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Intrapartum obstetric management

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ABSTRACT

Maternal cardiac disease complicates approximately 1–2% of all pregnancies in the United States. Just as during the antepartum period, in the immediate period surrounding delivery, obstetrical patients with cardiac disease (both congenital and acquired) will have specialized needs, tailored to the patient and her specific lesion. While the basic principles of labor and delivery management protocols are relevant to this subgroup of patients, there are certain areas in which adjustments must be made. These include endocarditis prophylaxis, recent anticoagulation, fluid management, and the need for increased maternal cardiac monitoring. Awareness of the challenges of the intrapartum period combined with a multi-disciplinary approach from anesthesia, cardiology, and the obstetrical provider will optimize the patient for a safe delivery.

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Introduction

There is a growing population of pregnant women with cardiac disease.^{1,2} Maternal cardiac disease complicates approximately 1–2% of all pregnancies in the United States.¹ These women require special attention during their entire pregnancy course, and this section will specifically focus on the intricacies of intrapartum care. It is important to note that different cardiac lesions require different intrapartum strategies, and this article will highlight areas in which care should be tailored.

The body undergoes important physiologic adaptations during pregnancy. Plasma volume expands and red blood cell mass increases; however, these changes are disproportionate, and a physiologic hemodilution occurs.³ Cardiac output increases, both by an increase in stroke volume and heart rate. Blood pressure

fluctuates in pregnancy; initially there is an early drop in the first trimester and then there is a progressive increase during the third trimester. Systemic vascular resistance also decreases initially, with a nadir at 14–24 weeks' gestation, and then rises progressively toward term.³ Therefore, at term, women have significant elevations in heart rate, stroke volume, and cardiac output with decreased systemic and pulmonary vascular resistance and serum colloid osmotic pressures. However, there is no significant alternation in pulmonary capillary wedge pressure, central venous pressure, or mean arterial blood pressure.⁴

During the labor and delivery process, additional changes occur. Uterine contractions cause approximately 300–500 mL of blood to be pushed back into the systemic circulation.⁵ The increase in venous return leads to a transient maternal bradycardia followed by an increase in cardiac output and

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compensatory tachycardia. The increase in maternal cardiac output during labor and delivery may also be caused by pain, anxiety, Valsalva, and maternal positioning. Depending on the cardiac lesion in question, control of cardiac rate becomes important.

General principles of labor and delivery

Labor induction

Functionally normal pregnant patients with cardiac disease may go into spontaneous labor. However, for many women with cardiac issues, there is an indication for delivery prior to the onset of spontaneous labor. Cardiac patients are at risk for hypertensive disorders and may need a timed delivery due to anticoagulation. The timing of delivery needs to be individualized, and it should take into account several components, including gravity/parity, cervical exam, and fetal gestational age. During the induction process, lateral decubitus positioning is recommended to minimize the uterine compression of the abdominal aorta and inferior vena cava, which serves to decrease the hemodynamic changes associated with major uterine contractions.

Overall, there is a good safety profile of labor-induction agents. Cervical ripening is often the first step in a labor induction in a nulligravida. One commonly used method is an intra-cervical Foley catheter. This provides mechanical stimulation for cervical dilation and is safe to use.⁶ Another method of cervical ripening is via prostaglandins, namely misoprostol (Cytotec) or dinoprostone (Cervidil). Prostaglandins are contraindicated in women undergoing a labor induction with prior cesarean delivery. Both misoprostol and dinoprostone carry a theoretical risk of coronary vasospasm and a low risk of arrhythmias.⁷ Dinoprostone can also profoundly affect blood pressures. Oxytocin (Pitocin) can also be used for labor induction but is preferable when a woman has a favorable cervix and/or for inductions of parous women. Although oxytocin has a risk of causing hypotension, the slow titration of oxytocin in labor-induction protocols generally prevents this complication. Artificial rupture of membranes can be used to initiate labor and carries no increased cardiovascular risk.⁶

