Objectives

- To recognize the physiological changes that occur during pregnancy
- To identify risk factors for adverse maternal and fetal outcomes
- To recognize that cardiovascular risks extend into the postpartum period
- To manage cardiac conditions during pregnancy

A 25 year old asymptomatic woman is referred for evaluation of a murmur noted during the early second trimester of pregnancy. She has no history of cardiac disease. Physical examination confirms a pulse of 95 beats per minute, blood pressure of 110/85 mmHg, a II/VI systolic ejection murmur at the left sternal border and an apical S3. What is the most likely cause of this murmur?

A. (A) Moderate aortic stenosis
B. (B) Tricuspid regurgitation
C. (C) Severe pulmonary stenosis
D. (D) Physiologic murmur
E. (E) Bicuspid aortic valve with severe aortic stenosis
Cardiovascular Changes in Pregnancy

NORMAL
- Brisk carotid upstrokes
- Mildly elevated JVP
- Systolic ejection murmur at LSB
- Mammary souffle
- S3 gallop
- Mild pedal edema
- Varicose veins

NOT NORMAL
- Lung rales
- Diastolic murmur
- Holosystolic murmur
- Fixed split S2
- S4

Changes in Existing Murmurs

- Stenotic lesions will get louder due to increased preload and cardiac output
- Regurgitant lesions will get softer due to decreased systemic vascular resistance
- A murmur from a ventricular septal defect also gets softer due to decreased SVR
Hemodynamic Changes Labor & Delivery

Labor:
- ↑ Cardiac output
- ↑ Heart rate
- ↑ Blood pressure
- ↑ Venous return
- ↑ Circulating blood volume with uterine contraction
- Post-partum: Auto-transfusion from placenta
- ↑ preload and CO

Hunter S. &r Heart J 1992

Pregnancy is a Hypercoaguable State

- Many hematological changes occur
- ↑ Clotting factors (VII, VIII, X, vWF)
- ↑ Platelet adhesion
- ↑ PAI-1, PAI-2 (produced by placenta)
- ↓ Fibrinolysis (due to ↑ fibrinogen)
- ↓ protein S activity

Increased risk for thrombotic events
20% arterial, 80% venous

Brenner B. Thrombosis Research 2004
James A. Hematology 2009

Prepregnancy Risk Assessment

Cardiovascular disease does not preclude pregnancy, but it poses increased risk to mother and fetus

CORRESPONDENCE

Pregnancy and Contraception in Congenital Heart Disease: What Women Are Not Told

- 37% of women denied having been told they were at increased risk of complications
- Only 50% had received contraceptive counseling

Kovacs A. J Am Coll Cardiol 2008
Why Risk Stratification is Important

- Increased morbidity and mortality associated with pregnancy
- Up to 20% maternal cardiac complications in women with congenital heart disease
- Rates of hypertensive syndromes, such as preeclampsia, are increasing
- Deaths attributable to maternal cardiac conditions have increased in the past decade

Berg C. J. Obstet Gynecol 2009

Maternal Cardiovascular Risk

An 22 yrold woman is referred to clinic to discuss the option of future conception. She has a history of “heart disease” which was surgically repaired in infancy. In performing your evaluation, which of the following factors poses the highest risk of maternal cardiac complications associated with pregnancy?

A. Restrictive ventricular septal defect
B. Left ventricular ejection fraction of 30%
C. Moderate aortic regurgitation w/ normal systolic function
D. Palpitations with occasional ventricular couplets
E. Bicuspid aortic valve with aortic stenosis and a peak LVOT gradient of 25 mmHg
Maternal Cardiac Risk Factors

- Prior cardiac event
- NYHA Class >II or cyanosis
- Left heart obstruction
- Left ventricular dysfunction

Mnemonic 15
1. Aortic valve area <1.5 cm²
2. Mitral valve area <2.0 cm²
3. LVOT peak grad >30 mm Hg
4. LVEF <40%

Siu S. Circulation 2001

Late Cardiovascular Events

NYHA class or cyanosis
Cardiac event during pregnancy
Subaortic ventricular dysfunction
Subpulmonary ventricular dysfunction
Left heart obstruction

Balint O. Heart 2010

High Risk Patients

WHO III
- Mechanical valve
- Systemic right ventricle
- Fontan circulation
- Other complex congenital heart disease
- Aortic dilatation 40-45 mm in Marfan syndrome
- Aortic dilatation 45-50 mm in aortic disease associated with bicuspid aortic valve

WHO IV
(pregnancy contraindicated)
- Pulmonary arterial hypertension of any cause
- Severe systemic ventricular dysfunction (NYHA III-IV)
- Previous peripartum cardiomyopathy with any residual impairment of left ventricular function
- Severe mitral stenosis, severe symptomatic aortic stenosis
- Marfan syndrome with aorta dilated >45 mm
- Aortic dilatation >50 mm in aortic disease associated with bicuspid aortic valve
- Native severe coarctation

Regitz-Zagrosek V. European Heart J 2011
A 35 yr old woman with a history of peripartum cardiomyopathy returns 18 months following the birth of her child. She desires a second pregnancy. She is asymptomatic, on no medications and her echocardiogram reveals a left ventricular ejection fraction of 30%. What is your recommendation?

