Caring for Pregnant Women with Cardiac Disease

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Objectives

• Review the physiologic effects of pregnancy, labor, and birth and how they impact a pregnant woman with underlying cardiac disease
• Review some cardiac diagnoses through definition and case studies
• Describe special considerations related to caring for women with cardiac disease
Prevalence

• The incidence of congenital cardiac disease in the general population is approximately 1 in every 100 births
• Congenital heart diseases are the most common birth defects in humans
• Many advances in reparative surgeries and treatments over the last 50 years have caused remarkable improvements in survival rates
• Neonatal repair of complex cardiac lesions began in the 1970’s

Prevalence, continued

• Since the 1970’s, approximately 85% of patients born with congenital cardiac disease are surviving into adulthood
• Adults with CHD now outnumber children with CHD in the US
• Within the next decade, it is estimated that 1 in every 150 people will have some form of congenital heart disease
• Many of these people are making it to adult reproductive age and starting families
Prevalence, continued

- Spectrum of cardiovascular diseases are changing
  - Increasing maternal age
  - Preexisting conditions (obesity, diabetes, hypertension)
  - Congenital heart disease is the most frequent cardiovascular disease in pregnancy
  - Maternal heart disease is a major cause of maternal mortality during pregnancy

Definitions

- Preload
  - Volume of blood contained in a ventricle at the end of diastole
  - Determined by blood return to the ventricle
  - Directly related to intravascular volume

- Afterload
  - Represents the downstream resistance to each ventricle during cardiac systole
  - Cardiac output is inversely related to afterload
  - Clinically assessed as systemic vascular resistance
Definitions, continued

• **Ejection Fraction (EF)**
  – Can be measured by Echocardiogram, cardiac catheterization, MRI, CT
  – Usually measuring the percentage of blood leaving the left ventricle with each contraction
  – Normal is 55-70%
  – May be looked at as part of a “stress” test

• **NYHA Classification - stages of heart failure**
  – Functional classification system relating symptoms to ADLs/quality of life
  – Often used to determine the best course of therapy

NYHA Classifications

• **Class I (Mild)**
  – No limitation of physical activity. Ordinary activity does not cause undue fatigue, palpitation, SOB.

• **Class II (Mild)**
  – Slight limitation of physical activity. Comfortable at rest; ordinary physical activity results in fatigue, palpitation, SOB.

• **Class III (Moderate)**
  – Marked limitation of physical activity. Comfortable at rest; less than ordinary activity causes fatigue, palpitation, SOB.

• **Class IV (Severe)**
  – Unable to carry out any physical activity w/out discomfort. Symptoms of cardiac insufficiency at rest. Increased discomfort w/ any physical activity.
Stratification of Risk

- **Highest risk of complications or death**
  - Pulmonary hypertension
  - Complicated coarctation of the aorta
  - Marfan syndrome with dilated aortic root
  - Severe symptomatic aortic stenosis
  - Single ventricle with poor systolic function

- **Moderate risk (5 to 15%)**
  - Unrepaired cyanotic defects
  - Mitral stenosis (NYHA classes III and IV)
  - Uncorrected or palliated tetralogy of Fallot
  - Previous myocardial infarction
  - Well-functioning Fontan circulation
  - Systemic right ventricle (d-TGA, l-TGA)
Stratification of Risk

- **Lowest risk of mortality (approximately 1%)**
  - Isolated ASD or VSD, repaired or not
  - Pulmonic or tricuspid disease
  - Repaired tetralogy of Fallot with normal RV function and competent pulmonic valve
  - Repaired coarctation with normal aortic size

Physiologic Changes

- **Pregnancy is a high volume, low resistance state**
- **Circulating blood volume increases 30 to 45%**
  - Peaks at 28 to 34 weeks gestation
  - Volume 1200 to 1600 mL greater than non-pregnant
  - More pronounced in multiple gestation pregnancies
Physiologic Changes, continued

- **Cardiac output increases 30 to 40%**
  - Increases by 20% by 8 weeks gestation
  - Peaks by 20 to 24 weeks gestation
  - 30% increase in stroke volume
  - Heart rate increases by 10 to 15 beats per minute
  - During delivery, pain can increase CO and SV 45%

  About 2% of pre-pregnancy cardiac output goes to the uterus...in the 3rd trimester, it is about 17%


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Physiologic Changes, continued

- **Systemic vascular resistance decreases 30% by 8 weeks gestation**
  - Associated with increased cardiac output, hormones, prostaglandins, heat produced by the fetus, low resistance placental bed

Physiologic Changes, continued

• Mild decrease in mean blood pressure
  – After 28 weeks, patients may have hypotension from aortocaval compression