Management of the fetal heart rate tracing

The fetal heart rate tracing has become a core element of intrapartum management. Unfortunately, although the use of fetal heart tracings has shown a reduction in neonatal seizures, it has not made a significant difference in reducing perinatal mortality, cerebral palsy, or other measures of neonatal well-being.⁸ It has, however, served to increase the cesarean delivery rate.⁸

For fetal heart rate tracing resuscitation in cases of tachysystole or tetanic contractions causing fetal bradycardia, terbutaline is a first-line agent for uterine relaxation. This can cause a transient but significant increase in maternal heart rate. In general, this medication is safe to use.⁹ However, maternal tachycardia, chest discomfort, palpitation, tremor, headache, nasal congestion, nausea and vomiting, hyperkalemia, and hyperglycemia are all potential side

effects.¹⁰ In a population of cardiac patients, especially for lesions that are preload dependent, this tachycardia can be especially concerning (for example, in aortic stenosis, tachycardia leads to decreased left ventricular filling and ejection fraction and reduces cardiac output).¹¹

Endocarditis prophylaxis

In labor and delivery management, there are currently few indications for endocarditis prophylaxis. In the absence of an infection, antibiotic prophylaxis is no longer recommended, except for a small subset of patients. This is true for patients undergoing a trial of labor or having a cesarean delivery.¹² The American Heart Association and American College of Cardiology currently recommend intrapartum prophylaxis in high-risk cardiac lesions only when deliveries are associated with infection.¹³ Maternal congenital heart disease is no longer an automatic indication for routine endocarditis prophylaxis. There are certain high-risk cardiac lesions that should be considered for prophylaxis:

- A prosthetic cardiac valve or prosthetic material used for cardiac valve repair
- Previous infective endocarditis
- Congenital heart disease that meets one of the following conditions:
 - unrepaired cyanotic defect including palliative shunts and conduits,
 - defects repaired with prosthetic material or device within the past 6 months, and
 - incompletely repaired defects using prosthetic material.¹²

When there is an indication for endocarditis prophylaxis, there are several acceptable regimens (preferably given 30–60 min prior to delivery). These regimens include 2 g of ampicillin IV or 1 g of cefazolin IV. If a patient has a penicillin or ampicillin allergy, then a regimen of 1 g of ceftriaxone IV or 600 mg clindamycin IV is recommended, and if enterococcus infection is a concern, then 1 g of vancomycin IV should be added.¹²

If a patient has had a complete repair with the use of prosthetic materials or devices, this is not an indication for prophylaxis beyond 6 months post-procedure, as endothelialization should be complete by that time.¹³ These recommendations are fairly new, and there are often individualized recommendations by cardiac surgeons, cardiologists, and obstetricians for antibiotic prophylaxis.

Anticoagulation

There are certain conditions that warrant the use of anticoagulation during pregnancy. This becomes a critical issue for intrapartum management, as recent treatment with anticoagulation will affect the options for regional anesthesia available to the patient.¹⁴ Conditions that may necessitate anticoagulation therapy include the following:

- Recent thromboembolic event,
- Mechanical heart valves,

- Atrial fibrillation,
- Pulmonary hypertension, and
- Acquired and inherited thrombophilias.

In the setting of acquired and inherited thrombophilias, recommendations should be based on a history of previous thromboembolism, severity of thrombophilia, and associated risk factors.^{15,16} To optimize a patient receiving anticoagulation for regional anesthesia, a timed delivery may be indicated. Although enoxaparin (Lovenox) can be safely used in pregnancy, there have been reports of an epidural hematoma in the setting of recent enoxaparin use.¹⁴ Therefore, the recommendations are that regional anesthesia should be placed 10–12 h after the last prophylactic dose of enoxaparin and 24 h after the last therapeutic dose of enoxaparin.¹⁴ In the setting of prophylactic heparin use (5000 units twice daily), regional anesthesia can be safely placed; however, there is less safety data for higher doses (10,000 units twice daily or greater), and in these settings, an individual assessment is required.^{14,17} Heparin drip is also safe to use during labor and delivery. However, should the patient require a cesarean delivery, heparin should be stopped. Reversal with protamine sulfate can be considered, but should only be used if needed. Low-dose aspirin, commonly used for prevention of preeclampsia and used as an anti-platelet agent, is safe to use in pregnancy, and importantly, it does not need to be stopped prior to the onset of labor.¹⁸

