Considerations in the Pregnant Cardiac Patient

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Heart Disease in Pregnancy

- Three million women age 18-44 in the US have heart disease.
- It is estimated that about 1% of pregnant women have some type of heart problem.

LAC +USC Medical Center
High Risk Pregnancy Clinic

Most Common Cardiac Problems
- Evaluation of a murmur
- Palpitations
- Chest pain / decreased exercise tolerance
- Valvular Heart Disease
- Congenital Heart Disease
- Syncope

Cardiology/High Risk Pregnancy Clinic 8/29/08

- Evaluation of a murmur - AS & AI
- Referral for echo by outside cardiologists b/o auscultatory findings of MVP & ASD - functional murmur
- Familial hypercholesterolemia s/p CABGS on lipitor
- MS & A-fib
- Syncope
- Murmur & decreased exercise tolerance - mitral stenosis
- Evaluation of murmur, functional vs bicuspid AV - normal echo
- Palpitations
- Mitral and aortic prosthetic valves

Cardiac Evaluation During Pregnancy

- Cardiac evaluation in pregnancy may be complicated by the normal anatomical and functional changes of the CV system.
- Such changes may result in signs and symptoms that can either simulate or obscure heart disease.

Cardiac Symptoms During Normal Pregnancy

- Decreased exercise tolerance.
- Hyperventilation-shortness of breath.
- Orthopnea.
- Palpitations.
- Light-headedness.
- Syncope.
Physical findings in Normal Pregnancy

- Edema.
- Prominent A and V wave.
- Displaced PMI and palpable RV impulse.
- Increased 1st heart sound.
- Exaggerated splitting of 1st and 2nd heart sounds.
- Murmurs.

Cardiac Evaluation During Pregnancy

- The selection of diagnostic tools should be influenced by their diagnostic yield but also by the potential risk to the fetus.
- Normal changes of pregnancy need to be taken into account when test results are being interpreted.

A patient with a murmur

- A 29 YO originally from Mexico, G1, P0, IUP@ 11 weeks.
- Patient is asymptomatic with no previous Hx of heart disease.
- PE: BP 102/66 mmHg, HR 78 bpm, RR 14/min.
- Auscultation: 3/6 diastolic murmur over the apex.
- What do you do?

A patient with a murmur

- 1. Nothing. The patient is asymptomatic and murmurs are common in pregnancy.
- 2. Schedule the patient to return in 1 month for a follow up.
- 3. Order an echocardiogram.

A patient with a murmur

- 1. Nothing. The patient is asymptomatic and murmurs are common in pregnancy.
- 2. Schedule the patient to return in 1 month for a follow up.
- 3. Order an echocardiogram.
Functional Murmur of Pregnancy

- Timing: Mid systolic
- Intensity: 1-2/6
- Location: Lower left sternal edge and pulmonic area
- Radiation: Suprasternal notch & > left side of the neck

Functional Cardiac Murmurs During Pregnancy

Does Physical Examination Alone Allow a Correct Diagnosis?

(Shotan et al, USC Medical Center, Los Angeles)

Patients Population
- 120 consecutive pregnant women without established diagnosis referred for evaluation of murmurs

Methods
- A comparison between PE & ECG and 2-D echo & Doppler results

Results

<table>
<thead>
<tr>
<th></th>
<th>Functional M</th>
<th>Organic M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct DX</td>
<td>84 (87%)</td>
<td>16 (70%)</td>
</tr>
<tr>
<td>False DX</td>
<td>13</td>
<td>7</td>
</tr>
</tbody>
</table>

Palpitations During Pregnancy

- A 22 YO WF G2, P1, IUP@ 32 weeks.
- C/O palpitations in the last 2-3 weeks with 1 episode of pre syncope when standing on line in the market.
- Palpitations described as fast heart beats occurring 2-3 times a week, lasting for few minutes and associated with slight SOB.
- Patient did not have similar symptoms prior to her pregnancy or during the first pregnancy.

