The Pregnant Patient with Cardiac Disease

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Introduction: maternal mortality ratio in United States has more than doubled, from 12 maternal deaths per 100,000 live births in 1990 to 26 maternal deaths per 100,000 live births in 2013; death due to cardiovascular conditions increasing, whereas death due to obstetric complications decreasing; increased rate of cardiovascular mortality can be attributed to improved management of patients with congenital heart disease (which has resulted in rate of survival to adulthood of >95%) and to acquired heart disease in pregnant women (who are increasingly likely to be older, obese, and hypertensive); risk for cardiac arrest in pregnancy — study found that adjusted odds ratio for cardiac arrest 13.3 in patients presenting with pulmonary hypertension

Prevention of maternal deaths: Main et al (2015) investigated 205 maternal deaths in California from 2002 to 2005; cardiac disease leading cause of death; review committee concluded that all but 8% of cardiac-related deaths could have been prevented; preventable deaths attributed to delayed response to clinical warning signs (present in >50% of cases), ineffective care (present in >40% of cases), misdiagnosis (eg, pulmonary edema commonly missed in pregnancy), lack of continuity of care, and failure to consult with specialists; most common facility factor was inadequate knowledge; study concluded that anesthesiologists should be present to provide expertise

Care of obstetric patients with cardiac disease: appropriate location for delivery — patient with mild valvular regurgitation can probably safely deliver in community hospital, whereas patient with pulmonary hypertension should be cared for in tertiary or quaternary care hospital; appropriate timing of delivery — perinatologists and cardiologists seek to optimize neonatal age while minimizing stress on mother’s heart; appropriate route of delivery — decision of vaginal or cesarean delivery made by obstetrician; role of anesthesiologist — to focus on appropriate location for delivery, appropriate monitoring of anesthesia and analgesia, and contingency plans for obstetric or cardiac emergencies

Choosing location for obstetric care: multiple classification systems available (eg, American Heart Association, American College of Cardiology, European Society of Cardiology, World Health Organization) for stratifying patients based on likelihood of complications; patients with high-risk lesion of either congenital heart disease or valvular heart disease should be transferred to tertiary or quaternary care hospital; obstetric patients with cardiac disease should be referred to cardiologist who specializes in that disease (rather than general cardiologist) and to perinatologist

Anesthetic plan: consider physiology of cardiac disease, physiologic changes in pregnancy, mode of delivery, and physiologic influences of anesthetic

Physiologic changes in pregnancy: increase in cardiac output (CO), blood volume, heart rate, and stroke volume; increased CO results in high risk for congestive heart failure in patients with preexisting heart disease; risk particularly high in patients for whom right ventricle serves as systemic ventricle or in patients with ventricular failure; decreased onotic pressure results in increased risk for pulmonary edema; pregnant patient requiring supplemental O2 should raise suspicion of cardiac disease; pulmonary hypertension — pregnancy associated with decreased pulmonary vascular resistance and increased pulmonary blood flow; in postpartum period, accelerated Eisenmenger physiology (resulting from postpartum loss of vasodilator effects of pregnancy superimposed on stenotic pulmonary vessels) may lead to death

Mode of delivery: indications for cesarean delivery — heart disease only rarely indicated, but some exceptions exist; mechanical valve — patients who go into labor fully anticoagulated at risk for hemorrhage and are also unlikely to receive neuraxial anesthetic; these patients often scheduled for cesarean delivery at 38 wk gestation; data indicate that thrombosis of vulnerable valves (ie, mitral, tricuspid) less likely in patients receiving warfarin (Coumadin, Jantoven) than in patients on other anticoagulants (eg, low-molecular-weight heparin); if patient receiving warfarin, fetus also anticoagulated; anticoagulation cannot be reversed in fetus, which places newborn at risk for intraventricular hemorrhage; therefore, patients on warfarin presenting at 39 to 40 wk must undergo cesarean delivery to avoid birth trauma to fetus; aortopathy or Marfan syndrome — increases risk for dissection and obstruction; desirable to be delivered in most controlled environment (ie, cesarean delivery); other indications for cesarean delivery — active congestive heart failure, critical valvular stenosis, and severe pulmonary hypertension (with increasing O2 requirements)

