



The Gravid Surgical Patient

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Objectives

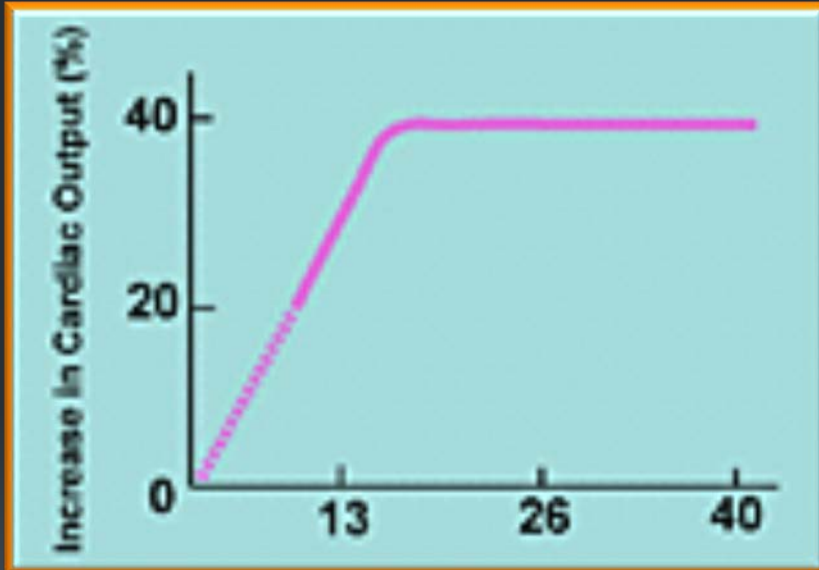
- Understand Maternal Physiologic Adaptations to Pregnancy
- Understand Radiology Safety Concerns During Pregnancy
- Understand Anesthesia Safety Concerns
- Understand Preterm Labor in the Surgical Setting



Maternal Physiologic Changes

Parameter	Change	Amount %
Heart Rate	Increased	20-30
Stroke Volume	Increased	20-50
Cardiac Output	Increased	30-50
Contractility	Variable	+/-10
Central Venous Pressure	Unchanged	
Pulmonary Capillary Wedge Pressure	Unchanged	
Systemic Vascular Resistance	Decreased	20
Systemic Blood Pressure	Slight Decrease	Midtrimester 10-15 mm Hg, then rises
Pulmonary Vascular Resistance	Decreased	30
Pulmonary Artery Pressure	Slight Decrease	

Cardiovascular Changes



- Plasma volume increases by 50%
- Red cell mass increases by 30%
- Dilutional anemia
- Uteroplacental shunt of 20-30%

Cardiovascular Changes



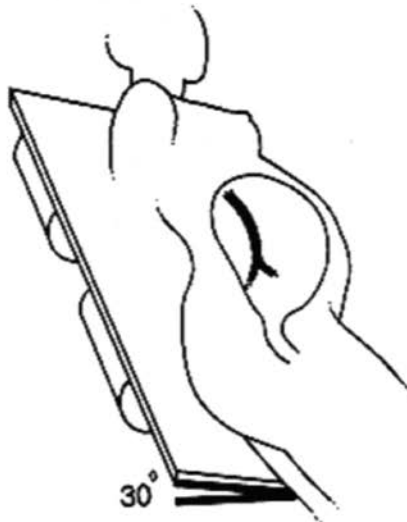
- Systolic and diastolic BP nadir at 28 weeks
- SVR decreases during gestation
- Supine hypotension

Supine Hypotension

Figure 1: Supine Hypotensive Syndrome



Supine hypotensive syndrome:
The gravid uterus compresses the vena cava in supine position



Treatment of supine hypotensive syndrome: 30° left lateral decubitus unloads vena cava



Treatment of supine hypotensive syndrome: Alternate method: manual shift of uterus



