Heart Disease in Pregnancy

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No disclosures
Objectives

- Understand the hemodynamic changes of pregnancy
- Review normal clinical and structural findings in pregnancy
- Review risk stratification of the pregnant patient with cardiac disease
- Review cardiac contraindications to pregnancy
- Review cardiac indications for cesarean delivery
- Review specific cardiac conditions in pregnancy

Hemodynamic changes

![Hemodynamic changes chart](image_url)

*Braunwald's Heart Disease, 9th ed.*
Pregnancy is a stress test for the heart

- Peripheral resistance ↓
- Uterine blood flow ↑
- Blood volume ↑ 40-50%
- Heart rate ↑ 10-20%
- Blood pressure ⇧ or ⇩
- Pulmonary vascular resistance ↓
- Venous pressure lower extremities ↑

Cardiac output ↑ 30-50%

Other notable changes

- Vascular derangements
  - Arterial & venous capacitance ↑
  - Collagen synthesis & deposition ↓
- Alterations in coagulation
  - Protein S activity/fibrinolysis ↓
  - Stasis → venous hypertension
  - Platelet adhesiveness/clotting factors ↑

Predisposes toward vascular dissection/aneurysm/rupture

Predisposes toward hypercoagulability
Clinical evaluation in a normal pregnancy

**Symptoms**
- Dyspnea, fatigue, reduced exercise capacity
- Non-exertional chest pain

**Physical findings**
- Bounding pulses
- Widened pulse pressure
- Normal JVP or mild JVD
- Hyperkinetic, displaced and enlarged PMI
- Loud S1, prominently split S2, +S3
- Systolic flow murmurs (mid-to-upper LS border)
- Cervical venous hum, internal mammary flow (souffle)
- Peripheral edema, varicose veins

Abnormal cardiac findings

- Exertional chest pain
- Exertional syncope
- Cyanosis, clubbing
- >2/6 systolic murmur
- Fixed split S2
- Left parasternal lift &/or loud P2
- Diastolic murmur

Diagnostic workup...
ECG changes with pregnancy

Heart rate increases
Third trimester left axis deviation < -30
Inferior ST-segment depression, NSSTT \( \Delta \) es left precordial leads Q's in III, aVF
Shortened PR/QT intervals with ↑ in HR

Echocardiography in pregnancy: what is normal?

<table>
<thead>
<tr>
<th>Feature</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left atrium</td>
<td>↑ 10-15%</td>
</tr>
<tr>
<td>Left ventricle</td>
<td>↑ LVEDD 5-10%,  ↓ LVESD</td>
</tr>
<tr>
<td>RA/RV</td>
<td>Dilatation</td>
</tr>
<tr>
<td>Aortic/pulmonic VTI</td>
<td>Increased</td>
</tr>
<tr>
<td>Small pericardial effusion</td>
<td>~20% of normal pregnancies</td>
</tr>
<tr>
<td>MV/TV annulus</td>
<td>Increase TV&gt;MV</td>
</tr>
<tr>
<td>Mitral valve</td>
<td>Altered coaptation</td>
</tr>
<tr>
<td>Inferolateral wall</td>
<td>Pseudo-wall motion abnormality</td>
</tr>
<tr>
<td>E/A ratio</td>
<td>Equalizes/reverses</td>
</tr>
<tr>
<td>Aortic root</td>
<td>↑ 2-3 mm</td>
</tr>
<tr>
<td>LVOT diameter</td>
<td>↑ 1-2 mm</td>
</tr>
</tbody>
</table>
Maternal cardiac disease and risk assessment

- Complicates 1-4% pregnancies in western countries
- NYHA functional class predicts outcome
  - III/IV: 7% mortality, 30% morbidity
- Perform pre-pregnancy risk assessment
  - Exercise capacity: ETT/metabolic ET
  - History of heart failure, arrhythmia, hypertension, diabetes, lipids, smoking, family history
  - ECG
  - Echocardiogram/CMR: assess anatomy, lesion severity, hemodynamics