She is concerned.

- PE is WNL except for occasional premature beats.
- Holter monitoring showed episodes of sinus tachycardia, multiple atrial premature beats, no relation to symptoms.
- Echocardiogram was normal.
- What do you do?

1. Reassure the patient that the PAC’s are common in pregnancy and do not affect either maternal or fetal outcome.
2. Start treatment with a beta blocker.
3. Advice the patient to reduce her physical activity.
4. Advice the patient to increase her physical activity.
**Palpitations in Normal Pregnancy**

*Shotan et al, Am. J. Cardiol. 1997;79:1061-1*

**Patient population:** 110 consecutive pregnant women C/O palpitations, dizziness, pre/syncope.

**Age:** 15-42 (mean 27 ± 7 years)

**Gravidity:** 1-13 (mean 3 ± 2)

**Parity:** 0-12 (mean 2 ± 2)

**Ethnic background:** Hispanic - 88%, Black - 6%, White - 3, Asian - 3%

**Gestational period:**
- 1st trimester - 11%
- 2nd trimester - 47%
- 3rd trimester - 42%

**Higher incidence of frequent and multifocal premature beats in the symptomatic group (3235 vs. 678 PVCs /24 hrs, P <0.05)**

**No correlation between presence of arrhythmias and symptoms (only 10% of symptomatic episodes related to arrhythmias)**

**Palpitations & arrhythmias may be independent markers of increased sympathetic activity**

**Holter findings in 9 pts during pregnancy and 6 wks postpartum**

*(Shotan et al AJC 1997;78:1061)*

<table>
<thead>
<tr>
<th>Arrhythmia</th>
<th>Pregnancy</th>
<th>Postpartum</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>APCs/24 h</td>
<td>1206 ±1845</td>
<td>48 ± 14</td>
<td>0.08</td>
</tr>
<tr>
<td>APCs/h</td>
<td>58 ± 88</td>
<td>3 ± 9</td>
<td>0.08</td>
</tr>
<tr>
<td>VPCs/24h</td>
<td>7567 ±9556</td>
<td>1207 ± 1804</td>
<td>0.07</td>
</tr>
<tr>
<td>VPCs/h</td>
<td>401 ± 498</td>
<td>67 ± 124</td>
<td>0.09</td>
</tr>
<tr>
<td>VPCs &amp; APCs/24h</td>
<td>9073 ±9210</td>
<td>1345 ±1997</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>VPCs &amp; APCs/h</td>
<td>495 ± 474</td>
<td>70 ± 153</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

**ECG Changes After C-Section**

*A 33 YO AA patient with a 10 years Hx of chronic hypertension seen 30 minutes after an uneventful C-section delivery for preeclampsia.*

- C/O a short lasting episode of chest pressure.
- ECG shows ST segment depressions in the anterolateral leads.
- There is no previous ECG available for comparison.
- What biomarker for Myocardial infarction can help?

**ST-segment depression assoc. with C-section in healthy women**

*McIntic et al, Anesth Analg 1992;74:51*

**1. MB CK will be the most helpful since troponin may be elevated in pts with preeclampsia.**

**2. Troponin will be the most helpful since MB CK may be elevated after delivery.**

**3. Both MB CK and troponin may be elevated in patients for reasons other than AMI.**
**ECG Changes After C-Section**

- 1. MB CK will be the most helpful since troponin may be elevated in pts with preeclampsia.
- 2. Troponin will be the most helpful since MB CK may be elevated after delivery.
- 3. Both MB CK and troponin may be elevated in patients for reasons other than AMI.

**Biomarkers for myocardial ischemia in Pregnancy**

- Creatine kinase and its MB fraction increase by ~2 folds within 30 min after delivery and peak at 24 hrs.
- Probably from the uterus and placenta.
- In contrast troponin demonstrates only small increase after delivery and remains below the upper limit of normal.
- Except in women with preeclampsia and gestational hypertension where it may be mildly elevated.