Coagulation Changes in Pregnancy

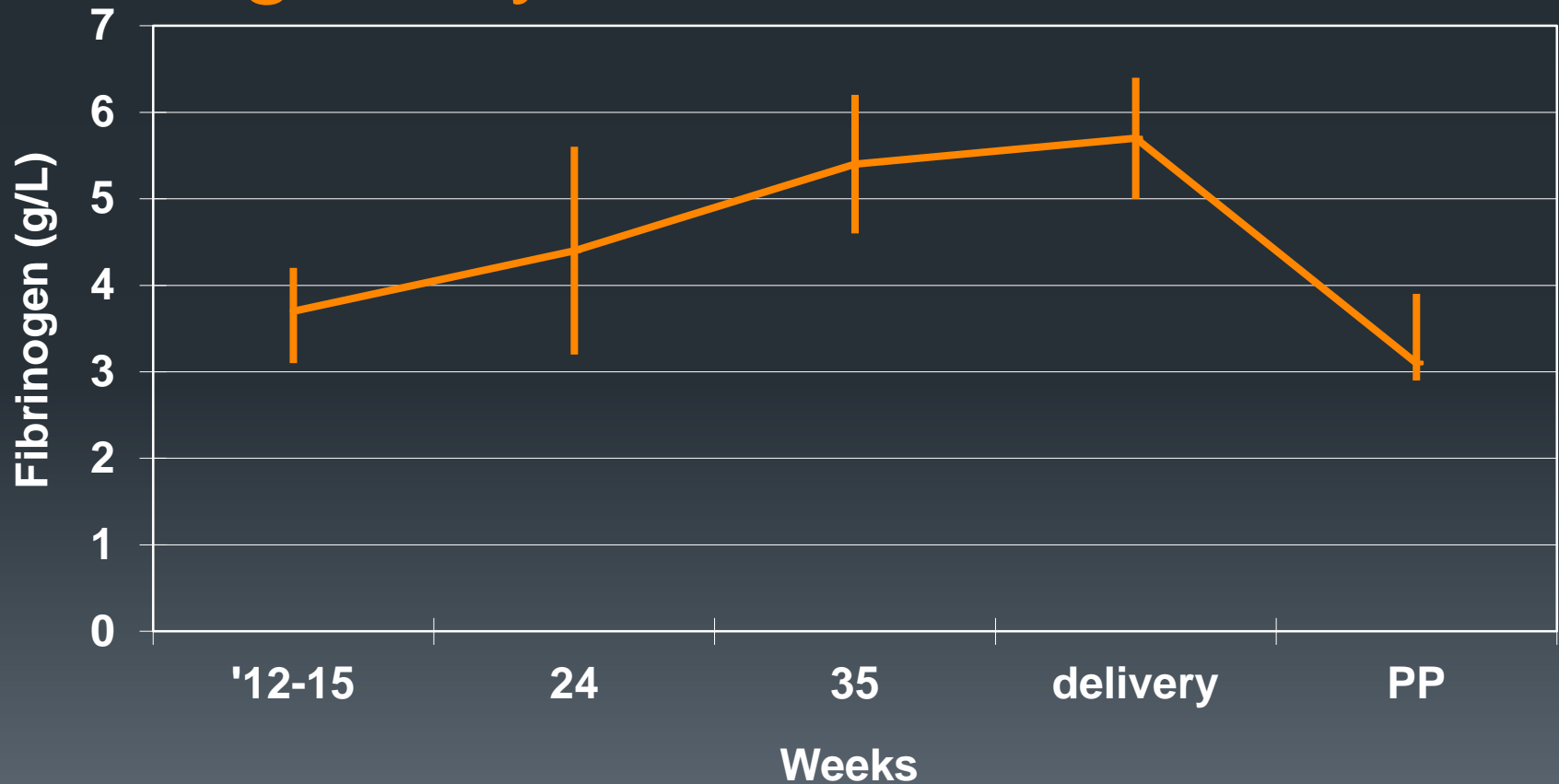
- Normal pregnancy is associated with major changes in all aspects of hemostasis
- Various aspects of the DIC diagnostic panel are affected
- There are changes from trimester to trimester along with during labor, delivery and the postpartum period



