SOAP
Society for Obstetric Anesthesia and Perinatology

Advancing the pregnancy-related health and outcomes of pregnant women and their newborn.

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Cardiac Disease in Pregnancy

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Outline

• This presentation covers four main disease states
  • Congenital Cardiac Disease in the Pregnant Patient
  • Valvular Heart Disease
  • Primary Pulmonary Hypertension
  • Cardiac Implanted Electrical Devices & Conduction Abnormalities

• Throughout the process, it’s important to think about the resources at your institutions to provide multidisciplinary care
  • Equipment (transthoracic / transesophageal echo, ECMO support)
  • Personnel (cardiac anesthesia, cardiac surgery, interventional cardiology)
  • Place (specialized cardiac ICU)
Adults Congenital Heart Disease (CHD) in Pregnancy

- Congenital heart disease (CHD) is the most common birth defect in humans, approx. 1% of all live births
- With surgical innovation, >80% of children born with CHD reach adulthood
- *# Adults* living with CHD (~1.4 million in the US) >> *# Children* with CHD (~1 million in the US) – 2010
- Greater risk of perioperative adverse events in patients with CHD compared to controls (especially complex CHD)
  - Perioperative cardiac arrest, myocardial infarction, stroke, respiratory complications, renal failure, sepsis, venous thromboembolism, perioperative transfusion, mortality etc.
- Approx. ⅓ of CHD patients have additional extra-cardiac anomalies.
  - Neurologic, pulmonary, hepatic, renal, oncological and endocrine manifestations
- Heart failure and arrhythmias cause most of the unplanned hospital admissions in CHD patients. Prevalence of cardiac event during pregnancy is ≥ 20%.
- Nearly ⅔ of sexually active young women with CHD have not discussed the risk of pregnancy with their physicians
Types of Lesions

A large variety of cardiac defects ranging from simple to highly complex defects

**Shunt Lesions**
- Atrial Septal Defect
- Anomalous Pulmonary Venous Connections
- Ventricular Septal Defect
- Atrioventricular Septal Defect
- Patent Ductus Arteriosus

**Left-Sided Obstructive Lesions**
- Cor Triatriatum
- Congenital Mitral Stenosis
- Subaortic Stenosis
- Congenital Valvular Aortic Stenosis
- Supravalvular Aortic Stenosis
- Coarctation of the Aorta

**Right-Sided Lesions**
- Valvular Pulmonic Stenosis
- Branch and Peripheral Pulmonary Stenosis
- Double-Chambered Right Ventricle
- Ebstein Anomaly
- Tetralogy of Fallot
- Right Ventricle to Pulmonary Artery Conduit

**Complex Lesions**
- Transposition of the Great Arteries
- Fontan Palliation of Single Ventricle
- Hypoplastic Left Heart Syndrome/Norwood Repair
- Truncus Arteriosus
- Double Outlet Right Ventricle
- Severe PAH and Eisenmenger Syndrome
- Coronary Anomalies
- Coronary Artery Fistula
### Common Congenital Cardiac Lesions

#### Clinical Correlation

<table>
<thead>
<tr>
<th>Category</th>
<th>Example(s)</th>
<th>Characteristics</th>
</tr>
</thead>
</table>
| **Right-to-Left Shunt**| Tetralogy of Fallot Eisenmeiger syndrome | Characterized by chronic hypoxemia (cyanosis) leading to: erythrocytosis, ↑sympathetic response, ↓CV reserve  
**Goal**: ↑/maintain SVR, ↓PVR |
| **Left-to-Right Shunt**| Unrepaired ASD, VSD, PDA       | Characterized by ↑Pulm blood flow → right side volume overload  
Chronically leads to ↑PVR → eventually right heart failure  
**Goal**: ↓/maintain SVR, avoid significant decreases in PVR |
| **Fontan Physiology**  | Surgically treated:            | Characterized by “New physiology = Single ventricle with passive non-pulsatile pulmonary blood flow”  
↑PVR, ↑CVP leads to liver sequelae, low cardiac output (CO) = preload-dependent  
**Goal**: Avoid tachycardia/bradycardia, hypovolemia, ↓use of positive pressure ventilation, ↓PVR and maintain contractility → maintain CO |
| **Obstructive Lesions**| Valve stenosis                 | Characterized by hypertrophy with ↓ventricular compliance and stroke volume  
**Goal**: maintain NSR for atrial kick, avoid tachycardia, maintain preload, maintain SVR |
| **Regurgitant Lesions**| Valve regurgitation or surgical conduit regurgitation | Characterized by volume overload → → ventricular dysfunction  
**Goal**: normal to fast HR, normal to low SVR (vasodilation) |
What is the risk of an adverse outcome in my pregnant patient with congenital heart disease?
Risk Stratification