• Oxygen consumption is higher in the pregnant woman for all levels of exertion
  – Total consumption increases approximately 20% in pregnancy
  – Increased sensitivity to carbon dioxide


Physiologic Changes, continued

• Increased glomerular filtration rate
  – Can make achieving therapeutic doses of meds difficult

• Pregnancy is a hypercoagulable state
  – Factors VII, VIII, X, and fibrinogen are increased

Physiologic Changes, continued

- **Gravid uterus effects blood flow**
  - Compresses iliac veins and inferior vena cava
  - Decreases blood flow to the lower extremities increasing risk of thrombosis

- **Placental blood flow**
  - 50 mL/min in the 1\textsuperscript{st} trimester
  - 500-600 mL/min by the end of the 3\textsuperscript{rd}

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**Normal Physiologic Changes, continued**

<table>
<thead>
<tr>
<th>Cardiovascular adaptations during pregnancy</th>
<th>Average change during pregnancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood volume</td>
<td>↑ 3%</td>
</tr>
<tr>
<td>Cardiac output</td>
<td>↑ 40 – 43%</td>
</tr>
<tr>
<td>Stroke volume</td>
<td>↑ 30%</td>
</tr>
<tr>
<td>Heart rate</td>
<td>↑ 15 – 17%</td>
</tr>
<tr>
<td>Systemic vascular resistance</td>
<td>↓ 15 – 21%</td>
</tr>
<tr>
<td>Mean arterial pressure</td>
<td>No significant change</td>
</tr>
<tr>
<td>Systolic blood pressure</td>
<td>↓ 3 – 5 mm Hg</td>
</tr>
<tr>
<td>Diastolic blood pressure</td>
<td>↓ 5 – 10 mm Hg</td>
</tr>
<tr>
<td>Central venous pressure</td>
<td>No significant change</td>
</tr>
<tr>
<td>Serum colloid osmotic pressure</td>
<td>↓ 14%</td>
</tr>
<tr>
<td>Hemoglobin</td>
<td>↓ 2.1 g/dl</td>
</tr>
</tbody>
</table>


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From: Abbas, et al.  
Preg. & the Cardiovascular System  
Int J of Cardiology  
Table 1
Hemodynamic Changes by Week of Gestation

- Vol: plasma volume
- HR: heart rate
- SV: stroke volume

Changes During Labor and Birth

- Valsalva maneuvers during active labor can result in marked fluctuations in central venous pressure and preload
- Autotransfusion of uteroplacental blood flow back into maternal circulation
  - With each contraction, about 300 mL
    - Further increases blood volume and cardiac output by 10-25%
    - Can be seen with invasive monitoring (CVP) before the toco registers
  - At placental separation, 300 to 500 mL

From: Harris, I.S.
Mgmt of Preg in Patients w/ CHD
Prog Cardiovasc Dis, 2011; 53
Figure 1, p. 306

Abbas, et al.; Harris
Changes During Labor and Birth, cont.

- Delivery of the uterine contents can cause significant maternal hemodynamic shifts
  - Blood loss at delivery
  - Immediately after delivery, cardiac output rises 60 to 80% above pre-labor levels then decreases rapidly after 10 to 15 minutes and continues to decrease to pre-labor levels by about 1 hour
  - Decreased systemic vascular resistance occurs due to the absence of placental blood flow

To Simplify ... Two Categories

- Valvular Disease
  - Left sided valve dz > complications than right
  - Aortic insufficiency
  - Mitral or Aortic stenosis
  - Mitral regurgitation

- Structural Disease
  - Abnormal heart formation
  - Tetralogy of Fallot
  - Single ventricle physiology
Aortic Stenosis – Valvular Disease

- Narrowing of the aortic valve that obstructs blood flow from the left ventricle
  - Leads to left ventricular hypertrophy and “preload” dependence
    - Can compromise systemic cardiac output and difficulty with volume shifts
  - Can be mild, moderate, or severe
  - Symptomatic severe AS or asymptomatic AS with impaired LV fxn: counsel against pregnancy

Aortic Stenosis, continued

- Common congenital lesion that may escape detection in childhood
- Three types of aortic stenosis
  - Valvular: failure of the cusps to separate which creates a bicuspid (instead of tricuspid) valve – most common type (80%)
  - Subaortic: formation of a fibrous ring with a narrowed opening below the aortic valve
  - Supravalvular: fibromembranous narrowing of the aorta above the aortic valve
Aortic Stenosis, continued

• With moderate - severe AS
  – Increased maternal complications:
    • Hypertension
    • Preterm labor
  – Increased neonatal complications (up to 25%):
    • Preterm birth
    • IUGR
    • Low birth weight