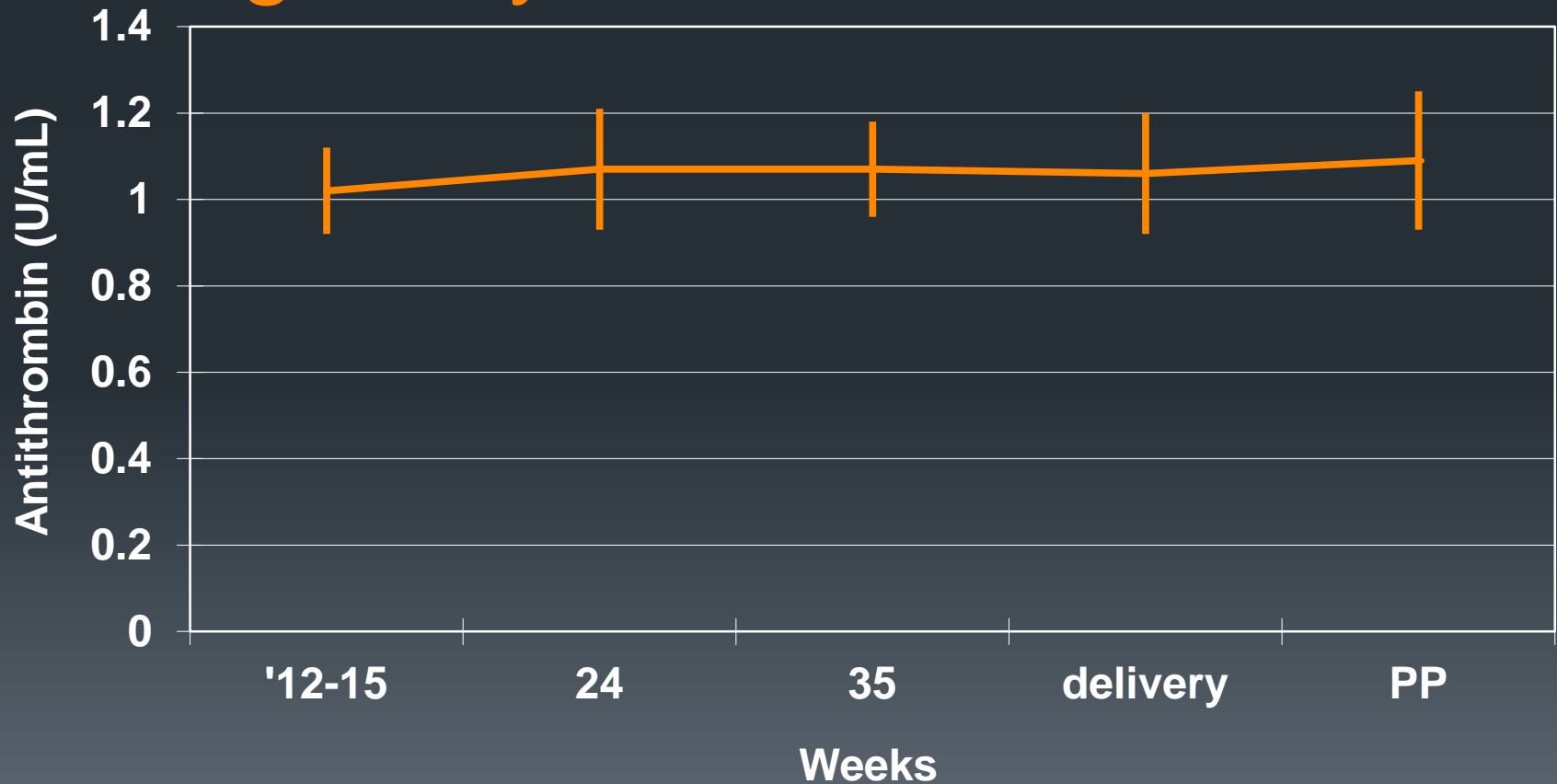
Hematopoietic System

- ↑ Plasma volume
- Increased RBC production 15-20%
 - Dilutional anemia
- Leukocytosis (6-16)
- ↑ fibrinogen, V, VII, VIII, IX, X, XII
- ↓ XI, XIII