LOWEST

- Left-to-right shunts
- Regurgitant lesions
- Repaired lesions w/o residua
- BAV without stenosis

HIGHEST

- TOF
- TGA
- PS
- Fontan
- Coarctation
- Ebsteins
- Severe pulmonary HTN
- Systemic ventricular dysfunction
  - NYHA FC III-IV
  - EF <40%
- Cyanosis
- Severe left heart obstruction
- Marfan syndrome root >4 cm
- Prior peripartum CM with
  - ventricular dysfunction
Management Considerations

1. Antepartum Optimization –
   - Counseling – patient education, contraception options, pregnancy risks, long-term outcomes
   - Risk Stratification – CARPREG, ZAHARA, modified WHO classification
   - Consider High-risk Anesthesia Consult, Cardiology consult
   - Multidisciplinary team planning
     - Obstetrician (Maternal Fetal Medicine), Cardiologist (Pediatric, Adult), Anesthesiologist (Obstetric, cardiac), Nursing, ICU (intensive care unit) team

2. Optimize Delivery Mode & Location –
   - Mode: Labor vs. Cesarean delivery (shared & multidisciplinary decision)**
   - Location (Hospital): Specialized CHD centers for complex CHD lesions
   - Location (Floor): Labor room, Operating room (Cardiac vs. Obstetric)**

3. Choice of Anesthetic Technique or Anesthesia Team –
   - No evidence of worse outcome with noncardiac (specialized) anesthesiologist
   - No evidence to favor one anesthesia technique over the other (based on cardiac physiology)
     - understanding physiological changes in each patient = crucial
   - Neuraxial (slowly titrated) preferred over General Anesthesia (in parturient)
Management Considerations Continued

• **4. Appropriate Monitoring** –
  • Standard ASA monitors (ECG, intermittent BP, continuous pulse oximetry, capnography, temperature)
  • Invasive monitors (intra-arterial catheter, CVC, ±PAC) vs. TTE vs. TEE
  • Precautions: avoid paradoxical air embolism (IV lines)
• **5. Delivery** –
  • TEE / cardiac anesthesia (stand-by) – especially post-delivery (↑CO)
  • Low threshold: ECMO / mechanical circulatory support
• **6. Postoperative/Postpartum Considerations** –
  • Triage – Discharge location
    • ICU (complex lesion, unstable, intraoperative events etc.)
    • PACU or Labor room with telemetry (very mild, well compensated disease)
  • Continued Multidisciplinary care
    • Endocarditis prophylaxis (prior to delivery), postoperative pain management
  • ↑risk of heart failure, arrhythmias, thrombotic events, bleeding
Conclusions

- Each patient’s disease and repair is unique. “Not all congenital defects are created equal and not all repairs are equal”, each patient should be therefore considered individually.

- The number of ACHD patients consulting non-specialized hospitals for labor and delivery will continue to increase due to improved survival in childhood.