A. (A) Proceed with pregnancy
B. (B) Start an ace-inhibitor and proceed with pregnancy
C. (C) Obtain a cardiac MRI and if her EF is improved, proceed with pregnancy
D. (D) Proceed with pregnancy with echo every trimester
E. (E) Counsel against pregnancy

Peripartum Cardiomyopathy
- Onset of heart failure in the last month of pregnancy through 5 months postpartum
- No other etiology identified
- No prior history of heart disease
- Demonstrable impairment in left ventricular systolic function:
  - Echocardiogram: LVEF <45%, SF <30%

Major cause of pregnancy related deaths in the United States


Pathogenesis of PPCM
- Viral antigen persistence
- Increased cytokine production
- Increased cardiac remodeling
- Increased cardiac fibrosis
- Increased cardiac apoptosis
- Increased cardiac dysfunction

Silva K. Lancet 2006
PPCM: Incidence

- Not well established
- Reports range from 1 in 1,485 to 1 in 15,000
- Although certain geographic locations have reported a higher incidence 1 in 1,000 (Africa)
- It is estimated that there are between 1,000 and 1,300 cases in the US annually

Pearson G. JAMA 2000

PPCM: Presentation

- Typical symptoms and signs of CHF
  - Shortness of breath
  - Fatigue
  - Chest pain
  - Palpitations
  - Weight gain, peripheral edema
- Findings are often masked by pregnancy
- Often first diagnosed in the post-partum period

PPCM: Prognosis

Elkayam U. J Am Coll Cardiol 2011
Risk Factors and Management

Risk factors:
- Multiple gestation
- Advanced maternal age
- Pregnancy induced HTN
- Tocolytic therapy

Management:
- CHF management
- Consider anticoagulation due to ↑ risk of thrombosis
- Deliver baby as soon as fetal lungs are mature

Onset of PPCM:

PPCM: Recovery of LV Function

- It is difficult to predict who will have recovery of function
- Subsequent pregnancies are associated with significant morbidities

A 22 year old woman who is 25 weeks pregnant presents with dizziness. On evaluation, her pulse is 150 and blood pressure is 80/50 and an electrocardiogram confirms atrial flutter. What is your initial management?

A. (A) Intravenous adenosine
B. (B) Intravenous beta-blocker
C. (C) Oral calcium channel blocker
D. (D) Intravenous amiodarone
E. (E) DC cardioversion
Arrhythmias
- Incidence of both atrial and ventricular arrhythmias increase during pregnancy
- Physiological changes in pregnancy alter the absorption, excretion and plasma concentration of antiarrhythmic drugs
- All antiarrhythmic drugs are myocardial depressants
  - Use the lowest effective doses
- DC cardioversion is safe

Hypertension in Pregnancy
- Definition: SBP ≥140 mmHg or DBP ≥90 mmHg
- ~5% of women have pre-existing HTN
- ~10% develop HTN after 20 weeks gestation
- Common therapies: labetalol, methyldopa, nifedipine
  - Hospitalization: SBP ≥170mmHg or DBP ≥110mmHg

Women with hypertension during pregnancy are at increased risk for long-term vascular events

Classification of HTN
- Pre-existing HTN (~5%)
  - Prior to 20 weeks gestation
- Pregnancy induced HTN (~10%)
  - Increase in systolic (≥30 mmHg) and diastolic (≥15 mmHg)
  - After 20 weeks gestation & resolution by 6 weeks postpartum
- HELLP syndrome
  - Hemolytic anemia, elevated liver enzymes, low platelets
  - 10-20% of women with preeclampsia
- After 20 weeks gestation & resolution by 6 weeks postpartum
- Eclampsia
  - Tonic clonic seizures

Preeclampsia

• A systemic vascular disorder
• New onset of hypertension and proteinuria during the 2nd half of pregnancy
• Occurs in 3-5% of pregnancies
• Sustained systolic or diastolic blood pressure ≥ 140 or ≥ 90 mmHg, respectively, with concurrent proteinuria ≥ 0.3 grams in 24 hrs

Powe C. Circulation 2011

A 21 year old woman with Marfan syndrome and an aortic root of 4.8 cm presents in the 2nd trimester of pregnancy. You counsel her that:

A. (A) She should start a beta-blocker, be followed closely for strict BP control and monthly echocardiograms
B. (B) She is not at an increased risk for aortic complications following pregnancy
C. (C) Future pregnancies should be avoided due to the risk of aortic dissection
D. (D) An ACE-inhibitor should be started immediately, as she is beyond the 1st trimester
E. (E) The chance that her child will have Marfan syndrome is >50%