Pre-pregnancy counseling is ideal

- Risk to patient
  - Maternal risk stratification:
    - History, exam, ETT/CPET, ECG, echo, (CMR)
    - Endocarditis prophylaxis?
    - Recommendations for labor and delivery
- Risk to fetus
  - Likelihood of congenital disease: fetal echo, genetic counseling
  - Eliminate teratogens
- Consider need for procedure/surgery
- Consider lifespan/functional status of mother
Risk stratification of pregnant cardiac patients

Carpreg Investigators

- Congenital acyanotic conditions:
  - Shunts
  - Coarctation
  - Bicuspid aortic valve
  - Pulmonic stenosis
  - Univentricular
- TOF/DORV
- Transposition
- Ebstein’s
- Marfan

- Congenital cyanotic conditions
- Acquired valvular disease
- Cardiomyopathies
- Ischemic heart disease
- Pulmonary hypertension
- Arrhythmias
- Conduction disease

- Retrospective outcomes analysis of 221 women with cardiac disease who had 252 pregnancies
- Findings applied in prospective study to 562 women with cardiac disease

Siu et al., Circulation 2001

Primary cardiac event occurred in 13% of women

Events = pulmonary edema, symptomatic arrhythmia, stroke, cardiac arrest, death

Table 4 Predictors of maternal cardiovascular events and risk score from the Carpreg study

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Risk Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior cardiac event (heart failure, transient ischemic attack, stroke before pregnancy or arrhythmia)</td>
<td>0 point: 5%</td>
</tr>
<tr>
<td>Baseline NYHA functional class &gt; II or cyanosis.</td>
<td>1 point: 27%</td>
</tr>
<tr>
<td>Left heart obstruction (mitral valve area &lt; 2 cm², aortic valve area &lt; 1.5 cm², peak LV outflow tract gradient &gt; 30 mm Hg by echocardiography)</td>
<td>&gt; 1 point: 75%</td>
</tr>
<tr>
<td>Reduced systemic ventricular systolic function (ejection fraction &lt; 40%)</td>
<td>LV = left ventricle; NYHA = New York Heart Association.</td>
</tr>
</tbody>
</table>
WHO classification of risk

Low risk!

WHO Class II-III are at moderate risk
WHO class III are high risk

- Mechanical valve
- Systemic right ventricle
- Fontan circulation
- Cyanotic heart disease (unrepaired)
- Other complex congenital heart disease
- Aortic dilation 40–45 mm in Marfan syndrome
- Aortic dilation 45–50 mm in aortic disease associated with bicuspid aortic valve

Consider avoidance/termination of pregnancy (WHO class IV)

- Pulmonary hypertension (Mean PAP ≥ 25 mm Hg)
- Cardiomyopathy with heart failure
  - Ejection fraction <30% or class III/IV symptoms
- History of peripartum CM, residual impairment in EF
- Marfan syndrome with dilated aortic root >45 mm
- Bicuspid aortic valve with aortic dilation >50 mm
- Severe mitral stenosis
- Severe symptomatic aortic stenosis
- Native severe coarctation
Valvular heart disease

The Effect of Valvular Heart Disease on Maternal and Fetal Outcome of Pregnancy

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OBJECTIVES
The aims of this study were to evaluate the association between valvular heart disease (VHD) and maternal and fetal outcomes, as a relatively large group of patients is a common referral group to tertiary care centers. A retrospective analysis of the effects of valvular heart disease on pregnancy outcomes is valuable for high-risk outcomes and the design of future research.

BACKGROUND
Valvular heart disease (VHD) is a leading cause of morbidity and mortality in women. The impact of VHD on maternal and fetal outcomes is not clearly understood.

METHODS
A retrospective, single-center, observational study was conducted. The study cohort included women with VHD who delivered at the high-risk OB/cardiology clinic. The primary outcomes were maternal and fetal complications, including CHF, arrhythmias, hospitalization, and perioperative cardiac medications. The secondary outcomes were fetal complications, including intrauterine growth restriction (IUGR), preterm delivery, and stillbirth.

RESULTS
Women with VHD had a significantly higher incidence of congenital heart disease (39% vs. 9%, p < 0.0001), arrhythmias (11% vs. 0%, p < 0.002), and cardiac medications (41% vs. 2%, p < 0.0001). The perinatal outcomes were similar to controls except for a higher incidence of fetal hospitalization (4% vs. 2%, p = 0.039), and a reduced birth weight (2,397 ± 347 g vs. 2,850 ± 547 g, p < 0.0001). Increased maternal morbidity and mortality are relatively infrequent in patients with VHD.