- Consider specialized center if complex lesion, even with low-risk surgery (AHA/ACC recommendation)

- Comprehensive preoperative evaluation and an multidisciplinary team approach is KEY

References


5. Jooste E, Machovec K. Anesthesia for adults with congenital heart disease undergoing noncardiac surgery. 2019 UpToDate
Valvular Heart Disease (VHD) and Pregnancy

**INTRODUCTION**

- VHD is the most common form of cardiovascular disease during pregnancy.
- Physiologic and hemodynamic changes of pregnancy leave women with VHD (including prosthetic heart valves) susceptible to increased risk of morbidity and mortality.
- Parturients with L-sided stenotic lesions are at highest risk for development of symptomatic heart failure (HF) and cardiovascular complications.
- Coupled with the intermittent or sudden effects of labor on a patient with VHD, analgesia/anesthesia can be poorly tolerated.
Valvular Heart Disease (VHD) and Pregnancy

**BACKGROUND**

Mitral Regurgitation (MR) is the leading cause of severe VHD in the US

Aortic Stenosis* (AS) is the 2nd most common valvular lesion in the US

- In the pregnant population AS is most often secondary to congenital bicuspid AV stenosis or acquired Rheumatic Heart Disease (RHD)

Mitral Stenosis* (MS) is primarily caused by RHD (in the developing world and the US), can also be congenital

* Cardiac indications to consider antepartum anesthesiology consultation/early involvement of anesthesia team
Valvular Heart Disease and Pregnancy

**CLINICAL CORRELATION**

*How will an anesthesia consult benefit my patient with VHD and the OB team caring for her?*

Anesthesia team members will likely

- Manage hemodynamic and cardiac disturbances during labor and delivery
- Anticipate/respond to issues of airway management and ventilation
- Assess risks/benefits of analgesia options (pain control is an essential component of hemodynamic stability)
- Contribute experience in critical care to the preparation and execution of
  - hemodynamic goals and fluid management
  - peripartum monitoring (±PA catheter, TTE)
  - medical optimization (including antiarrhythmics, diuretics)
  - communication with critical care specialists (cardioversion)
Valvular Heart Disease in Pregnancy

**RECENT RESEARCH AND CONTROVERSIES**

Due to high risk of adverse maternal/fetal outcomes, pregnancy can be contraindicated for patients with

- Severe, symptomatic AS and severe aortic dilatation (>50mm)
- Severe MS (MV valve area < 1.5cm², diastolic pressure half-time > 150ms)

Surgical intervention (including cardiopulmonary bypass) during pregnancy is associated with significant risk

- Severe AS; 6% maternal, 30% fetal mortality
- Mechanical Heart Valve thrombosis; 11.2% maternal, 33.1% fetal mortality

Consequently, emergent valve replacement for VHD is only considered during pregnancy in the setting of refractory heart failure or arrhythmias.
Valvular Heart Disease in Pregnancy

RECENT RESEARCH AND CONTROVERSIES continued

Balloon valvuloplasty can be used to bridge to postpartum surgical intervention (for AS, MS)

• Preferable during 2nd trimester to avoid radiation to fetus during organogenesis

All pregnant women with bioprosthetic heart valves should be treated with low-dose aspirin in the 2nd and 3rd trimesters to prevent thrombosis; women with mechanical heart valves require therapeutic anticoagulation throughout pregnancy – however current guidelines are based on small, retrospective series.
Valvular Heart Disease and Pregnancy

Key points:

• Parturients with VHD and L-sided stenotic lesions (symptomatic AS, severe MS) are at highest risk for increased maternal/fetal morbidity and mortality.

• Prenatal consultation and peripartum coordination with the obstetric anesthesia team can facilitate important monitoring and management goals for the patient’s care.

References:


Primary Pulmonary Arterial Hypertension in Pregnancy (Primary PAH)

Introduction and Background

• Primary PAH is also known as Idiopathic Pulmonary Arterial Hypertension, and is 4 x greater in females than males

• It is considered Group 1 of 5 groups of the World Health Organization’s (WHO) clinical classification of pulmonary hypertension (PH) – See Table 1

• Eisenmenger syndrome (bidirectional cardiac shunting physiology) is included also in WHO Group 1 of PH, which carries a maternal mortality rate of 50% in pregnancy

• Traditionally women with Primary PAH were advised not to get pregnant, or if already pregnant to consider pregnancy termination

• Recent US surveys indicate that pregnant women with PH are increasing, and associated with a high risk of maternal adverse cardiac events (MACE) and neonatal morbidity
WHO Clinical Classification of Pulmonary Hypertension (2013)

