Thought for the Morning…

During pregnancy, multiple physiological and anatomical adjustments are made to maintain normal maternal hemostasis. In a non-pregnant patient, many of these alterations would be considered pathological rather than physiological.

Obstetrical decision making is based upon an awareness of what these changes are.
Disclosures

• No real or perceived conflicts for this presentation
Weight Gain in Pregnancy

• Normal weight gain can be 30-35 lbs in average patient and 50-70 lbs. in twin pregnancy
• Daily requirements of 2000-2500 calories
• Associated with good outcome, ie delivery of normal sized baby
• Excess weight gain associated with variety of complications:
  – GDM, pre-eclampsia, macrosomia
• Inadequate weight gain is also associated with newborn complications
• Total pregnancy expenditure is 75,000 k calories
• Recommendations for appropriate weight gain in pregnancy based on initial weight, BMI
# Weight Gain in Pregnancy

<table>
<thead>
<tr>
<th>Category</th>
<th>Kg.</th>
<th>Lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thin (BMI &lt;19.8)</td>
<td>12.5-18</td>
<td>28-40</td>
</tr>
<tr>
<td>Average (BMI 19.8-26.0)</td>
<td>11.5-16</td>
<td>25-35</td>
</tr>
<tr>
<td>Heavy (BMI 26.1-29.0)</td>
<td>6.0-11.5</td>
<td>15-25</td>
</tr>
<tr>
<td>Obese (BMI &gt; 29.0)</td>
<td>6.0</td>
<td>15</td>
</tr>
</tbody>
</table>
Gastrointestinal Changes

• Key Changes
  – AppetiteUsually increased, with cravings
  – Gastric RefluxSphincter relaxation
  – GI MotilityDecreased
  – GI Transit TimeSlower
  – LiverFunctionally unchanged
  – GallbladderDilated
  – AppendixAnatomical location change
Common GI Changes in Pregnancy

• Nausea and vomiting of pregnancy or “morning sickness”
  – Exact etiology is unknown
  – Supportive therapy usually helpful
• Dietary cravings commonplace
  – Pica
  – Ptyalism
• HEG a variant with criteria for diagnosis and treatment
• Increased tendency for gallbladder dysfunction with possible need for surgery not uncommon
# Hepatic Function Laboratory Studies

<table>
<thead>
<tr>
<th>Laboratory Study</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albumin</td>
<td>20% decrease</td>
</tr>
<tr>
<td>Total Protein</td>
<td>Slight decrease</td>
</tr>
<tr>
<td>Alkaline Phosphatase</td>
<td>Markedly elevated</td>
</tr>
<tr>
<td>Bilirubin</td>
<td>Unchanged</td>
</tr>
<tr>
<td>Triglycerides</td>
<td>Gradual increase at term</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>Twice normal value</td>
</tr>
<tr>
<td>PT/PTT</td>
<td>Essentially unchanged</td>
</tr>
<tr>
<td>Clotting Factors</td>
<td>General increase at term</td>
</tr>
</tbody>
</table>
Hematological Changes in Pregnancy

- Plasma volume increases early in pregnancy with a 50% increase (and higher in higher order multiple pregnancies) and a delayed increase in RBC mass and volume but less than the plasma volume, the net result is a “physiological anemia of pregnancy”

- Normal pregnancy associated with a “demand” of 1000 milligrams of additional iron
  - 500 mg. to increase maternal RBC volume
  - 300 mg. transported to fetus
  - 200 mg. for normal iron loss

- 60 mg. of elemental iron required daily, provided in 300 mg. of ferrous sulfate
Total Blood Volume, Plasma Volume and RBC Volume Changes in Pregnancy

FIG 7-1.
More Hematological Changes Occurring During Pregnancy

- Pregnancy considered a “hypercoagulable state”
- Fibrinogen increases to 450-600 mg/dl
- Factors VII, VIII, IX and X increase
- Prothrombin, Factor V, and XII are unchanged
- Bleeding time does not change
- Platelet count may increase to 450,000 to 600,000
- WBC count may increase to as high as 20,000 due to an increase in granulocytes
- May see changes in WBC count both with treatment with steroids and also during and/or after labor
Pulmonary Adaptations

• Anatomical
  – Increased chest diameter, subcostal angle changes, increased diaphragmatic excursion with diaphragm elevated as well