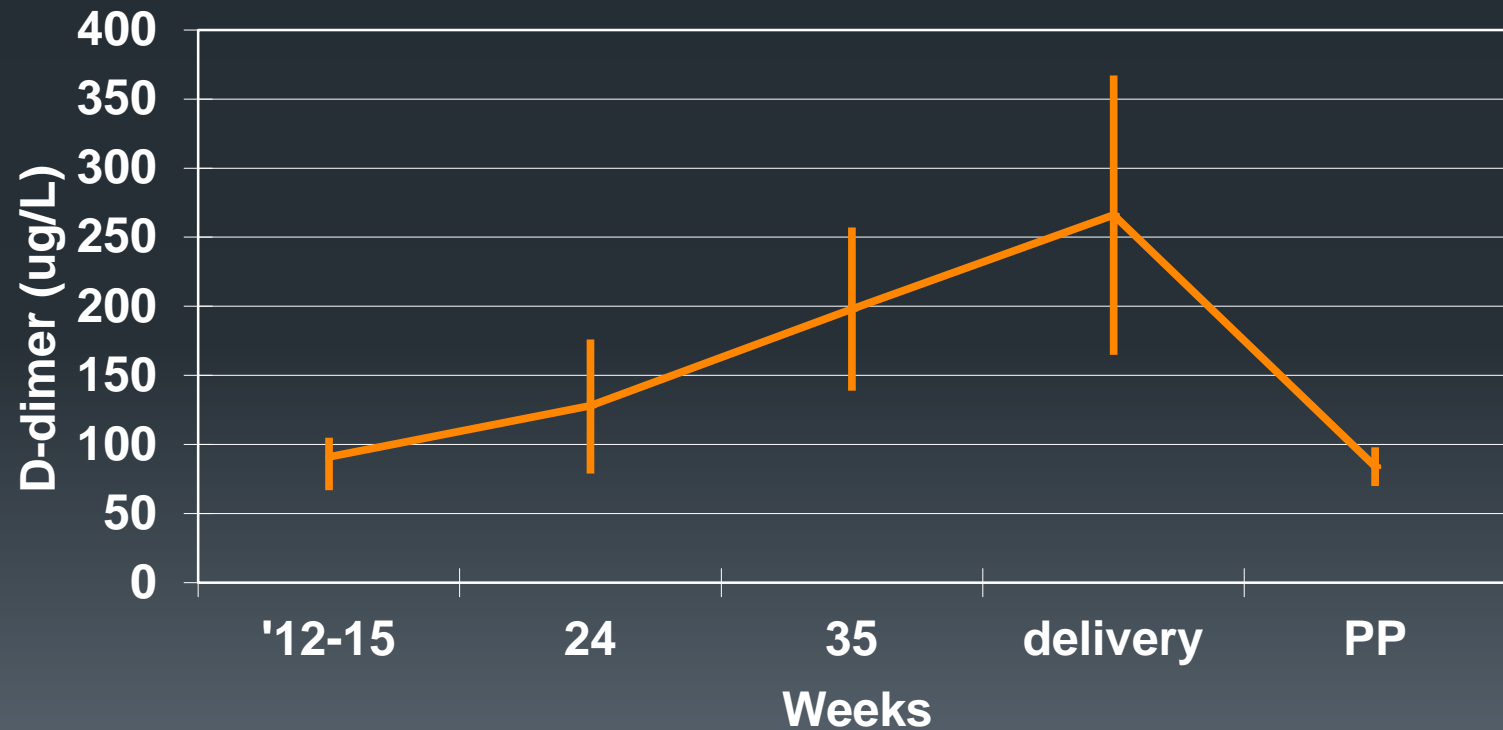
Changes in Fibrinogen in Pregnancy



Changes in Antithrombin in Pregnancy



Changes in D-dimer in Pregnancy





Respiratory Changes

- Compensated respiratory alkalosis
- Lowered $P_a\text{CO}_2$
- Lowered bicarbonate (18-22 mEq/L)
- Minute ventilation increases by 40%
- Decreased functional residual volume
- Elevated diaphragm by 4 cm