Table 1

<table>
<thead>
<tr>
<th>Group</th>
<th>Etiologic Factors</th>
<th>Pathophysiology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>Idiopathic PAH, Congenital heart disease and Eisenmengers syndrome, drug/toxin/parasite causes</td>
<td>Pulmonary Arterial Hypertension (PAH)</td>
</tr>
<tr>
<td>Group 2</td>
<td>Left ventricle systolic or diastolic dysfunction, left heart inflow/outflow obstruction, valvular disease</td>
<td>PH due to left heart disease</td>
</tr>
<tr>
<td>Group 3</td>
<td>COPD, scoliosis, interstitial lung disease</td>
<td>PH due to chronic lung disease and/or hypoxia</td>
</tr>
<tr>
<td>Group 4</td>
<td>SBE from multiple etiologies, sickle cell disease</td>
<td>Chronic thromboembolic PH</td>
</tr>
<tr>
<td>Group 5</td>
<td>Chronic Hemolytic anemia, Sarcoidosis</td>
<td>Multifactorial mechanisms</td>
</tr>
</tbody>
</table>
Primary Pulmonary Arterial Hypertension
Clinical Correlation

• PAH = pulmonary artery occlusion pressure (PAOP) greater than 15 mm Hg and increased pulmonary vascular resistance (PVR) greater than 3 Woods units

• MACE = death, cardiac arrest, cardiogenic shock, infarction, arrhythmia, respiratory failure, thromboembolic event and stroke

• 80 % of women who develop primary PAH are of childbearing age with many not diagnosed until they are pregnant

• MACE is highest in mothers who have PH and concurrent cardiomyopathy, especially in the primary PAH group

• Maternal mortality occurs due to right ventricular failure and inability of pulmonary vasculature to accommodate the cardiovascular changes during pregnancy, delivery and especially the postpartum period

• Diagnosis is usually by cardiac echocardiography and right heart catheterization, prompted by DOE or syncope
Management of a Parturient with Primary Pulmonary Hypertension

Clinical Correlation

• After diagnosis management must be done in a high resource obstetrical center with multidisciplinary consultation availability: high risk obstetricians, obstetrical anesthesiology, cardiology, and upper level neonatology services.

• There is a high rate of preterm delivery in this population

• Other services that may be required urgently if the right heart decompensates include, extracorporeal membrane oxygenation and cardiopulmonary bypass

• Maternal anticoagulation therapy is often instituted throughout pregnancy due to a high incidence of thromboembolism in these patients

• Transthoracic echo may be used to monitor PH severity and progression, but maternal Right heart failure remains unpredictable
Medical Management of Primary Pulmonary Hypertension
(lack peer-reviewed evidence)

• Calcium Channel Antagonists such as nifedipine have been used
• Inhaled Nitric Oxide causes selective pulmonary vascular dilation with promising results in parturients with primary PAH but is not readily available and cumbersome
• Endothelin-receptor antagonists and guanylyl cyclase agonists are teratogenic in pregnancy, thus contraindicated
• Prostaglandin analogs - See Table 2
• Phosphodiesterase Inhibitors – See Table 2
• Diuretics in the immediate postpartum period to counteract uterine autotransfusion
• Inotropic Agents (such as Dobutamine in low doses for right heart failure)
• Vasopressors to maintain maternal and placental perfusion pressure with vasopressin contraindicated predelivery
Investigational Pharmacological Therapies  
(decrease peripheral vascular resistance)  
Table 2

<table>
<thead>
<tr>
<th>Pulmonary Vasodilators</th>
<th>Name</th>
<th>Route of Administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplemental oxygen delivery</td>
<td></td>
<td>Various devices</td>
</tr>
<tr>
<td>Prostaglandin Analogs</td>
<td>Epoprostanol</td>
<td>Continuous infusion IV</td>
</tr>
<tr>
<td></td>
<td>Illoprost</td>
<td>Inhalation</td>
</tr>
<tr>
<td></td>
<td>Treprostinil</td>
<td>SQ or Inhalation</td>
</tr>
<tr>
<td>Phosphodiesterase Inhibitors</td>
<td>Sildenafil</td>
<td>Oral</td>
</tr>
<tr>
<td>Nitric Oxide</td>
<td></td>
<td>Inhaled</td>
</tr>
</tbody>
</table>