Indications for full anticoagulation are less common and include but are not limited to acute thromboembolic disease in pregnancy and mechanical heart valves. It is important to note that unadjusted prophylactic regimens are insufficient for patients with mechanical heart valves; these patients require full anticoagulation.^{19,20} The standard regimen of choice includes warfarin, but this medication cannot be used in early pregnancy during organogenesis as it can cause a fetal embryopathy^{21,22} and cannot be used later in gestation as it can cause a fetal intracerebral hemorrhage.^{23,24} Notably, bioprosthetic valves require no anticoagulation therapy.²⁰ If the indication for anticoagulation is a mechanical heart valve, there seems to be a higher frequency of valve thrombosis with these medications as therapeutic levels are more difficult to obtain and to prove.^{19,25}

There is a paucity of data regarding the intrapartum management of newer medications such as the anti-platelet agents clopidogrel (Plavix) and new anticoagulant agents like dabigatran (Pradaxa), fondaparinux (Arixtra), and rivaroxaban (Xarelto).^{26,27} Clopidogrel, for example, has become more prevalent in the obstetric population as there is a growing cohort of patients with coronary stents in situ or who have a history of a myocardial infarction. There are few reports of pregnant women on clopidogrel, but concerns have been raised regarding an increased risk of bleeding associated with recent medication use, and therefore peripartum discontinuation of this medication at least 1 week before delivery is a reasonable consideration, especially in the setting of a plan for regional anesthesia.^{14,28}

Fluid management and oxygen supplementation

Other important management decisions to consider during labor and delivery are that of fluid hydration and oxygen supplementation. In general, all patients presenting to a labor and delivery unit have an IV placed and receive IV fluid hydration. However, fluid management decisions should be carefully assessed for cardiac patients. There are some conditions in which fluid hydration is important and others in which fluid restriction is critical. For example, lesions such as aortic stenosis require adequate fluid hydration as these lesions are preload dependent; these lesions require adequate volume to maintain cardiac output. In other lesions, such as mitral stenosis, it is critical to fluid restrict as these patients are at risk for pulmonary edema. Regardless of the lesion, close monitoring of fluid intake and output is essential.

Supplementation with oxygen often occurs during labor and delivery for fetal benefit, as it is an important maneuver in resuscitation of a fetal heart tracing. However, in cyanotic heart disease or in patients with shunt physiology (for example, congenital Eisenmenger's syndrome), oxygen supplementation is critical to maintain adequate oxygen saturation in proximal and distal extremities (with distal extremities as a surrogate marker for uterine blood oxygenation status). Maternal oxygenation can be sufficiently monitored via transcutaneous fingertip pulse oximetry.

Cardiac/hemodynamic monitoring

Intrapartum care requires constant monitoring of both maternal and fetal vital signs. Standard management includes maternal heart rate and O₂ saturation monitoring, with regular blood pressure and temperature evaluation. For patients with cardiac arrhythmias or with cardiac disease that is pre-disposed to arrhythmias, telemetry during intrapartum care is both possible and necessary. For this to be an effective management strategy, cardiac- or critical care-trained obstetric nursing is also essential. In the event of an arrhythmia, there may also be a need for interval electrocardiogram (ECG) assessment. An arterial line will provide direct measurements of blood pressure and provide access for serial blood gas assessments. Central line placement (usually via an internal jugular or subclavian venous access) can provide large-bore venous access, if indicated. More invasive monitoring may be indicated in patients who will not tolerate large or rapid fluid shifts, for instance in case of left-sided obstructive lesions such as aortic stenosis.²⁰

For most patients with cardiac disease, the aforementioned tools provide a comprehensive level of monitoring. However, there is a role, though ever decreasing, for invasive hemodynamic monitoring, specifically using pulmonary artery catheters, known as Swan–Ganz catheters. These catheters, when accurately placed, provide direct measurements of central venous, right-sided intracardiac, pulmonary arterial, and pulmonary artery wedges pressures. Samples of mixed venous blood from these catheters can be used to quantify oxygen utilization. The use of Swan–Ganz catheters overall remains controversial,^{29,30} and especially so in the obstetric population.^{20,31} In particular, these catheters should never be

placed in the setting of a corrected congenital heart disease. The decision to use invasive monitoring should be done on an individualized basis, after consultation with an interdisciplinary team, including cardiology, anesthesia, and maternal-fetal medicine specialists.