**Electrocardiographic Findings in normal Pregnancy**

- Sinus tachycardia
- QRS axis deviation
- Arrhythmias
- Increased R/S ratio in leads V1 and V2.
- ST segment and T wave changes (Ritodrine tocolysis, C section)

**Doppler Echocardiography during Normal Pregnancy**

- Both Transthoracic and transesophageal echocardiographic examinations are safe during pregnancy.
- Slightly increased LV systolic and diastolic diameters.
- Unchanged or slightly improved LV systolic function.

**Doppler Echocardiography during Normal Pregnancy**

- Moderate increase in LA, RA and RV size.
- Functional trace to mild MR, TR and PR.
- Normal PAS pressure.
- Small pericardial effusion.

**Cardiac Chamber Dimensions (mm) During Normal Pregnancy and Puerperium**

<table>
<thead>
<tr>
<th>Chamber</th>
<th>Normal Pregnancy</th>
<th>Puerperium</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>LV</td>
<td>40 ± 2</td>
<td>40 ± 2</td>
<td>40 ± 2</td>
</tr>
<tr>
<td>LA</td>
<td>30 ± 2</td>
<td>30 ± 2</td>
<td>30 ± 2</td>
</tr>
<tr>
<td>RA</td>
<td>43 ± 2</td>
<td>43 ± 2</td>
<td>43 ± 2</td>
</tr>
</tbody>
</table>

Abbreviations: LA, left atrium; LV, left ventricle; RA, right atrium; RV, right ventricle.
Prevalence of Physiological Valvular Regurgitation During Pregnancy and the Puerperium

Valve Annular Diameter (mm) in Normal Pregnancy and Puerperium

Valvular / Congenital Heart Disease Potential Risks of Pregnancy
- Hemodynamic changes.
- Arrhythmogenic effect.
- Thrombogenic effect.
- Side effects of drugs.

Heart Disease in Pregnancy
Assessment of Prognosis

Congenital Heart Disease and Pregnancy
- A 23 YO HF G1 IUP @ 36 weeks.
- Large ASD with QP/QS ratio of 4.5:1.0.
- PA systolic pressure 45 mmHg.
- Small LV cavity with normal syst. function.
- Severely dilated RV with normal systolic function.
- NYHA class I prior to pregnancy without sig. change during pregnancy.

Congenital Heart Disease and Pregnancy
- What is the risk of developing cardiac complications?
  - 1. <5%.
  - 2. 20-30%.
  - 3. 60-70%.
Congenital Heart Disease and Pregnancy

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  - 1. <5%.
  - 2. 20-30%.
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Patients with Heart disease are at Increased risk of Complications

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Odds Ratio (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior cardiac event (HF, TIA, stroke or arrhythmia)</td>
<td>6 (3-14)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>NYHA &gt; II or cyanosis</td>
<td>6 (2-22)</td>
<td>0.009</td>
</tr>
<tr>
<td>Left heart obstruction (MVA&gt;2 cm², AVA &lt;1.5 cm², LV outflow gradient &gt;30mmHg)</td>
<td>6 (3-14)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Systemic ventricular dysfunction (EF &lt;40%)</td>
<td>11 (4-34)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Predictors of Cardiac Complications

- A 23 YO HF G1 IUP @ 36 weeks.
- Large ASD with QP/QS ratio of 4.5:1.0.
- PA systolic pressure 45 mmHg.
- Small LV cavity with normal syst. function.
- Severely dilated RV with normal systolic function.
- NYHA class I prior to pregnancy without sig. change during pregnancy.
**Congenital Heart Disease and Pregnancy**

- Simple CHD (ASD, VSD, PDA) without pulmonary vascular disease tolerate pregnancy well.
- Pregnancy in pts with complex CHD is commonly associated with increased rate of fetal loss, and prematurity as well as maternal complications (CHF, arrhythmias, TE events, Endocarditis).