Tetralogy of Fallot – Congenital Structural Disease

• Association of four cardiac abnormalities
  – Subpulmonary stenosis
  – Right ventricular hypertrophy
  – Malaligned VSD
  – Overriding aorta

• Varying degrees of hemodynamic changes and cyanosis related to amount of subpulmonary stenosis (resulting in limited pulmonary blood flow)
Tetralogy of Fallot, continued

- Cardiac complications increased
  - Arrhythmias, heart failure
- Neonatal complications increased
  - Especially if unrepaired, cyanotic

Dilated Aorta – Structural Change Over Time

- Aortic root disease can lead to aneurysmal dilatation, aortic regurgitation, and dissection
- Several genetic diseases and congenital heart disease are associated with dilated aorta
- Untreated frequently associated with aortic dissection
  - Especially with Marfan syndrome and/or family history of dissection
  - Dissection is rarely limited to the abdominal aorta
  - Most often occurs in 3rd trimester or early postpartum

ESC guidelines; Warnes, et al.
Dilated Aorta, continued

- Pregnancy is a high-risk period for aortic dissection and rupture
  - May be due to increased arterial wall stress associated with the hypervolemic and hyperdynamic circulatory state and/or hormonal effects on aortic wall composition
- Preconception
  - Assess the risk of aortic dissection/rupture (size of aorta)
  - >4.7cm, repair before pregnancy
- Mode of Delivery
  - Early epidural and assisted 2nd stage for <4.5 cm aortic root diameter
  - Elective cesarean section ≥4.5 cm

Pulmonary Hypertension

- Abnormally high blood pressure in the arteries of the lungs which leads to ventricular hypertrophy
- Associated with many diseases
- Contraindication to pregnancy with high maternal mortality (17-33%)
- Neonatal mortality of approx. 10%
- If pregnancy is not terminated
  - Limit physical activity
  - Avoid supine position in the 3rd trimester
  - Careful (invasive) monitoring of oxygenation and fluid status during labor and birth

*ESC guidelines*
Counseling

• Preconception care is vital
  – Request appropriate consults (MFM, congenital cardiology specialist)
  – Evaluate safety of pregnancy on maternal health
  – Assess pre-pregnant baseline cardiac function
  – Discuss risk of passing CHD onto children
  – Assess current medication regimen
  – Left ventricular dysfunction has been shown as a significant predictor of morbidity/mortality
  – Pulmonary hypertension, dilated aortic roots are contraindications to pregnancy

Counseling, continued

• Psychosocial assessment
  – Knowledge assessment of cardiac condition
  – Perception of health, risk to self and fetus

• Maternal and Fetal echocardiograms as appropriate
  – The majority of fetal cardiac development occurs between the 4th and 7th week gestation
Assistance with Conception

• Assisted Reproductive Technology
  – May be considered if risk of procedure, hormonal stimulation, and pregnancy are low
  – Preconception counseling is mandatory with cardiology and perinatology whenever possible

Termination

• 1st trimester is safest
• Should be performed in hospital setting with emergency services available
• D&E is usually recommended over medications
Care During Pregnancy

• Close co-management with cardiologist, perinatologist may be warranted
• Consults with other services as needed
• Psychosocial considerations
  – Off work on disability earlier
  – May feel loss of “normal” pregnancy
• Risk of antepartum admissions
  – For obstetric or cardiac reasons
  – Where will these patients be admitted?

Care During Pregnancy, continued

• Lower threshold to treat rising BP and pulse
  – Will initiate medication therapy
• Medication therapies
  – Maintaining therapeutic levels due to physiologic changes is difficult (increased blood volume, renal clearance, hepatic clearance, and decreased GI absorption)
• Risk of preterm birth
  – Tocolytics
  – Betamethasone

Care During Pregnancy, continued

• Anticoagulation therapy
  – Warfarin during 1st trimester associated with risk of embryopathy
  – Use unfractionated heparin until the 12th week gestation
  – Resume warfarin for majority of pregnancy
  – Transition to heparin 2 weeks (36th week) before delivery to decrease risk of fetal intracranial hemorrhage
  – Stop before active labor/cesarean section
  – Resume warfarin postpartum

Care During Admission

• What is the nursing role
  – Increased vital signs as needed
  – STRICT intake and output throughout stay
  – Facilitate telemetry
  – Work with ICU RNs as needed
  – Support your patient and normalize her pregnancy, birth, and postpartum course as much as we can
ACLS Guidelines

• **Modifications to resuscitation**
  - Secure and airway early due to risk of aspiration
  - Displace the uterus from midline either manually or left lateral tilt because the pregnant uterus can press against the inferior vena cava and the aorta, impeding venous return and cardiac output
  - Perform chest compressions higher on the sternum
  - Defibrillation has not shown to have adverse fetal effects (recommend removing fetal monitors first)