Anesthesia and analgesia

Although a detailed discussion of the effect of analgesia options available during labor and delivery is beyond the scope of this article and addressed in a separate article in this issue, it will briefly mentioned here as analgesia plays a critical role in intrapartum management. For many pregnant cardiac patients, there is a goal of early analgesia, preferably with an epidural to control maternal pain and anxiety, and therefore control maternal heart rate.³² Women with regional anesthesia have a less pronounced increase in cardiac output compared to women without regional anesthesia. This may be due to reduced pain and anxiety of the mother. After placement of regional anesthesia, there is potential for severe maternal hypotension, which can necessitate fluid boluses and may also affect cardiac output.⁵

In the event that anticoagulation was not stopped in time, or there is an anatomic or laboratory contra-indication to epidural, patient-controlled anesthesia (PCA) can be used. However, analgesia medication via an IV comes with the added risk of fetal exposure to the narcotic medications (as narcotics will cross the placenta) and inferior control of contraction-related pain. In the event that a cesarean delivery is indicated, if regional anesthesia is an option, epidural anesthesia is generally preferred to avoid the often-rapid drop in blood pressure associated with spinal anesthesia.^{2,20} Finally, general endotracheal anesthesia (GETA) is an option, should anatomic or laboratory concerns prevent use of regional anesthesia.

Special populations

Acute intrapartum events

During the intrapartum period, an acute coronary event is a rare but possible event for women with existing cardiac disease. Coronary angiography and percutaneous coronary intervention (PCI) are the mainstays of therapy.³³ Thrombolytic or fibrinolytic agents have been less well studied although preliminary data suggest that these can safely be used in pregnancy.³³ In settings of unstable angina, the goal is pain relief, anti-thrombotic therapy (with anti-platelet and anticoagulation agents), and initiation of beta-blocker therapy.³³

As many patients with cardiac disease are on telemetry, to allow monitoring for an arrhythmia, it is important to know how to manage such a complication. For some women prone to life-threatening arrhythmias, a defibrillator may be in place.³⁴ For other women, structural cardiac defect may predispose to arrhythmias, even without having had a previous arrhythmia event. Anti-arrhythmic medications have potential maternal and fetal side effects, and based on

general principles, the lowest recommended dose should be used and titrated to a clinical response³⁴ (Table).

Other cardiac emergencies that should be monitored for include pulmonary edema and anaphylaxis. Pulmonary edema should be managed by oxygen supplementation and diuretics. Anaphylaxis is treated initially by stopping the trigger medication and treating with H-2 blockers, diphenhydramine, epinephrine, and steroids, as needed.

Pacemakers/AICD (defibrillators)

There is little evidence to guide the management of patients with an automatic implantable cardioverter-defibrillator (AICD) in place. Certainly, patients requiring AICD placement are at risk of life-threatening arrhythmias, and recurrent ventricular tachycardia could cause under-perfusion of the placenta thereby causing harm to the fetus.³⁵ Conversely, mild tachycardia can be a normal part of the intrapartum process and there is the possibility of an inappropriate AICD shock.³⁵ It has been suggested that an AICD be left on during both vaginal and cesarean delivery, with the caveat that no electrocautery be used during surgery.³⁵ For some physicians, the inability to use electrocautery is unacceptable, and in these cases, the AICD should be turned off for surgery.^{36,37} Regardless of the approach, coordination between anesthesia, cardiology, and the obstetrical provider should be tailored to each individual patient.