All of the agents above have been used as solo therapy or in combinations in various case reports.
Anesthesia Management Goals: Epidural or General Anesthesia

- **Anesthetic Goals**
  - Maintenance of Sinus Rhythm
  - Optimization of RV preload monitored by TEE or CVP (avoid Spinal anesthesia due to rapid vasodilation)
  - Maintenance of Systemic Blood pressure monitored with Arterial catheterization
  - Maintenance of RV contractility - inotropes

- **Decreased PVR**
  - Avoid Hypoxia, Hypercapnia, and Acidosis
  - Maternal stress reduction
  - Maintain or augment pharmacologic agents that decrease PVR

- **Standby**
  - ECMO and urgent heart transplantation

- **Careful use of utero-contractile agents and good pain control**
Obstetrical Management: No Gold Standard Currently Exists

• Patients may often deliver early due to right heart failure (antenatal steroids and titrated magnesium for neuroprotection)
• Maternal anticoagulant therapy
• Vaginal Delivery
  • Requires excellent pain control
  • Valsalva maneuvers may decrease venous return
• Cesarean Delivery
  • Indicated for Right heart failure
  • More risk of Infection, bleeding, and pain
• Meticulous post-delivery monitoring of maternal hemodynamics as most women decompensate during this period
References for Further Information


Cardiac Implanted Electrical Devices (CIEDs) in Pregnancy

• Lots of different devices, inserted for lots of different reasons
• Most common devices are pacemakers or ICDs
  • All ICDs have pacing capability, but pacemakers can’t defibrillate
  • All apples are fruits, but not all fruits are apples
• We’ll spend a few minutes talking about indications for CIEDs, peripartum management, and how you can tell what device your patient has
  • The device and its settings are important for management
Why Put These In?

• Problems with conduction can occur at all stages of conduction
  • Disconnected parts
  • Parts with retrograde conduction
  • Parts that don’t respond to other signals

• Problems can occur for lots of reasons
  • Intrinsic structural problems
  • Mechanical/surgical problems
  • Electrolyte abnormalities
  • Medications

• Sometimes conduction problems are treated medically or with ablation
  • But sometimes a pacemaker needs to take over
Some Indications for Pacemakers

• Sick sinus syndrome
  • SA node doesn’t function well, causing symptomatic bradycardia
  • Often presents as fatigue, syncope, or presyncope
  • Diagnosed with ambulatory ECG monitoring

• Heart Block
  • Normal electrical conduction system of the heart doesn’t function normally
  • Depending on where the block is, may require pacing atrium, ventricle, or both

• Post-MI – rare in this age group

• Neurocardiogenic syncope
  • Syncope caused by neurally-mediated bradycardia
Some Indications for Defibrillators

- **Primary prophylaxis**
  - Sudden cardiac death from ventricular arrhythmias occurs in patients with profoundly low EF
  - The threshold is controversial, but <25% is usually considered an indication

- **Secondary prophylaxis**
  - Patients with a history of malignant arrhythmia at risk for recurrence

- **More rare syndromes**
  - Arrhythmogenic RV dysplasia
  - Congenital long QT syndrome failing medical therapy
  - HOCM
**Flavors**

- **Pacemaker**
  - Can either be single-chamber (ventricle) or dual-chamber (atrium & ventricle)
  - Choice depends on patient’s underlying condition and reason for pacing
  - For patients with severe refractory heart failure, can place BiV pacer (for pacing both ventricles) as an effort at cardiac resynchronization therapy
  - Typically set in a three-letter code (more to follow)

- **Defibrillator**
  - Usually has one lead in the SVC/RA and another lead in the cardiac apex
  - These look like charging coils on X-ray
How Can You Tell?

