Anesthesia for the Child with Congenital Heart Disease (CHD) for Non-cardiac Surgery

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HLHS - circa 1980

Stage I Procedure

Superior Cavopulmonary Connection with Takedown of B-T Shunt Removes Volume Load on Single Ventricle

Bidirectional Glenn

Hemi-Fontan
OBJECTIVES

- Demographics
- Determinants of physiologic function
- Surgical procedures
- Anesthetic management

DEMOGRAPHICS OF CHD IN USA

- 21,000-43,000 live births annually
- 20,000 cardiac surgical procedures
- Over 80% survival to third decade
- Prevalence 500,000-800,000
- Heterogeneous population
PREVALENCE OF CONGENITAL HEART MALFORMATIONS

<table>
<thead>
<tr>
<th>Lesion</th>
<th>Infants (%)</th>
<th>Children (%)</th>
<th>Adults (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventricular septal defect</td>
<td>28.3</td>
<td>24</td>
<td>15</td>
</tr>
<tr>
<td>Patent ductus arteriosus</td>
<td>12.5</td>
<td>15</td>
<td>15.5</td>
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<tr>
<td>Atrial septal defect</td>
<td>9.7</td>
<td>12</td>
<td>16</td>
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<tr>
<td>Coarctation</td>
<td>8.8</td>
<td>4.5</td>
<td>8</td>
</tr>
<tr>
<td>Transposition of great art</td>
<td>8</td>
<td>4.5</td>
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<tr>
<td>Hypoplastic left heart synd</td>
<td>7.8</td>
<td>—</td>
<td>—</td>
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<tr>
<td>Tetralogy of Fallot</td>
<td>7</td>
<td>11</td>
<td>15.5</td>
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<tr>
<td>Pulmonary stenosis</td>
<td>6</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>Aortic stenosis</td>
<td>3.5</td>
<td>6.5</td>
<td>5</td>
</tr>
<tr>
<td>Truncus arteriosus</td>
<td>2.7</td>
<td>0.5</td>
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<tr>
<td>Tricuspid atresia</td>
<td>1</td>
<td>1.5</td>
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</tbody>
</table>

OBJECTIVES

- Demographics
- Determinants of physiologic function
- Surgical procedures
- Anesthetic management

DETERMINANTS OF PHYSIOLOGIC FUNCTION

- Sequelae
- Complications
- Palliation
- Correction

COMMON SEQUELAE

- Arrhythmia
- Ventricular dysfunction
- Hemodynamic disturbance
- Pulmonary vascular disease

DETERMINANTS OF PHYSIOLOGIC FUNCTION

- Sequelae
- Complications
- CNS
- Renal
- Hematologic
DETERMINANTS OF PHYSIOLOGIC FUNCTION

- sequelae
- complications
- palliation
  - e.g. single ventricle & Fontan

DETERMINANTS OF PHYSIOLOGIC FUNCTION

- Sequelae
- Complications
- Palliation
- Correction

FONTAN OPERATION

- Functional level - NYHA
- Arrhythmia 20 – 30%
- Ventricular function 10 – 20%
- Pulmonary vascular disease 25%
- Hemodynamic sequelae 100%
- Protein losing enteropathy 5 – 10%
- Thromboembolism 15 – 20%

OBJECTIVES

- Demographics
- Determinants of physiologic function
- Surgical procedures
- Anesthetic management

SURGERY IN CHILDREN WITH CHD

- Dental Procedures
- General surgery
- Urology
- Trauma
- Orthopedic surgery

CHOP NON-CARDIAC SURGERY 2004

- Requests 945/CVA 424
- PS II (154), PS III (195), PS IV (75)
- Elective (400), emergency (24)
- Day Surgery (274), overnight stay (150)
- Simple procedures (60%) – BMT, T/A, circumcision, hernia
- Complex procedures (40%) – TEF, brain tumor, tumor resection, transplant, etc.