Blood Gas Values

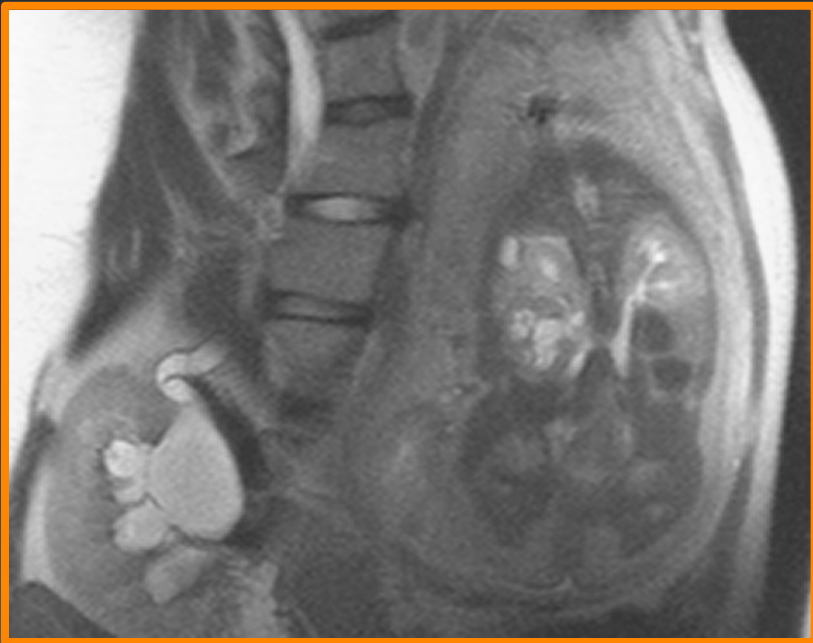
pH 7.40-7.45

pO₂ 104-108 mm Hg

pCO₂ 27-32 mm Hg

HCO₃ 18-22 mEq/L

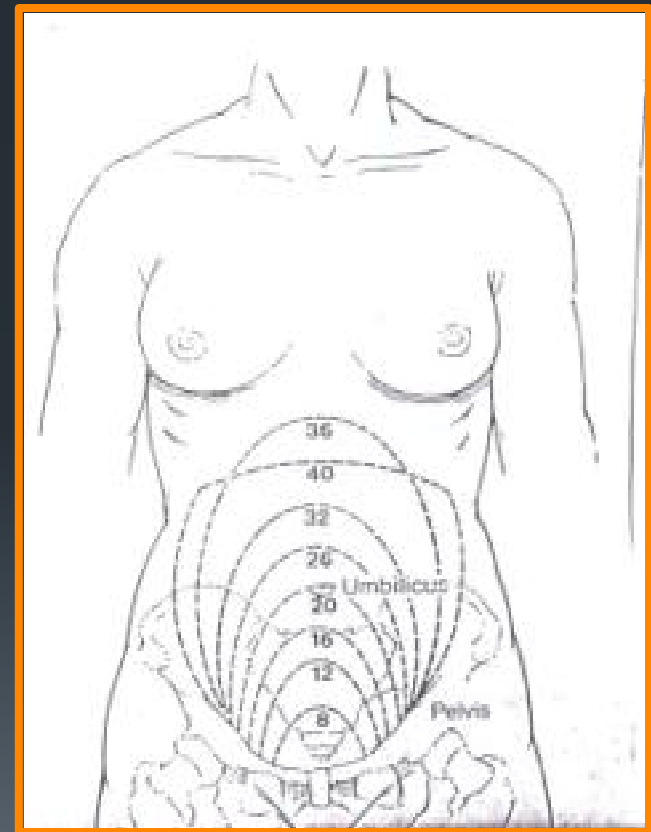
Kidneys and Urinary Tract



- Renal enlargement, dilation and position change
- GFR increases by 50%
- Impaired tubular glucose resorption
- Bladder is displaced upward and 'flattened'

Alterations in Anatomy

- 1st-trimester uterus is thick-walled and intra-pelvic
- Out of pelvis > 12 wks
- 2nd-trimester uterus contains large amount of amniotic fluid
- 3rd-trimester uterus is thin-walled, large; fetal head engaging pelvis
- At 36 weeks, uterus reaches costal margin





GI Changes

- Reduced motility (controversial)
- Large and small bowel move upward and laterally
- Decreased gallbladder emptying





Diagnostic Studies



ACOG Committee Opinion Number 299, September 2004

- Women should be counseled that X-ray exposure from a single diagnostic procedure does not result in harmful fetal effects. Specifically, exposure to less than 5 rad has not been associated with an increase in fetal anomalies or pregnancy loss.