Delivery planning

Assisted second stage

An operative vaginal delivery, via forceps or vacuum, is an important obstetrical tool. There are very few absolute contraindications to pushing (or, performing repetitive Valsalva maneuver) in pregnancy (see section on "Cesarean delivery indications" below). However, as a general principle, shortening the second stage of labor is thought to be beneficial for patients with cardiac disease. Parturients with preload-dependent disease or those with prior acute coronary syndrome should be strongly considered for an operative delivery.³⁸ The decision between forceps and vacuum is dependent on the clinical situation and the experience of the obstetrical provider.³⁹

Cesarean delivery indications

For certain conditions, notwithstanding the increased risk of infection, hemorrhage, and large volume shifts, a cesarean delivery is indicated. These conditions include dilated aortic root (>4 cm) or aortic aneurysm, acute severe CHF, history of recurrent MI, severe symptomatic aortic stenosis, need for emergent valve replacement immediately after delivery, and pulmonary hypertension necessitating extracorporeal membrane oxygenation (ECMO).² Cesarean delivery is also indicated when warfarin use occurred within 2 weeks prior to delivery for a risk of fetal intracranial hemorrhage.^{23,24} In these cases, careful preoperative planning with obstetric

Table – Commonly used anti-arrhythmic drugs during pregnancy.³⁴

Drug	Drug class	Primary indication	Potential adverse event	Comments
Quinidine	IA	Variety of maternal and fetal arrhythmias	Maternal and fetal thrombocytopenia, eighth nerve toxicity, and torsade de pointes	Long record of safety
Procainamide	IA	Drug of choice for acute treatment of undiagnosed wide complex tachycardia	Lupus-like syndrome with long-term use and torsade de pointes	Has the advantage of intravenous dosing and long record of safety
Lidocaine	IB	Maternal ventricular tachyarrhythmia and arrhythmia due to a digoxin toxicity	CNS adverse effects and bradycardia	Long record of safety, avoid if fetal distress
Phenytoin	IB	Arrhythmia due to a digoxin toxicity	Mental and growth retardation and fetal hydantoin syndrome	Better alternatives available, avoid if possible
Flecainide	IC	Variety of maternal and fetal ventricular tachycardia and SVT	Increased mortality in patients with previous myocardial infarction, generally well tolerated in structurally normal hearts	First-line option for treating fetal SVT with hydrops
Beta-blocking agents	II	Maternal SVT, idiopathic ventricular tachycardia, and atrial fibrillation rate control	Intrauterine growth retardation, fetal bradycardia, hypoglycemia, and fetal apnea	Generally well tolerated, avoid during first trimester, cardiac selective are preferred
Amiodarone	III	Life-threatening ventricular arrhythmias	Fetal hypothyroidism, prematurity, low birth weight, and congenital malformations	Avoid if possible especially during first trimester
Sotalol	III	Maternal ventricular tachycardia and SVT, and hypertension in the past	Torsade de pointes and beta-blocker effects	Limited experience
Verapamil	IV	Maternal and fetal SVT, idiopathic ventricular tachycardia, and atrial fibrillation rate control	Maternal hypotension, fetal bradycardia, and heart block	Relatively well tolerated but safer options are available
Diltiazem	IV	Maternal SVT and atrial fibrillation rate control	Limited experience, same concerns as with verapamil	Verapamil preferred due to longer record in pregnancy
Adenosine	N/A	Acute termination of maternal SVT	Dyspnea and bradycardia	First option for acute treatment
Digoxin	N/A	Fetal and maternal SVT and atrial fibrillation rate control	Low birth weight	Long record of safety

anesthesia and potential coordination with cardiac surgery teams is essential.

Postpartum management

Postpartum hemodynamic changes

Following delivery, there are several hemodynamic changes that occur. Cardiac output and stroke volume increase immediately after delivery, and then cardiac output begins to decline to prelabor values within 1 h and up to 1 day after delivery and continues to rapidly decrease during the first 2 weeks after delivery.⁴⁰ Heart rate remains elevated for approximately 24 h after delivery and then begins to decline to normal pre-pregnancy ranges within 10 days after delivery while blood pressure and blood volume tend to decline immediately following delivery and return to pre-pregnancy ranges within 10 days after delivery.⁴⁰ Within 2–3 weeks, most pregnancy-related hemodynamic changes tend to resolve; however, stroke volume and cardiac output may

never completely recover to pre-pregnancy baseline.^{20,40} The body must adapt postpartum to multiple cardiovascular parameter changes; for some patients with cardiac lesions, such as patients with cardiomyopathies or pulmonary hypertension, there remains an elevated risk of death in the postpartum period.^{41,42} Close surveillance following delivery by maternal–fetal medicine and cardiology is critical for such patients.