• Physiological
  – Hyperventilation, Increased IC, VC and Minute Volume, Residual volume decreased, Expiratory Reserve Volume decreased, Tidal volume increased by 40%, pO2 increased, pCO2 decreased, arterial pH unchanged, and serum bicarbonate reduced
Pulmonary Changes in Pregnancy

Fig 1–3.—Lung volume and capacities in pregnancy. (From Hyttten F.E., Leitch I.: The Physiology of Human Pregnancy (ed. 2). Oxford: Blackwell Scientific Publications, Ltd., 1971, p. 120. Used by permission.)
Changes in Pulmonary Function in Pregnancy

Diagram showing changes in pulmonaary function during pregnancy. The graph compares the total lung capacity, inspiratory capacity, vital capacity, functional residual capacity, residual volume, and expiratory reserve volume over 9 months of pregnancy. The bars represent the percentage changes from control values at various stages of pregnancy.
Cardiac Changes in Pregnancy

- Cardiac output increases around 50% from an increase in HR and SV (3L/min to 6.2L/min)
- There is an additional 40% increase above that level during active labor
- Immediately following delivery, cardiac output may be increased by an additional 10-20%
- Cardiac exam is different during pregnancy
  - Many patients will have an S3 after midpregnancy
  - Diastolic murmurs are usually considered serious
  - Systolic murmurs ("flow murmurs") common
  - Displacement of heart is to right and upwards
  - EKG shows left axis deviation and low voltage QRS complexes
# Key Cardiovascular Changes During Pregnancy

<table>
<thead>
<tr>
<th>Blood Flow to Other Organs</th>
<th>Increased</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peripheral Vascular Resistance</td>
<td>Decreased</td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>Mid pregnancy decrease</td>
</tr>
<tr>
<td>Pulmonary Blood Pressure</td>
<td>Unchanged</td>
</tr>
<tr>
<td>Heart Size</td>
<td>Increased</td>
</tr>
<tr>
<td>Cardiac output</td>
<td>Increased</td>
</tr>
<tr>
<td>Stroke volume</td>
<td>Increased</td>
</tr>
<tr>
<td>Systolic murmurs</td>
<td>Common</td>
</tr>
<tr>
<td>Diastolic murmurs</td>
<td>Potentially pathological</td>
</tr>
<tr>
<td>EKG changes</td>
<td>LAD, low voltage</td>
</tr>
</tbody>
</table>
Changes in Cardiac Output, Mean Blood Pressure, and SVR in Pregnancy

![Graph showing changes in cardiac output, mean blood pressure, and SVR during pregnancy.](image-url)
Renal Changes in Pregnancy

- Minimal renal enlargement, bilaterally
- Both renal pelvises and ureters are dilated (“hydronephrosis of pregnancy”)
- Greater urinary stasis, ureteral compression, leading to urinary stasis and possible urinary tract infections, and pyelonephritis
- Ureteral compression more often on right rather than left side
- Loss of urinary control
- Bladder capacity diminished
- RPF increases to 75% of non-pregnant value
More Renal Changes in Pregnancy

- GFR increases 50% over non-pregnant state
- Creatinine clearance increases to 150-200 ml/min
- Plasma osmolality decreases
- Urine output is unchanged
- There is an increased sensitivity to renin and angiotensin
- Renal glycosuria common
- Proteinuria up to 300 mg/24 hours normal
Endocrine Changes with Pregnancy

• Carbohydrate Metabolism
  – Overall effect is that pregnancy is diabetogenic
    • First half: tendency to hypoglycemia
    • Second half: tendency to hyperglycemia
  – Progressive insulin resistance as pregnancy progresses
    • Progesterone
    • Estrogen
    • HPL
  – “Typical” FBS less than in non-pregnant state
  – Blunting response to meals, eating as pregnancy progresses
  – Hypertrophy of beta cells as well
Endocrine Changes in Pregnancy

- Thyroid Function in Pregnancy
  - The normal pregnant woman remains euthyroid while pregnant despite/with hormonal changes which occur
    - Estrogen production increases
    - Increased TBG
    - Increased total thyroxine, and T3
    - Free T4 and T3 remain unchanged
    - BMR increases 15-20% above normal
    - There is lowered T3 uptake during pregnancy
    - TSH does not cross the placenta