**Predictors of poor outcome** include cyanosis, pulmonary hypertension due to pulmonary vascular disease, ventricular dysfunction, decreased functional capacity and Hx of cardiac events prior to pregnancy.

**Pulmonary Hypertension and Risk of Pregnancy**

- A 23 YO HF G1 IUP @ 36 weeks.
- Large ASD with QP/QS ratio of 4.5:1.0.
- PA systolic pressure 45 mmHg.
- Small LV cavity with normal syst. function.
- Severely dilated RV with normal systolic function.
- NYHA class I prior to pregnancy without sig. change during pregnancy.

**Pulmonary BP** is a product of pulmonary blood flow and pulmonary vascular resistance.

- Increase pulmonary pressure is a risk in patients with PHT due to increased PVR.
- It is not a risk factor in pts with increase pulmonary pressure due to increase flow.
- Cardiac conditions associated with risk: Eisenmenger’s syndrome, PPH, SPH (Lupus, Scleroderma, drugs)

**Valvular Heart Disease and Pregnancy**

- 32 YO HF G1, P1, preconception consultation.
- Diagnosed with AS due to bicuspid valve during her previous pregnancy 5 yrs ago, AVA 1.5 cm².
- Pregnancy and delivery were uneventful.
- Asymptomatic.
- Echo - AS with a mean AV gradient of 38mmHg and AVA of 1.2 cm².
- Exercise test – walked 10 min on Bruce protocol, stopped B/O fatigue.

**Questions**

- What is the risk to the mother?
- What is the risk to the fetus?
- Should she have surgery prior to pregnancy?
- How to follow the patient during pregnancy?
- Mode of delivery.
Complications during pregnancy in pts with VHD can be predicted mainly by the type and location of disease (Stenosis vs regurgitation, AS and MS vs PS), the severity of the disease (especially in pts with AS and MS), ventricular function (LV & RV), and by the functional capacity prior to pregnancy.

Moderate & severe MS and AS are associated with increased maternal morbidity including CHF, arrhythmias, hospitalizations and need to start or increase dose of cardiac medications.

In spite of significant increase in maternal morbidity, mortality is rare.

Outcome of pregnancy in pts with mild MS & AS (valve area >1.5 cm²) and with PS is comparable to healthy controls.

The management of a woman with VHD should begin before conception.

with a careful assessment of the type and severity of the disease, cardiac function as well as functional capacity.

Exercise test (preferably with measurement of oxygen consumption) should be done in questionable cases.
Valvular Heart Disease and Pregnancy

What is the likelihood that this patient will need to be delivered by a C section due to cardiac reasons?

1. 2-4%
2. 30-40%
3. 40-50%
4. 80-90%.

Valvular Disease in Pregnancy: Mode of Delivery


<table>
<thead>
<tr>
<th>Valvular Disease</th>
<th>No of Patients</th>
<th>No of Pregnancy</th>
<th>No (%) Cesarean Deliveries</th>
<th>No (%) of Cesarean Deliveries for Cardiac Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitral Stenosis</td>
<td>39</td>
<td>49</td>
<td>16 (33%)</td>
<td>1 (2%)</td>
</tr>
<tr>
<td>Aortic Stenosis</td>
<td>74</td>
<td>80</td>
<td>21 (26%)</td>
<td>1 (1.25%)</td>
</tr>
</tbody>
</table>

Valvular Heart Disease and Pregnancy

Should this patient have surgery or valvuloplasty prior to her pregnancy to avoid deterioration during pregnancy?

1. Yes.
2. No

When to correct Valve Disease before Pregnancy?

MR, AR, TR: Prophylactic surgery not recommended for patients who are not candidates for surgery on the basis of currently accepted indications.

Aortic stenosis: surgery prior to pregnancy recommended in severe AS.
### When to correct Valve Disease before Pregnancy?