- If the wires going to the heart have coils on them, it’s a defibrillator
  - The generator “box” on the chest also has a capacitor on it
- If the wires don’t have coils, count the wires
  - If there’s only one wire, it’s a single-chamber pacemaker
  - If there are two wires, it’s likely dual-chamber
Settings?

- Pacemakers have a three-letter setting system. Most common mode is DDD
  - **First letter** – which chamber is being paced? Can be atrium, ventricle, or dual
  - **Second letter** – which chamber is being sensed?
  - **Third letter** – what happens when a beat is sensed?

- Most of the time, we want our pacemaker to only pace when necessary
  - It should pace when it detects no activity
  - It should NOT pace when it detects activity

- This is important for electrocautery
  - If you bovie, the pacemaker could potentially detect activity where there is none
    - And not pace, which would be bad
  - Also for ICDs – cautery can be read by the machine as ventricular fibrillation, which would shock unnecessarily
How to Manage in Pregnancy?

• Multidisciplinary approach
  • EP team to make sure device is functioning well, has adequate battery life, is programmed appropriately
  • Anesthesia / OB teams to comanage during labor and delivery stay

• No anticoagulation necessary for these devices
• Should perform baseline ECG, frequent follow-up ECGs
• Ideally patient should monitor in room with telemetry and continuous ECG recording

• Normal device settings usually need not be changed
  • Occasionally the pacing rate will be increased for pacer-dependent patients to augment cardiac output

• Cautery usually okay as long as dispersion pad placed on leg, cautery source >15cm away from chest
  • Short bursts are ideal
  • Bipolar cautery is preferable if feasible
  • If issues with cautery, magnet over a pacemaker will convert to asynchronous mode
Summary – Cardiac Implanted Electrical Devices

• Consultation with electrophysiologist is encouraged early and often
• Consider original reason for implantation, underlying disease
• Usually no changes necessary to device for vaginal or cesarean delivery
• Recommend a monitored bed for continuous ECG monitoring during labor and immediately postpartum

References
General vs. Neuraxial Anesthesia for Cesarean Delivery (CD)

INTRODUCTION

• For patients with cardiovascular disease (CVD) but adequate cardiac output, vaginal delivery (VD) is usually preferred

• CD is performed for usual obstetric indications or if the need to deliver quickly presents from a maternal or fetal perspective

• While neuraxial analgesia/anesthesia is the therapy of choice in many circumstances for both VD and CD; there are examples of increased risk with this technique for parturients with CVD
General vs. Neuraxial Anesthesia for CD

**BACKGROUND**

The two primary goals of any anesthetic for CD

1) Maintain hemodynamic stability
2) Provide safe and effective anesthesia

These goals are not always compatible... especially when patients with CVD undergoing CD (versus VD) face increased risk of

- Cardiac arrest
- Anesthetic complications
- VTE
- Hemorrhage requiring hysterectomy
- Adverse fetal/neonatal outcomes
General vs. Neuraxial Anesthesia for CD

**CLINICAL CORRELATION**: Selecting the appropriate NEURAXIAL TECHNIQUE

- **Single-shot spinal block** is traditionally contraindicated in CV lesions that rely on preload to compensate for severely limited forward flow
  - In patients with AS, the uncontrolled and/or sudden drop in preload and systemic vascular resistance (SVR) typical of a spinal block’s sympathectomy can lead to significant hypotension and diminished uteroplacental perfusion

- **Lumbar epidural catheter** permits gradual blockade titration, guided by hemodynamics (to maintain SVR, cardiac filling and coronary perfusion pressure)
  - An epidural can also be titrated for assisted vaginal delivery to avoid expulsive efforts of the second stage of labor

- **Combined spinal-epidural** has been successful applied for CD, usually with a reduced intrathecal dose (or with dural puncture followed by epidural dose) to permit hemodynamic stability

- **Continuous spinal catheter** has been promoted as means of providing dense surgical anesthesia but with capacity to titrate hemodynamically appropriate dose
General vs. Neuraxial Anesthesia for CD