Physiologic influences of anesthetic: epidural anesthesia stabilizes heart rate, tissue oxygenation, and CO; in some patients (eg, at risk for malignant arrhythmias), if unable to administer epidural, may be inadvisable to proceed with

Educational Objectives

The goal of this program is to improve outcomes of pregnant patients with cardiac disease and intracranial disease. After hearing and assimilating this program, the clinician will be better able to:

1. Outline the indications for cesarean delivery in patients with cardiac disease.
2. Explain the role of cardiac delivery.
3. Formulate strategies for anesthetizing patients with cardiac disease undergoing cesarean delivery.
4. Identify the challenges of neuraxial anesthesia in patients with intracranial disease.
5. Choose appropriate techniques for general anesthesia in obstetric patients with intracranial lesions.

Faculty Disclosure

In adherence to ACCME Standards for Commercial Support, Audio Digest requires all faculty and members of the planning committee to disclose relevant financial relationships within the past 12 months that might create any personal conflicts of interest. Any identified conflicts were resolved to ensure that this educational activity promotes quality in health care and not a proprietary business or commercial interest. For this program, members of the faculty and planning committee reported nothing to disclose.
vaginal delivery because of stress on cardiovascular system; changes in CO observed during labor attributable mostly to release of catecholamines secondary to labor pain; swings in CO increasingly severe as labor progresses; therefore, epidural catheter should be placed early

Cardiac delivery: described as early dense epidural with painless labor; after cervix completely dilated, fetus descends to introitus with no pushing; baby then extracted by instrumentation; data support both reduction in cardiac complications and increase in obstetric complications; however, data demonstrate increased risk for maternal hemorrhage and neonatal morbidity

Valsalva maneuver: onset of straining increases intrathoracic pressure and heart rate, and decreases venous return, mean arterial pressure (MAP), and pulse pressure; release of strain followed immediately by large drop in MAP; “overshoot” then occurs, characterized by increase in MAP and pulse pressure and decrease in heart rate; choice to push made by obstetrician, but anesthesiologist may consider placement of arterial line and pulse oximetry with waveform; monitoring permits observation of physiologic response to pushing and degree to which patient tolerates it; if pushing results in severe hemodynamic swings, then cardiac delivery may be considered

Optimizing vaginal delivery: place epidural early; never position patients on their backs (because of aortocaval compression); avoid epinephrine in local anesthetic; titrate epidural to T10 level for labor analgesia; minimize or titrate postoperative administration of oxytocin; monitoring for vaginal delivery — commonly inadequate in cardiac patients; speaker recommends use of waveform on pulse oximetry; with any history of arrhythmia, 5-lead electrocardiography should be applied; consider arterial line in patients with ventricular outflow tract obstruction or hypertrophic obstructive cardiomyopathy; measurement of central venous pressure not useful

Anesthesia for cesarean delivery: indications for general anesthesia include anticoagulation, inability to lie flat, severe illness with need for mechanical ventilation (eg, fulminant congestive heart failure), need for pulmonary vasodilation (eg, administration of nitric oxide or other pulmonary vasodilators), and risk for hemodynamic disaster (eg, active aortic dissection); considerations for neuraxial block — spinal anesthesia with infusion of phenylephrine reasonable option; epidural anesthesia not as reliable as spinal anesthesia; some anesthesiologists use sequential combined spinal-epidural anesthesia, consisting of isobaric bupivacaine 5 mg instilled via spinal catheter followed by epidural; some research has suggested that reduced doses of spinal anesthesia mitigate changes in CO and systemic vascular resistance