**Mitral stenosis:**
- Severe MS - PMBV should be performed before pregnancy.
- Moderate MS – PMBV in selected cases based on MVA, Pulmonary pressures, symptoms and exercise tolerance. When pt is not a candidate for PMBV option of medical therapy vs surgery should be carefully assessed.

### MS and Pregnancy

- A 24 YO HF G1, 30 wks gestation.
- C/O DOE and orthopnea.
- Hx of RF in childhood.
- PE: HR 100 bpm regular, BP 110/76, mild JVD, lungs clear. Heart – parasternal heave, ↑ S1 and S2, OS, 2/6 diastolic rumble.
- ECG – Sinus tachycardia, LAE.
- Echo – MS, MVA~0.9 cm², gradient 14 mmHg. RVSP~80 mmHg.
- MV leaflets are pliable with minimal calcification, mild MR.
- What do you recommend?

### MS and Pregnancy

- A. HR control, diuresis, and warfarin.
- B. Open mitral commissurotomy.
- C. PMBV.
- D. MVR.

### MS and Pregnancy

- A. HR control, diuresis, and warfarin.
- B. Open mitral commissurotomy.
- C. PMBV.
- D. MVR.

### MS and Pregnancy

- Patient returns 2 weeks later with persistent symptoms in spite medical TX.
- Repeat echo – No change.
- What do you recommend?

### MS and Pregnancy

- A. change medical Tx.
- B. Open MV commissurotomy.
- C. MVR.
- D. PMBV.
- E. Urgent C section.
**MS and Pregnancy**

- A. change medical Tx.
- B. Open MV commissurotomy.
- C. MVR.
- D. PMBV.
- E. Urgent C section.

**PS and Pregnancy**

- A 27 YOWF 20 wks pregnant referred for evaluation of a murmur.
- Parasternal heave.
- Early systolic click which decreases with inspiration.
- 3/6 early to mid peaking murmur at LSB.
- TTE – PS with gradient of 46 mmHg.
- What do you recommend?

- Observation during pregnancy and Ross procedure after the delivery.
- PV replacement now.
- Reassured that this is due to increased flow during pregnancy.
- Percutaneous valvuloplasty.
- Observe and repeat echo in 4 weeks.

**Valvular Disease and Pregnancy**

**Pulmonic Stenosis (N=17)**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Controls</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth weight (g)</td>
<td>3278 ± 474</td>
<td>3360 ± 432</td>
</tr>
<tr>
<td>EGA (wk)</td>
<td>38.4 ± 1.9</td>
<td>39.3 ± 1.2</td>
</tr>
<tr>
<td>Apgar score @ 1 min</td>
<td>9 (8-9)</td>
<td>9 (8-9)</td>
</tr>
<tr>
<td>Apgar score @ 5 min</td>
<td>9 (8-9)</td>
<td>9 (8-9)</td>
</tr>
<tr>
<td>Placental weight (g)</td>
<td>648 ± 184</td>
<td>693 ± 421</td>
</tr>
</tbody>
</table>

Elkayam et al. Am Heart J 2008

**Valvular Disease and Pregnancy**

**Pulmonic Stenosis**

<table>
<thead>
<tr>
<th>Peak Gradient (mmHg)</th>
<th>&lt; 50 (34 ± 11)</th>
<th>≥ 50 (82 ± 28)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth weight (g)</td>
<td>3198 ± 569</td>
<td>3192 ± 553</td>
<td>0.99</td>
</tr>
<tr>
<td>EGA (wk)</td>
<td>39.5 ± 1.6</td>
<td>37.5 ± 2.2</td>
<td>0.17</td>
</tr>
<tr>
<td>Apgar score @ 1 min</td>
<td>9 (8-9)</td>
<td>9 (8-9)</td>
<td>0.2</td>
</tr>
<tr>
<td>Apgar score @ 5 min</td>
<td>9 (8-9)</td>
<td>9 (8-10)</td>
<td>0.098</td>
</tr>
<tr>
<td>Placental weight (g)</td>
<td>681 ± 205</td>
<td>597 ± 150</td>
<td>0.38</td>
</tr>
</tbody>
</table>