**CLINICAL CORRELATION:** When GENERAL ANESTHESIA is appropriate

- Patients with cardiovascular disease may not be suitable candidates for neuraxial anesthesia (contraindications include patient refusal, anticoagulation, neurological disease or focal infection)
- Neuraxial technique attempts may be unsuccessful or require conversion to general anesthesia
- Plans for intraoperative interventions (including ECMO) call for a secure airway and invasive monitoring (TEE)
- A “cardiac” induction (medications having limited effect on cardiovascular stability) commonly includes opioids, etomidate and/or ketamine
- Risks of general anesthesia include difficult intubation and intraoperative awareness
General vs. Neuraxial Anesthesia for CD

RECENT RESEARCH AND CONTROVERSIES

• Evidence in support of one anesthetic technique over the other for patients with CVD requiring CD is lacking.

• Consider that cardiac pathology spans a broad spectrum of conditions (including congenital, acquired, functional, structural, cyanotic, noncyanotic, endocardial, myocardial or pericardial defects) in varying degrees of severity during pregnancy.
General vs. Neuraxial Anesthesia for Cesarean Delivery

Key points:

• All anesthetics – neuraxial, intravenous and inhaled – decrease SVR and therefore present risk for patients with CVD needing CD

• The anesthetic goals during the peri-cesarean delivery period include
  • Normal sinus rate control with immediate treatment of arrhythmia
  • Maintenance of adequate venous return and systemic vascular resistance
  • Avoidance of aortocaval compression
  • Prevention of stressors increasing pulmonary vascular resistance (including pain, hypoxemia, hypercarbia and acidosis)

References:

Where Should These Patients Deliver? Depends on the Resources at the Tertiary Care Center at which the Parturient Delivers

- At minimum a parturient with a complicated cardiac problem should be referred to a tertiary care center with experience with comprehensive maternal fetal medicine, obstetrical anesthesia, neonatal ICU, and cardiology capabilities early in her pregnancy.
- The actual arrangement of the resources at any one center may vary by location, requiring an individualized plan for each parturient and her particular cardiac pathology.
# Required Multidisciplinary Resources

<table>
<thead>
<tr>
<th>Experienced Maternal Fetal Medicine Personnel</th>
<th>Obstetric Anesthesiology with Experience</th>
<th>Neonatologists and Level 1 Neonatal Intensive Care Unit</th>
<th>Cardiology Cardiac Surgery Consultation Capabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 hour capability for emergency delivery</td>
<td>24 hour capability for emergency delivery</td>
<td>24 hour capability for emergency delivery</td>
<td>24 hour capability for emergency delivery</td>
</tr>
<tr>
<td>Advanced fetal monitoring practices</td>
<td>Echo cardiology capability</td>
<td>Infant ventilator</td>
<td>Echo cardiology capacities: TTE and TEE</td>
</tr>
<tr>
<td>Experience Labor and Delivery Nurses</td>
<td>Arterial line and Central monitors</td>
<td>ECMO</td>
<td>ECMO</td>
</tr>
<tr>
<td>Cell Salvage Technology</td>
<td>Experienced neonatal nurses</td>
<td></td>
<td>Cardiopulmonary Bypass</td>
</tr>
<tr>
<td>Dependable 24/7 ICU capabilities</td>
<td></td>
<td></td>
<td>Heart Transplantation Program</td>
</tr>
</tbody>
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Conclusions

- Multidisciplinary involvement is key to management of the complex cardiac patient
  - OB/MFM, OB/cardiac anesthesia, cardiology, critical care, and others
- Knowledge of the resources in your system is important
  - ICU level of care
  - Cardiac surgery availability
  - ECMO/cardiopulmonary bypass infrastructure
  - Cardiology subspecialties (heart failure/mechanical circulatory support, electrophysiology, interventional cardiology)
  - Anesthesia / OR availability
- There is no one way to care for these patients well
  - But planning can improve outcomes and set everyone up for success
Thank You!

• Please feel free to contact us if we can be of any help
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  • David Berman, MD – DaveBerman@jhmi.edu

• Thank you for reading!