ACLS Guidelines, continued

• **Consider emergency hysterotomy after 4 minutes of ACLS/BLS care if no response to resuscitation for any pregnant patient > 20 weeks gestation**
  - GA < 20 wk, urgent C/S not warranted, a gravid uterus this size is unlikely to significantly compromise maternal CO
  - GA approx. 20-23 wk, perform emergency C/S to enable successful resuscitation of the mother, not the survival of the delivered infant (unlikely at this gestational age)
  - GA approx. 24-25 wk, perform emergency C/S to save the life of both the mother and the infant
ACLS Guidelines, continued

- Consider your setting and resources:
  - Are appropriate equipment and supplies available?
  - Is emergency hysteroscopy within the rescuer’s procedural range of experience and skills?
  - Are skilled neonatal/pediatric support personnel available to care for the infant, especially if the infant is not full term?
  - Are obstetric personnel immediately available to support the mother after delivery?

Care During Labor and Birth

- Individualized to each patient
- Include all stakeholders
  - Maternal Fetal Medicine/ObGYN
  - Cardiology
  - Anesthesia
  - Nursing
  - Neonatology/Pediatrics
  - Cardiothoracic Surgeons
- Ideal to have an established plan ahead of time that is known by, and/or available to, the delivery team
Care During Labor and Birth, continued

• Plan should include:
  – Monitoring requirements
  – Significant cardiac and obstetric history
  – Identification of highest risks for morbidity and mortality
  – Medication regimen
  – Available resources from each specialty
  – Planned mode of delivery

Infective Endocarditis Prophylaxis

• Antibiotic prophylaxis
  – Not recommended except in patients at high risk for infective endocarditis
    • Previous infective endocarditis
    • Prosthetic cardiac valve or prosthetic material used for valve repair or CHD repair
    • Unrepaired cyanotic CHD
    • Individualized patient risk
  – Recommended in the presence of infection
    • Cardiac patients who develop fever in labor often receive a septic work-up with blood and urine cultures
**Labor Considerations**

- **Invasive monitoring**
  - Arterial line
  - Central access
- **Pain management**
- **Mode of delivery**
  - Vaginal delivery preferred
  - Consider assisted delivery to shorten 2nd stage, decrease valsalva
  - Consider cesarean section for stable aortic dissection, dilated aortic root, warfarin therapy within 2 weeks of labor onset

**Postpartum Considerations**

- **ICU Care**
  - Is it warranted?
  - ICU care in OB?
- **Continued telemetry**
- **Pulmonary edema**
  - Greatest risk immediately postpartum
  - Strict intake and output critical
- **DVT prophylaxis**
- **Anticoagulation**
  - Cardiac condition (replaced valve)
  - DVT
Postpartum Considerations, continued

- **Medications**
  - NSAIDs
  - Uterotonics
  - Anticoagulation
  - Cardiac medications

- **Breastfeeding**
  - Not contraindicated!!!
  - Medications from pregnancy may need to be modified for lactation
  - Decision driven by OB and pediatrics
  - Use a lactation medication reference
    - Briggs; Hale; LactMed Database

- **Psychosocial Assessment**
  - Ability to care for herself/her child
  - Additional surgeries, treatments needed
  - Different then the other moms

- **Contraception**
  - Tubal ligation vs. Essure
  - IUD: Mirena vs. copper
  - Progesterone only
    - Avoid with heart failure
  - Oral contraceptives
    - Is an estrogen containing pill safe?
Neonatal Complications

• Cyanotic Heart Disease
  – Oxygen saturation > 90%, good fetal outcomes
  – Oxygen saturation < 85%, chance of a live birth is low

Neonatal Complications, continued

• Risk of preterm birth
  – From preterm labor
  – From induction secondary to maternal indications

• Risk of growth restriction

• Risk of premature lungs
  – If betamethasone wasn’t given

• Risk of congenital cardiac disease
An Integrated Model of Care:

PACT Program
(Pregnancy and Cardiac Treatment)

Comprehensive Care

• All OB patients with a viable/"go-for" fetus are best served on L&D
  – Other services can come to the unit as consults
  – Remote telemetry monitoring available
  – Exception: ICU needs
• Monthly interdisciplinary conference
  – Maternal Fetal Medicine
  – Congenital Cardiology
  – Anesthesiology
  – Nursing
  – Others as needed
Statistics from UCSF

- Program formally started in 2008
- Now called PaCT: Pregnancy and Cardiac Treatment
- See approximately 50 patients per year
- The majority give birth at UCSF due to need for higher level of care or home providers concerns for resources
- Approximately 25-30 patients on the list each month
References

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