Connective Tissue Disorders

Pregnancy increases the risk of long-term aortic complications in women with Marfan syndrome
Class Ia
• Counsel about the risk of aortic dissection and the heritable nature of the condition
• Strict blood pressure control
• Monthly/bimonthly echo measurements of the ascending aorta
Class IIIa
• It is reasonable to replace the aortic root and ascending aorta if the diameter > 4.0 cm in Marfan syndrome
• Fetal delivery via cesarean section is reasonable for patients with significant aortic enlargement, dissection, or severe aortic valve regurgitation

Hiratzka L. J Am Coll Cardiol 2010
Valvular Heart Disease

- Stenotic lesions are not well tolerated
- Mitral stenosis: ↑ heart rate and ↓ diastolic filling results in ↑ LA pressure and pulmonary edema
- Management: maintain sinus rhythm, beta-blockers, diuretics, invasive strategies only if severe compromise
- Prosthetic heart valves: specific challenges

No pregnancy in a woman with a mechanical valve is safe

Endocarditis in Pregnancy

- Rare, yet life-threatening
- High maternal mortality rate, between 11 and 33%
- Death due to emboli, heart failure
- Highest maternal mortality for aortic valves
- Rheumatic heart disease cases declining, IVDA cases increasing
- High fetal mortality, between 15 and 33%
- Most common species: Streptococcus

2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines

Class IA
- Warfarin is recommended for all pregnant patients with a mechanical valve in the 2nd and 3rd trimesters
- Warfarin should be discontinued with initiation of UFH before a planned vaginal delivery
- Low dose aspirin (75-100 mg/day) is recommended in the 2nd and 3rd trimesters for pregnant women with both mechanical valve or bioprosthesis
- Class IIA
  - Continuation of warfarin during the 1st trimester of pregnancy is reasonable if the dose is <5 mg/day

Nishimura R. Circulation 2014

2003 Kebed Y Mayo Clinic Proc

Campuzano K Arch Gynecol Obstet 2003
Kebby Y Mayo Clinic Proc 2014
Question 6
A 43 yr old woman who is 30 weeks pregnant presents with chest pressure and shortness of breath. She is a smoker, and is on medical therapy for HTN and diabetes. Her electrocardiogram is shown here:

A. (A) Serial troponins and observation
B. (B) Coronary angiography
C. (C) Thrombolysis
D. (D) Cardiac MRI with viability
E. (E) Start aspirin and deliver the baby

Acute Myocardial Infarction

- Acute MI in pregnancy is rare
- Must rule out coronary artery dissection
- Case fatality rate is between 5 and 37%
- Risk factors include:
  - Hypertension - Diabetes
  - Age > 30 yrs - Smoking
  - Thrombophilia - Tranfusions
  - Postpartum infection
- Occurrence up to 6 weeks postpartum

James A. Circulation 2006
Ladner H. Obstet Gynecol 2005
Cardiopulmonary bypass during Pregnancy

- Results in utero-placental hypoperfusion
- Maternal outcomes are similar to cardiac surgery in non-pregnant women
- Poor fetal outcomes (up to 33% mortality): fetal mortality improved if CPB is delayed
- Perfusion strategy to ensure adequate placental homeostasis includes high-flow, high-pressure, normothermia and brief CPB time

Kapoor MC. Ann of Cardiac Anesthesia 2014

Resuscitation Guidelines:
Cardiac Arrest

- Place the patient in the full left-lateral position to relieve possible compression of the inferior vena cava
- Give 100% oxygen
- Establish IV access above the diaphragm
- Assess for hypotension
- Consider & treat reversible causes
- Emergency cesarean section may be considered at 4 minutes after onset of maternal cardiac arrest if there is no return of spontaneous circulation (Class IIb, LOE C)

AHA Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care
Vanden Hoek T. Circulation 2010

It’s Not Just the Mother…

- Adverse Obstetric Outcomes
  - Higher rates of premature rupture of membranes, postpartum hemorrhage
- Adverse Neonatal Outcomes
  - Higher rates of preterm birth, small for gestational age neonates, respiratory distress, intraventricular hemorrhage and death
  - Congenital heart disease in the offspring
**Summary**

- Physiologic changes are dramatic during pregnancy and delivery.
- Established maternal cardiac risk factors include:
  - Prior event, poor functional capacity, cyanosis
  - Elevated pulmonary vascular resistance, connective tissue disorders

**Mnemonic**

1. (Aortic valve area < 1.5 cm$^2$)
2. (Mitral valve area < 2.0 cm$^2$)
3. (LVOT peak gradient > 30 mm Hg)
4. (Systemic ventricular EF < 40%)

- These risks extend into the postpartum period.
- Women with cardiac events in pregnancy have a higher risk of cardiac complications later in life.

**References**

References


References


References


*Denotes articles not included in presentation, but contains helpful information.