Elkayam et al. Am Heart J 2008
BNP levels in Normal Pregnancy

Clinical Cardiol. 2009

Hameed A et al, Clin Cardiol in press

VALVULAR DISEASE AND PREGNANCY

Risk Assessment

- Patient 1. Moderate mitral stenosis (MVA 1.2 cm²)
- Patient 2. Moderate mitral regurgitation (3+).
- Patient 3. Moderate aortic stenosis (AVA 1.2 cm²).
- All 3 patients are asymptomatic prior to pregnancy and have normal cardiac function.
- Who is the least likely to develop hemodynamic deterioration?

Regurgitant lesions (MR, AR, TR) are well tolerated, probably due to the ventricular unloading effect of gestation.

VALVULAR DISEASE AND PREGNANCY

Risk Assessment

- Patient 1. Moderate mitral stenosis (MVA 1.2 cm²)
- Patient 2. Moderate mitral regurgitation (3+).
- Patient 3. Moderate aortic stenosis (AVA 1.2 cm²).
- All 3 patients are asymptomatic prior to pregnancy and have normal cardiac function.
- Who is the least likely to develop hemodynamic deterioration?

Would you recommend antibiotic prophylaxis for labor and delivery?

1. No.
2. Yes.
Valvular Heart Disease and Pregnancy

- Would you recommend antibiotic prophylaxis for labor and delivery?
  - 1. No.
  - 2. Yes.

AMI and Pregnancy

- A 24 yo Indian female G1 IUP at 38 wks who presented to the ED with an episode of severe chest pressure.
- Risk factors for CAD: family Hx of premature CAD, low HDL cholesterol.
- Troponin increased to 2 ng/mL.

AMI and Pregnancy

What is the most likely mechanism of this patient AMI?

- 1. Plaque rupture.
- 3. Coronary dissection.
- 4. Takotsubo.

AMI and Pregnancy

What is the most likely mechanism of this patient AMI?

- 1. Plaque rupture.
- 3. Coronary dissection.
- 4. Takotsubo.

Marfan’s Syndrome and Pregnancy

Case Scenario

- A 34-year-old Korean woman with Marfan syndrome who was referred for cardiac evaluation in the 24th weeks of her 1st pregnancy. Although diagnosis of Marfan syndrome was made at the age of 7, the patient did not have cardiac evaluations prior to her pregnancy. An echocardiogram demonstrated mildly dilated left ventricle with normal systolic function, moderately dilated left atrium, severe dilation of the aortic root with maximum diameter of 64 mm and moderate aortic regurgitation. MRI showed a 62X54 mm aortic root aneurysm with no evidence of aortic dissection.
Marfan’s Syndrome and Pregnancy

1. Start the patient on a high dose beta blocker until fetal maturity and then deliver and operate.
2. Refer patient for urgent aortic root repair.

Marfan’s Syndrome and Pregnancy
Women with MFS with pregnancy related complications published between 1995 to 2007

- Number - 39
- Mean age (years) - 30 ± 4
- Acute aortic dissection - 29
  - Type A - 19
  - Type B - 8
  - Type A & B - 2
- Timing of dissection -
  - Weeks 13-20 - 5
  - Weeks 24-40 - 18
  - After delivery - 6
- Progressive aortic dilatation - 5
- Intracranial hemorrhage postpartum - 2
- Prior distal aortic dissection -
  - Stable during pregnancy - 2
  - Extension 1 week post partum - 1

Considerations in the Pregnant Cardiac Patient

Questions?

Exercise Testing During Pregnancy

- Exercise testing can be performed during pregnancy for the diagnosis of myocardial ischemia or risk stratification following AMI.
- Fetal bradycardia, reduction of fetal HR variation, and absence of body movement have been described during moderate to heavy maternal exercise.
- Because of these findings, the use of a submaximal exercise is recommended.