CONCLUSIONS
Pregnancy in women with VHD and AS is associated with increased risk of maternal complications and significant effect on fetal outcomes, which are related to severity of disease. Women with moderate and severe mitral and aortic stenosis have a higher risk of complications during pregnancy.

Study conclusions

- Women with valvular heart disease have higher risk of:
  - CHF: 35 vs 0%
  - Arrhythmias: 15 vs 0%
  - Initiation/increase in cardiac meds: 41 vs 2%
  - Hospitalizations: 35 vs 2%

- Fetuses have higher risk: preterm delivery, IUGR, stillbirth

- Most adverse outcomes occur in women with moderate and severe mitral and aortic stenosis

- If mild disease, outcomes were similar to controls
Mitral stenosis

- ↑ Heart rate
- ↓ Diastolic filling time
- Volume load of pregnancy

Preload, hypotension sensitive

↑ LA/PV pressure → Heart failure, ischemia

↓ Placental perfusion → IUGR, preterm labor

Clark S. Crit Car Clin 91'; Barbosa. Arq Bras Card 00''

Rheumatic deformity of the mitral valve

06/16/2005 13:04:43
Regurgitant valves are better tolerated

- Etiologies in reproductive age women:
  - Mitral: prolapse, endocarditis, rheumatic
  - Aortic: bicuspid, endocarditis, dilated annulus, rheumatic
- ↓ in SVR can ↓ L-sided regurgitation
- Medical management:
  - Diuretics, vasodilators IF hypertensive
    - ACE-I/ARB contraindicated
    - Consider hydralazine, nitrates, nifedipine
- Vaginal delivery preferred

Diseases of the aorta

- Marfan syndrome
- Ehlers-Danlos syndrome
- Turner syndrome
- Vasculitides (Takayasu, SLE, RA, GCA)
- Familial annuloaortic ectasia
- Image entire aorta
- Surgery if >45 mm
- Consider c/s if aorta 40-45
Bicuspid aortic valve

- Stenosis or regurgitation
- Associated aortopathy in 50%
- Surgery pre-pregnancy if >50 mm
- May be autosomal dominant
- If stenosis, ETT pre-pregnancy
- Heart failure ~10% with severe AS

Prosthetic valves

- Mechanical vs. bioprosthetic
- Pregnancy ↑ es risk of prosthetic valve complications
  - Thromboemboli, valve dysfunction, bleeding, endocarditis, reoperation, death
  - Mostly due to hypercoagulable state
- Valve thrombosis maternal mortality rate 1-4%
- Baseline TTE, aspirin

Elkayam, JACC 2005; Chan WS, Archives, 2000
Warfarin (OAC) vs. heparin/LMWH

- OAC confers greatest maternal protection of all strategies
- OAC cross placenta → fetal cerebral hemorrhage
- Fetal exposure weeks 6-12 ↑ risk of embryopathy (0.6-10%)
  - Controversial if dose related (>5 mg)
- OAC throughout pregnancy ↑ risk fetal loss, spontaneous abortion, prematurity, stillbirth
- Large review: risk of thrombosis
  - 3.9% if OAC
  - 9.2% if UFH substituted T1
  - 33% if UFH throughout pregnancy

Elkayam, JACC 2005; Chan WS; Archives, 2000 Vitale N JACC 99; Wesseling J, Thrombosis Haemo 01

Choices of anticoagulation in pregnancy

2004 American College of Chest Physicians
Consensus on Antithrombotic Therapy in Pregnancy

1. Aggressive adjusted dose LMWH throughout pregnancy:
   Dose adjust to weight OR as necessary for anti-Xa level
2. Adjusted dose UFH throughout pregnancy: Use PTT at ≥ 2x control, or anti-Xa heparin level
3. Use of UFH or LMWH weeks 6-12 & starting the middle of third trimester; warfarin all other times.