Oxytocin: intravenous bolus of 5 U results in marked decrease in systemic vascular resistance; some women do not require any oxytocin, therefore administration by titration reasonable approach; only microboluses (eg, 0.5 or 1 U) acceptable; slow infusion may also be considered; boluses of 5 U should not be given

Role of anesthesiologist: anticipate unexpected events; arrhythmias should be cardioverted quickly; automatic implantable cardioverter defibrillator (AICD) should be switched on during vaginal delivery; do not use cautery until AICD turned off; extracorporeal membrane oxygenation and cardiopulmonary bypass should be available; prepare for obstetric emergency (eg, cesarean delivery, hemorrhage); oxytocin and misoprostol (Cytotec) useful for hemorrhage; misoprostol may be used prophylactically with no harm to heart; other uterotonic agents may cause life-threatening side effects (eg, carboprost [Hemabate] may result in >125% increase in pulmonary artery pressure, and ergonovine and methylergonovine associated with α-agonist effects)

Suggested Reading

The Pregnant Patient with Intracranial Disease
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Importance of neuraxial block: optimal analgesia for labor; facilitates non-Valsalva birth, which may be critical in patients with intracranial lesions; likelihood of needing urgent general anesthesia (with attendant fetal exposure to general anesthesia) minimized; allows for maternal-fetal bonding

Elevated intracranial pressure (ICP): must decide whether intracranial lesion associated with increased ICP; clinical features of elevated ICP include pupillary changes, nystagmus, papilledema, and new-onset hemiparesis; radiologic features can be seen on computed tomography or magnetic resonance imaging; clinical and radiographic data suggestive but not diagnostic; ICP normally increases with respiration, heartbeat, pregnancy, labor contractions, and Valsalva maneuver

Pathophysiology: head characterized as fixed space with 3 major elements, ie, brain tissue, cerebrospinal fluid (CSF; 150 mL), and blood (150 mL); CSF can move in and out of cranium, but blood less so; buffer system — explained by Munro-Kellie doctrine, which describes conservation of volume in fixed cranium; with each heartbeat, CSF flows from brain into spinal neuraxis; during diastole, flow reverses; in pregnancy, epidural veins dilate and push into intervertebral foramen, which results in translocation of CSF into brain (manifested clinically during spinal anesthesia by requiring reduced amounts of medication and achieving increasingly potent block); substances infused into epidural space cause transient increase in ICP (≈6 mm Hg); in patients with elevated ICP, instillation of 10 mL of fluid into epidural space can cause increase in ICP of 21 mm Hg lasting ≈4 min; as volume of intracranial space increases (eg, presence of intracranial lesion), ICP buffered by flow of CSF from head to spine; buffering capacity can be overwhelmed by large lesions; when dura punctured by performance of spinal anesthetic; perforation created with leak of CSF; this creates pressure gradient with flow of CSF from brain to spinal neuraxis, provided that flow unobstructed

Role of neuraxial anesthesia: some intracranial lesions not associated with elevated ICP (eg, small tumors, or tumors distant from ventricles); these patients may be candidates for neuraxial anesthetic; case study — patient presented with large cyst of brain with no compression of CSF flow; anticipated that neuraxial block would result in free flow of CSF with no ill effects

Dangers of neuraxial anesthesia: case study — patient underwent uneventful cesarean delivery under regional anesthesia; on postoperative day 1, exhibited neurologic changes and found to have large intracranial tumor with displacement of brain tissue; CSF displaced out of head into spinal neuraxis; dural puncture had caused drop in pressure with inability for
any further flow of CSF; this resulted in downward shift of brain tissue (ie, herniation); masses of posterior fossa — less space to accommodate space-occupying lesions; changes in pressure may cause tonsillar herniation