Postpartum hemorrhage

In addition to normal physiologic changes that occur after delivery, patients with cardiac disease should be followed closely for evidence of a postpartum hemorrhage. Most commonly, a postpartum hemorrhage is the result of uterine atony, retained placenta, coagulation abnormalities, or a uterine inversion.⁴³ Unrepaired vaginal or cervical lacerations may also result in a hemorrhage. Risk factors for a postpartum hemorrhage include prolonged, augmented, or rapid labor; prior postpartum hemorrhage; preeclampsia; overdistended uterus (macrosomia, multiple gestation, and

polyhydramnios); operative delivery; episiotomy; certain ethnicities (specifically Asian or Hispanic); and chorioamnionitis.⁴³ As previously stated, certain cardiac lesions are preload dependent. In contrast to the general obstetric patient who can tolerate a blood loss of 500–100 mL (or greater) before showing significant signs of anemia, cardiac patients have the potential to decompensate more quickly. Patients with cardiac disease may also be on anti-hypertensive medications (such as beta-blockers) that have the potential to block normal physiologic response (ie, tachycardia) to blood loss. Monitoring urine output is an excellent marker of volume status.

As routine management, the urinary bladder should be emptied via Foley catheter, as a full bladder (often a result of having regional anesthesia) may preclude contraction of the lower uterine segment. Bi-manual uterine massage may also alleviate uterine atony.⁴³

Standard medical treatment of a postpartum hemorrhage involves the following medications:

- oxytocin (Pitocin),
- misoprostol (Cytotec),
- carboprost (Hemabate), and
- methylergonovine (Methergine).

Oxytocin can be given IV (10–40 units in 1-L of normal saline or lactated Ringer's) or IM (10 units). Oxytocin can be run continuously after delivery, and most labor and delivery units have a postpartum oxytocin protocol. Undiluted or rapidly infused Pitocin has the potential to cause hypotension.⁴³ Misoprostol is administered rectally or buccally, up to 1000 mcg. Rectal misoprostol may cause GI upset/diarrhea. Carboprost is given IM (250 mcg) every 15–90 min (with an 8 dose maximum). This medication should be avoided in asthmatics and is relatively contraindicated in certain hepatic, renal, and cardiac diseases.⁴³ Diarrhea and tachycardia are common side effects. Methylergonovine is also given IM (0.2 mg) every 2–4 h or PO (0.2 mg) every 6 h. This medication should be avoided if the patient is hypertensive.⁴³

There are also non-invasive and surgical options. Vaginal packing can be considered; however, as the vagina is a potential space, this may not be an effective strategy. A Bakri balloon filled with 300–500 mL of saline may provide adequate tamponade, especially in the case of lower uterine segment atony. Surgical options include uterine curettage, uterine artery ligation, B-Lynch suture, hypogastric artery ligation, and hysterectomy.⁴³

Conclusion

Despite the potential risks, most women with cardiac disease can undergo a safe trial of labor and have a vaginal delivery. For a limited number of conditions, cesarean delivery is a safer option. Careful consideration of transition of anticoagulation and anti-platelet agents, in coordination with anesthesia and cardiology providers, will enable patients to have regional anesthesia. Endocarditis prophylaxis in the absence of an

ongoing infection should be used only when indicated, which is for a very limited number of cardiac patients. Cardiac and invasive hemodynamic monitoring should be employed on an individual basis. Providers should be ready to triage cardiac emergencies such as arrhythmias or acute coronary syndrome. Providers should also be ready for the management of a postpartum hemorrhage. With the increasing numbers of pregnant women with cardiac disease, obstetrical providers should be familiar with appropriate intrapartum management strategies and use a multi-disciplinary team approach to optimize the potential for a safe delivery and a healthy mother and child.

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