SURGERY IN ADULTS WITH CHD

- Labor and delivery
- Trauma
- Orthopedic surgery
- General surgery
- Cardiac surgery

OBJECTIVES

- Demographics
- Determinants of physiologic function
- Surgical procedures
- Anesthetic management

Table I. Personnel and Services Recommended or Required for Regional ACHD Centers

<table>
<thead>
<tr>
<th>Type of Service or Personnel</th>
<th>Local Care</th>
<th>Regional ACHD Center</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pediatric ACHD cardiologist</td>
<td>Optional</td>
<td>One or several 24/7*</td>
</tr>
<tr>
<td>Adult medical ACHD cardiologist</td>
<td>Optional</td>
<td>One or several 24/7*</td>
</tr>
<tr>
<td>Mid-level practitioner</td>
<td>Optional</td>
<td>Two/several</td>
</tr>
<tr>
<td>Congenital heart surgeon</td>
<td>No</td>
<td>Two/several 24/7*</td>
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<tr>
<td>Cardiac anesthesia</td>
<td>No</td>
<td>Several 24/7*</td>
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<tr>
<td>Echocardiography**</td>
<td>Refer to regional ACHD center</td>
<td>Two/several 24/7*</td>
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<tr>
<td></td>
<td>Includes TEE, intraoperative TEE (required for surgery)</td>
<td></td>
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<tr>
<td>Diagnostic catheterization**</td>
<td>Refer to regional ACHD center</td>
<td>Yes 24/7*</td>
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<tr>
<td>Noncoronary interventional catheterization**</td>
<td>Refer to regional ACHD center</td>
<td>Yes 24/7*</td>
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<tr>
<td>Electrophysiology**</td>
<td>Consult regional ACHD center unless unrelated to CHD</td>
<td>Yes 24/7*</td>
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<tr>
<td>Exercise testing</td>
<td>Standard</td>
<td>Echo, radionuclide, cardiopulmonary, metabo</td>
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<tr>
<td>Transplant</td>
<td>Optional</td>
<td>Heart, lung, heart-lung desirable</td>
</tr>
<tr>
<td>Cardiac imaging/radiology services</td>
<td>Optional</td>
<td>CT scan, cardiac MRI with fast-pulse sequen nuclear medicine</td>
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</tbody>
</table>
**Cardiac pathology**
- Information technology
- Other

**Optional**
- Interface with regional ACHD center
- Data collection
- Participation in patient-care and best-practice guidelines review

**Yes**
- Data collection
- Database support
- Interface with local practitioners, including internet-based applications
- Quality assessment review and protocols
- Optional development of best practice guidelines
- Adolescent transitional unit
- High risk obstetrics
- Genetics
- Rehabilitation services
- Social services
- Vocational services
- Financial counselors

* «24/7» denotes availability 24 hours/day, 7 days/week. **These modalities must be supervised/performed and interpreted by physicians with specific skills and knowledge.

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### DESIRABLE HEMODYNAMIC OBJECTIVES

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<thead>
<tr>
<th></th>
<th>Preload</th>
<th>PVR</th>
<th>SVR</th>
<th>HR</th>
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<td>Infundibular PS</td>
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<td>Coarctation</td>
<td>↑</td>
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<td>↓</td>
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<td>MS</td>
<td>↑</td>
<td>N↓</td>
<td>N</td>
<td>N</td>
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</table>

* overriding consideration

### EVALUATION OF CARDIAC STATUS

- Activity tolerance
- Growth pattern
- Congestive heart failure
- Magnitude of cyanosis
- Medications
- Cardiologist evaluation

### FORMULATION OF AN ANESTHETIC PLAN

- Patient considerations
- Operative considerations
- Postoperative considerations

### PATIENT CONSIDERATIONS

- Associated conditions – e.g. Chr 22
- Airway – e.g. tracheal stenosis
- Psychosocial issues – e.g. depression
- Medications
- Hematocrit – e.g. cyanosis

### OPERATIVE CONSIDERATIONS

- SBE prophylaxis – e.g. AHA
- Monitoring – e.g. BP, ECG, Pulse Ox
- Vascular access – e.g. CVP, A-line
- Positive pressure ventilation – e.g. VR
- Laparoscopy
- Insufflation, Trendelenburg

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**ANESTHETIC MANAGEMENT**

- More important to be guided by a safe, familiar, established anesthetic technique than to have a detailed understanding of the specific pathophysiologic lesion

- Patient evaluation
- Cardiologist communication
- Perioperative plan
  - Preoperative goals
  - Postoperative expectations
- Physiologic anesthetic
CONCLUSIONS

- Physiologic spectrum wide
- Expected outcome of a specific lesion and sequelae
  - (Arrhythmia, ventricular dysfunction, hemodynamic residua, pulmonary vascular disease)
- Formulation of anesthetic plan
- Response to provocative conditions
  - General
  - Specific
- Successes in surgery create later challenges for anesthesia