**Considerations for performing general anesthesia:** in obstetrics, ideal to use rapid sequence induction, employ volatile agent (to avoid accidental awareness), minimize intravenous agents, avoid hyperventilation, and use awake emergence to prevent aspiration; in contrast, if anesthetizing patients for craniotomy, best to avoid almost all these parameters; same considerations apply for treatment of patients with intracranial lesions; in general, brain should be priority; hyperventilation not harmful to fetus; may premedicate with furosemide and mannitol

**Use of neuraxial anesthetic: Arnold-Chiari malformation** — characterized by baseline tonsillar enlargement or small amount of tonsillar herniation; type I most common, and neuraxial block may not be problematic; for more severe lesions, neuraxial blocks should usually not be considered; however, some varieties may have no obstruction (discuss with neurologist or neurosurgeon); important to consider that Valsalva maneuver may cause obstruction and patient may benefit from cardiac-like neuraxial delivery; **vascular lesions** — most patients deliver vaginally; may use neuraxial anesthesia for lesions with no mass effect and that have not bled

**Multiple sclerosis:** concern that exposure of nerves to local anesthetic will cause denervation; patient just as likely to relapse during year of pregnancy as any other time; relapse typically occurs in postpartum period; document preexisting condition; should inform patient that no randomized trials exist that reveal impact of anesthetic; in general neurologists opine that no problem administering spinal or epidural anesthetics

**Suggested Reading**


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THE PREGNANT PATIENT WITH COEXISTING DISEASE

1. A study investigated 205 maternal deaths due to cardiovascular disease from 2002 to 2005. Of the following provider-related contributors to preventable death, which was cited most often?
   (A) Misdiagnosis
   (B) Delayed response to clinical warning signs
   (C) Lack of continuity of care
   (D) Ineffective care

2. When treating a pregnant patient with cardiac disease, the anesthesiologist is obliged to focus on all the following, EXCEPT:
   (A) Contingency plans for obstetric or cardiac emergencies
   (B) Appropriate timing of delivery
   (C) Location for delivery
   (D) Appropriate monitoring of anesthesia and analgesia

3. The increase in cardiac output observed during labor is primarily attributable to which of the following?
   (A) Release of catecholamines secondary to labor pain
   (B) Decrease in systemic vascular resistance
   (C) Autotransfusion
   (D) Increased blood volume

4. In patients with cardiac disease delivering vaginally, recommended monitoring modalities include all the following, EXCEPT:
   (A) Pulse oximetry with waveform
   (B) 5-lead electrocardiography
   (C) Central venous pressure
   (D) Arterial line

5. Which of the following uterotonic agents may result in a >125% increase in pulmonary artery pressure?
   (A) Oxytocin
   (B) Misoprostol
   (C) Carboprost
   (D) Ergonovine

6. Which of the following is diagnostic of elevated intracranial pressure (ICP)?
   (A) Nystagmus
   (B) Papilledema
   (C) New-onset hemiparesis
   (D) None of above

7. In patients with elevated ICP, instillation of 10 mL of fluid into an epidural space can cause an increase in ICP by as much as _______ and lasting >4 min.
   (A) 20 mm Hg
   (B) 25 mm Hg
   (C) 30 mm Hg
   (D) 35 mm Hg

8. Which of the following intracranial lesions is typically associated with elevated ICP?
   (A) Small tumors
   (B) Tumors distant from ventricles
   (C) A and B
   (D) Neither A nor B

9. Which of the following is recommended for a patient with an intracranial lesion requiring general anesthesia for cesarean delivery?
   (A) Rapid-sequence intubation
   (B) Premedication with mannitol
   (C) Avoidance of hyperventilation
   (D) Awake emergence

10. Which of the following anesthetic techniques is(are) considered safe for use in pregnant patients with multiple sclerosis?
    (A) General
    (B) Spinal
    (C) Epidural
    (D) All the above

Answers to Audio Digest Anesthesiology Volume 58, Issue 11: 1-C, 2-B, 3-A, 4-D, 5-B, 6-D, 7-A, 8-C, 9-D, 10-B