

### Controversies in Prophylaxis
- No controlled clinical trials
- Most transient bacteremias are untreated
- Low incidence
- Potential for increased antimicrobial resistance
- Prophylaxis covers only 2/3 of causative organisms

### AHA Recommendations 2007
- Changes based on the following
  - Random bacteremias more common than procedural related bacteremias
  - Rare disease - prophylaxis, if effective - will prevent few cases (no evidence for efficacy)
  - Risk of antibiotics exceeds benefit
  - Optimal oral health most important factor

### AHA Recommendations- 1997
- **Risk Stratification**
  - **High Risk**: prosthetic valves, previous endocarditis, complex congenital heart disease, surgically constructed shunts, conduits
  - **Moderate Risk**: Most other CHD, aquired valve dysfunction, hypertrophic cardiomyopathy, MVP with MR
  - **Negligible Risk**: ASD, ASD, VSD, PDA closed > 6 months (includes devices), MVP no MR, CABG, innocent murmurs, KS, pacemakers and defibrillators

### SBE prophylaxis-2007 guidelines
- **Cardiac conditions requiring prophylaxis:**
  - Prosthetic cardiac valve
  - Previous infective endocarditis
  - CHD
    - Unrepaired/cyanotic CHD
    - Complete repair with prosthetic material for 6 months post repair
    - Repair with prosthetic material and residual lesions
    - Cardiac transplantation with valve abnormalities
**Guidelines for Antibiotic Prophylaxis**
From Taubert and Dajani “Infective Endocarditis” in Moller and Hoffman, Pediatric Cardiovascular Medicine, 2000.

**Procedures Requiring Prophylaxis - AHA Guidelines**

- **1997**
  - Dental Extractions
  - Orthodontic Bands
  - Cleaning or Scaling with Bleeding
  - Oropharyngeal Surgery
  - Esophageal, Urethral, GI procedures

- **2007**
  - **ALL DENTAL PROCEDURES THAT Involve MANIPULATION OF GINGIVAL TISSUE, PERIAPICAL REGION OF TEETH OR PERFORATION OF THE ORAL MUCOSA**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Antimicrobial</th>
<th>Dosage</th>
<th>Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dental surgery</td>
<td>Amoxicillin</td>
<td>250 mg</td>
<td>PO, IM</td>
</tr>
<tr>
<td>Orthodontic bands</td>
<td>Amoxicillin</td>
<td>250 mg</td>
<td>PO, IM</td>
</tr>
<tr>
<td>Cleaning or scaling with bleeding</td>
<td>Erythromycin</td>
<td>500 mg</td>
<td>PO, IM</td>
</tr>
<tr>
<td>Oropharyngeal surgery</td>
<td>Amoxicillin</td>
<td>250 mg</td>
<td>PO, IM</td>
</tr>
<tr>
<td>Esophageal, urethral, GI procedures</td>
<td>Erythromycin</td>
<td>500 mg</td>
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*Precautions: For high-risk patients, half the dose may be administered 30 minutes before the procedure.*