Warfarin during first trimester NOT recommended by ACCP

Bates SM, Chest 2004
Case example: This 32-year-old woman presents with clinical heart failure and the following echocardiogram two weeks after an uncomplicated delivery. She had normal left ventricular systolic function prior to pregnancy, and no known history of heart disease or any other comorbidities. She had regular prenatal care during pregnancy.
Peripartum cardiomyopathy: criteria

- Development of cardiac failure in last month of pregnancy or within 5 months of delivery
- Absence of other identifiable cause of heart failure
- Absence of recognizable disease prior to last month of pregnancy
- LV systolic dysfunction by classic echo criteria
  - EF <45%
  - Fractional shortening <30%

Prognosis is better than other cardiomyopathies

1,230 patients with cardiomyopathies
Prognosis is best if EF is >30% at diagnosis

- Recovery usually by 6 months after diagnosis
- Recovery to EF ≥ 50% in 54% of patients, n=123
- Predictors of persistent LV dysfunction:
  - LVEF <30%
  - FS <20%, LVEDD ≥ 6 cm
  - Elevated TnT
- Recurrence risk 30-50%

Case example: A 34 week pregnant woman with hypertension, obesity, diabetes, and hyperlipidemia presents to the ED in active labor with severe substernal chest discomfort associated with nausea and diaphoresis. After a GI cocktail fails to relieve her symptoms, an ECG is obtained.
Myocardial infarction

- Rare event in child-bearing women
- Risk ↑ 3-4 fold in pregnancy/early post-partum
- Nationwide Inpatient Sample of pregnancy discharges
  - 859 discharges with MI (12.5 million deliveries, ~1000 hospitals)
  - Incidence of 6.2 in 10,000 pregnancies (usual range 3-10/10K)
- Recent study from U.K.
  - Ischemic heart disease most common cause of cardiac disease leading to maternal death


- Ischemic heart disease most common cause of cardiac disease leading to maternal death

Review of 103 cases, 1995-2005: 96 coronary arteries reviewed

- Spontaneous coronary dissection major mechanism in peripartum period
- Predisposing factors:
  - Hypercoagulability
  - ↑ Myocardial oxygen demand (blood volume, SV, HR)
  - ↓ Reduced myocardial oxygen supply (anemia, ↓ diastolic BP)

Roth A et al JACC 2008, Roth A. Annals 1996
Risk factors for MI during pregnancy in 859 cases

- Other risk factors: age >35, hyperlipidemia, family history
- Pregnancy-related risk factors: pre-eclampsia, postpartum hemorrhage, post-partum infection, transfusion

Unique etiologies of myocardial infarction

- Collagen vascular disease/vasculitis
- Paradoxical embolization
- Sickle cell
- Pheochromocytoma
- Coronary ostium trauma (papillary fibroelastoma)
- Cocaine/methergine-induced vasospasm
- Prosthetic valve thrombosis/vegetation
Myocardial infarction in pregnancy

- Most events T3→6-weeks postpartum
- Anterior wall most common location
- Troponins for diagnosis during/after L&D
- Treatment of choice: 1° PCI + fetal shielding
- Thrombolytics used if no PCI capable hospital
- Management similar:
  - Beta-blockers, aspirin, clopidogrel, heparin, nitrates, diuretics
  - Stop clopidogrel ~ 37 weeks electively
  - Stop heparin at onset of L&D (6h for heparin, 24 h for LMWH)
  - Attempt to hold off delivery for at least 2-3 weeks


Arrhythmias in pregnancy

- Most common cardiac complication in pregnancy
- High recurrence if structural disease
- History of arrhythmias confers ↑ risk of CV events
- ↑ risk of neonatal/fetal events
  - Associated with prematurity: medication or arrhythmia?