In Utero Radiation Effects
Colletti P. Cardiac Problems in Pregnancy 1998

<table>
<thead>
<tr>
<th>Post conception time (Days)</th>
<th>Phase</th>
<th>Possible Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-9</td>
<td>Preimplantation</td>
<td>Possible death, malformation unlikely (10-50 rads)</td>
</tr>
<tr>
<td>10-12</td>
<td>Implantation</td>
<td>Death and malformations unlikely IUGR possible (10-50 rads)</td>
</tr>
<tr>
<td>13-50</td>
<td>Organogenesis</td>
<td>Fetal anomalies IUGR</td>
</tr>
<tr>
<td>51-280</td>
<td>Fetal growth</td>
<td>IUGR, CNS anomalies, ↑ cancer (&gt; 1 rad)</td>
</tr>
</tbody>
</table>

Radiation During Pregnancy

- The majority of the exposure to the fetus from radiation to the mother’s chest is due to scattered radiation.
- The amount of scattered radiation to the uterus is ~5% of the radiation absorbed by the tissue directly in the X ray beam.
- Radiation to the fetus from nuclear medicine procedures is primarily due to distribution of the radioisotope to the bladder or to the placenta.
Estimated Radiation Absorbed By The Fetus

### Cardiac Procedures

<table>
<thead>
<tr>
<th>Test</th>
<th>microGy</th>
<th>mrad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest radiography</td>
<td>&lt;1.0</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Fluoroscopy</td>
<td>500-1000/min</td>
<td>50-100/min</td>
</tr>
<tr>
<td>Cine</td>
<td>2500-5000/min</td>
<td>250-500/min</td>
</tr>
<tr>
<td>Thallium 201</td>
<td>&lt;10,000</td>
<td>&lt;1000</td>
</tr>
<tr>
<td>Sestamibi</td>
<td>&lt;10,000</td>
<td>&lt;1000</td>
</tr>
</tbody>
</table>

### Pulmonary procedures

<table>
<thead>
<tr>
<th>Test</th>
<th>microGy</th>
<th>mrad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfusion lung scan</td>
<td>60-120</td>
<td>6-12</td>
</tr>
<tr>
<td>Ventilation lung scan</td>
<td>200</td>
<td>20</td>
</tr>
<tr>
<td>CT angiography 1st trimester</td>
<td>3-20</td>
<td>0.3-20.</td>
</tr>
<tr>
<td>CT angiography 2nd trimester</td>
<td>8-77</td>
<td>8-7.7</td>
</tr>
<tr>
<td>CT angiography 3rd trimester</td>
<td>51-130</td>
<td>5-13</td>
</tr>
<tr>
<td>Pulm angio femoral</td>
<td>2210-3740</td>
<td>220-374</td>
</tr>
<tr>
<td>Pulm angio brachial</td>
<td>&lt;500</td>
<td>&lt;50</td>
</tr>
</tbody>
</table>

### Contrast Agents

- Commonly used contrast agents (including Gadolinium) readily cross the placental barrier. Clinical experience however, suggests no increased risk during pregnancy.

### Use of Radiation during Pregnancy Recommendations

- CT angiography should not be avoided for risk of radiation if PE is a serious clinical possibility.
- Cardiac catheterization typically yield fetal exposure of < 1 rad. Difficult study and interventional procedures could easily yield fetal exposure of 5-10 rads.

- Am Coll Radiol recommend the use of nonionizing techniques such as sonography and MRI when imaging is required during pregnancy.
- Amount of radiation to the fetus from a chest radiography is extremely small and probably safe.
- Cardiac nuclear studies should convey < 1 rad to the conceptus and should be used when absolutely necessary.

- Methods of reducing radiations should be used and direct irradiation to the fetus should be avoided.
- With 10-15 rads many experts suggest termination of pregnancy if possible.