Tan HL, Eur H J 01', Siu, SC. Circ 01': CARPREG investigators; Hack M. Arch Pediat Adolesc Med 00
Atrial/ventricular stretch
- Ion channels activated
- Membrane depolarization
- Slowed conduction
- Shortened refractoriness

Hyperdynamic state

Higher resting heart rate
- Late potentials
- VPBs
- ↓ HR variability

↑ adrenergic responsiveness
- Estrogen ↑ myocardial α receptors → enhanced automaticity, triggered activity

Arrhythmogenesis

Recurrence Rates of Arrhythmias During Pregnancy in Women With Previous Tachyarrhythmia and Impact on Fetal and Neonatal Outcomes
Cardio K. Silversides, MD, SM*, Louise Harris, MD®, Kym Hambert, Barcics, MA", Madhur Somani, MD®, Jack M. Colman, MD®, and Samir I. Sin, MD, SM®

- 1° endpoint: sustained/symptomatic arrhythmia
- Pregnancy (n) with arrhythmia:
  - 36: PSVT
  - 23: p-AFib/p-AFlutter
  - 6: Persistent AF/flutter
  - 22: Ventricular tachycardia
    - Long QT
    - Structural heart disease (50%)
    - Catecholamine-mediated VT

73 women, 87 pregnancies
64% had congenital heart disease
Arrhythmia recurrence rate was high at 44%

- 81% of arrhythmias antepartum
- Higher when compared to similar studies:
  - Recurrence rate 29% (Tawan M. AJC 93)
  - Recurrence rate 22% (Lee SH. AJC 95)
- Pulmonary edema most common complication at 14%
- Recurrence rate greatly adverse fetal/neonatal event
- Fetal complications 20%

<table>
<thead>
<tr>
<th>Variable</th>
<th>DNT</th>
<th>Preconceptual</th>
<th>Recurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of pregnant</td>
<td>36</td>
<td>29</td>
<td>8</td>
</tr>
<tr>
<td>% of cases</td>
<td>51</td>
<td>34</td>
<td>6</td>
</tr>
<tr>
<td>Adverse fetal/neonatal event*</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Premature birth</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Stillborn/infant death</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Fetal bradycardia</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Fetal demise</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

* Adverse fetal/neonatal events were not mutually exclusive. Abbreviation as in Table 1.

Arrhythmia treatment considerations

- Lack of randomized controlled trials
- Greatest risk of teratogenicity in first 8 weeks
- Risks later in pregnancy:
  - Fetal growth/development
  - Drug-induced adverse effects
  - Proarrhythmia in fetus
  - Effects on uterine contractility
- Antiarrhythmics cross placenta & are excreted in breast milk
- Close monitoring: altered absorption, bioavailability, elimination
- Catheter ablation if refractory arrhythmia/intolerable symptoms/hemodynamic instability
Cardioversion and implantable defibrillators in pregnancy

- Cardioversion safe in all stages
- Risk of inducing fetal arrhythmias low
  - current reaching fetus insignificant
  - fetus has ↑ fibrillation threshold
- Pregnancy with ICD
  - Not associated with adverse maternal/fetal events
- Retrospective multicenter study on outcomes in ICDs: 25% of 44 patients had shock
  - Pregnancy did not ↑ shocks/ICD complications

Schroeder JS. Am J Card 71; Lee RV Am J Med 86; Natale A Circ 97; Piper JM. Am J Ob Gyn 92

Congenital heart disease (CHD)

- Heart failure, arrhythmias, stroke
- Cardiovascular complications (arrhythmia, HF, pregnancy related hypertension) occur in ~ 11% of pregnant patients
- Should be followed closely at a tertiary care center by a cardiologist, high-risk OB specialist, and be evaluated in advance by anesthesiology
Arrhythmias in 4.5%
Heart failure in 4.8%
Thromboembolic complications in 2%

Planning for labor/delivery

- Minimize cardiac workload
  - Epidural/oxygen/left lateral decubitus
  - Treat hypertension/tachycardia/arrhythmia
  - Assisted delivery

- Plan for rapid delivery if maternal decompensation
  - Cesarean within 4-5 minutes

- Try to avoid oxytocin and ergonovine
- Filter I.V. if intracardiac shunt
Indications for surgical delivery

- Active labor on coumadin
- Fixed severe obstructive lesions

Consider if:
- Unstable aorta: dissection, expansion, Marfan + dilated aorta >40-45 mm
- Advanced heart failure, especially hemodynamic instability
- Severe pulmonary hypertension (if deterioration)
- Cyanosis (if deterioration)
Objectives

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- Review specific cardiac conditions in pregnancy