(Replaces No. 158, September 1995) (Reaffirmed 2009) **Committee on Obstetric Practice**



ACOG Committee Opinion Number 299, September 2004

- Concern about possible effects of high-dose ionizing radiation exposure should not prevent medically indicated diagnostic X-ray procedures from being performed on a pregnant woman.
- During pregnancy, other imaging procedures not associated with ionizing radiation (i.e., ultrasonography, MRI) should be considered instead of X-rays, when appropriate.

(Replaces No. 158, September 1995) (Reaffirmed 2009) **Committee on Obstetric Practice**



ACOG Committee Opinion Number 299, September 2004

- Ultrasonography and MRI are not associated with known adverse fetal effects.
- Consultation with an expert in dosimetry calculation may be helpful in calculating estimated fetal dose when multiple diagnostic X-rays are performed on a pregnant patient.

(Replaces No. 158, September 1995) (Reaffirmed 2009) **Committee on Obstetric Practice**



ACOG Committee Opinion Number 299, September 2004

- The use of radioactive isotopes of iodine is contraindicated for therapeutic use during pregnancy.
- Radiopaque and paramagnetic contrast agents are unlikely to cause harm and may be of diagnostic benefit, but these agents should be used during pregnancy only if the potential benefit justifies the potential risk to the fetus.

(Replaces No. 158, September 1995) (Reaffirmed 2009) **Committee on Obstetric Practice**



Plain Films

- **< 5-10 rads**
 - No risk on congenital malformation, abortions or intra-uterine growth ret.
 - Smaller risk of increase in childhood cancer
- **Radiation doses > 10 rads**
 - 6 % chance of severe mental impairment
 - < 3 % chance childhood cancer

Radiographic Examination

Dose to Ovary / Uterus-mrad

Low-Dose Group:

Head, C-Spine,
Thoracic Spine
Chest, Extremities

<1

High-Dose Group:

Lumbar Spine
Pelvic
Hip
Intravenous Pyelogram
Urethrocytogram
KUB

204 – 1260

190 – 357

124 – 450

503 – 880

1500

200 – 503



Ultrasound

- Best modality to assess both fetus and mother
- Not sensitive:
 - Colonic lesions
 - Biliary tree lesions
 - Sub-placental hematoma
- Safe procedure



CT SCAN

- Complementary to U/S & DPL
- Penetrating wounds of flank & back
- Can miss diaphragmatic and bowel injuries
portability
- **Spiral** CT reduces radiation exposure by
14-30 %

Radiographic Examination	Dose (mrad)
Computed Tomography	
Head (1 cm slice)	< 50
Chest (1 cm slice)	< 1000
Upper Abdomen (20 slices 2.5 cm above uterus)	< 3000
Lower Abdomen (10 1 cm slices over the uterus/ fetus)	3000 – 9000
Angiography	
Cerebral	< 100
Cardiac Catheterization	< 500
Aortography	< 100



Bottom Line:

**If the study is needed
to make the
diagnosis
DON'T COMPROMISE!**



REMEMBER:

**A POORLY TREATED
MOTHER = A
POORLY TREATED
BABY!!!!**



Anesthesia Concerns

- Progesterone relaxes the smooth muscle
 - Impairs esophageal and intestinal motility during pregnancy
 - Delayed gastric emptying is controversial
 - However, the risk of pulmonary aspiration of gastric contents remains real
 - Endotracheal intubation reduces this risk



Anesthesia Concerns

Maternal accommodation of the increased oxygen demands and requirement for carbon dioxide elimination:

- Decrease in functional residual capacity
- Increase minute ventilation as a result of increased tidal volume
- Unchanged respiratory rate
- Unchanged closing capacity
 - Therefore, decreased FRC/CC ratio
 - Faster airway closure with reduced lung volume



Anesthesia Concerns

Bottom Line: PREGNANT WOMEN WILL DESATURATE FASTER THAN NON-PREGNANT WOMEN

Solution: ADMINISTRATION OF 100% O² FOR 3-5 MINUTES PRIOR TO INDUCTION OF ANESTHESIA (capacity breaths in and emergency situation sufficient)



Anesthesia Concerns

- Capillary engorgement of the mucosa and edema of the oropharynx, larynx, trachea may lead to difficult intubation
- Friable mucosa
 - Intubation may cause bleeding making visualization while securing airway difficult



Anesthesia Concerns

- Uterine Blood Flow


- Lacks autoregulation as vessels are maximally dilated
- Uterine artery flow is dependent on maternal blood pressure and cardiac output

Bottom Line: ALTER MATERNAL BLOOD PRESSURE, ALTER FETAL BLOOD SUPPLY



Anesthesia Concerns

- Pregnant women demonstrate increased sensitivity to both regional and general anesthesia
- Extent of drug transfer is dependent on numerous factors
 - Molecular weight
 - Degree of lipid solubility
 - Maternal drug concentration
 - Maternal and Fetal pH

- 
- Lower fetal pH favors ionization of basic local anesthetics (i.e., lidocaine) and may explain the accumulation of drugs in a compromised fetus





Case

- 24 yo G1P0 @ 18 wks uncomplicated
- c/o generalized abdominal pain 3-hr duration, nausea vomiting, afebrile, no vaginal bleeding
- UA neg, WBC 16,000
- Fetal ultrasound without defects
- FHR 160 by Doptone



Differential Diagnosis

- Appendicitis
- Ovarian Torsion
- Cholecystitis
- Cholelithiasis
- Pancreatitis
- Degenerating Fibroid



Intra- OP

- Uneventful LMA placement
- Laparoscopic Appendectomy
- Transferred to PACU
 - No contractions
 - FHR 155 by Doptone



1-Hour Postop

- Reports shortness of breath and chest pain
 - HR 105
 - Pox 85%
 - Get ABG
 - 7.3/80/40



- EKG

- Right axis deviation and right bundle branch block
- What's normal

- CXR

- Apparent cardiomegaly with increased vascular markings



What Concerns You Most?

- Tachycardia
- Pulse OX
- ABG
- CXR
- EKG
- Echo

What Concerns the Obstetrician Most?



ABG

What's Normal in Pregnancy?

	Pregnant	Pre-Pregnant
pH	7.4-7.45	7.35-7.45
PO ₂ (mmHg)	104-108	80-100
PCO ₂ (mmHg)	27-32	35-42
HCO ₃ (mEq/L)	22	26


- Compensated respiratory alkalosis
 - PaCO₂ of 40mmHg is very abnormal in pregnancy
 - Fetus relies on high maternal PaO₂

Normal CXR in Pregnancy

- Apparent Cardiomegaly
- Enlarged left atrium (lateral views)
- Increased vascular markings
- Straightening of left-sided heart border
- Postpartum pleural effusion

Normal Electrocardiography

- Right axis deviation
- Right bundle branch block
- ST segment depression of 1 mm on left precordial leads
- Q waves in lead III
- T-wave inversion in leads III, V_2 , V_3
- Small decrease in PR and QT interval (heart-rate dependent)
- Rotation +/- 25 degrees (QRS axis)



Normal Echocardiography

- Trivial tricuspid regurgitation (up to 43-93% at term)
- Pulmonary regurgitation (up to 94% at term)
- Increased atrial size 12-14%
- Increased left ventricle end-diastolic dimensions by 6-10%
- Inconsistent increase in left ventricle thickness
- Mitral regurgitation (28% at term)
- Pericardial effusion (40% postpartum)



When to Intervene and Consult

EARLY !



Remember:

**Delivery is NOT
Always in the
Mothers Best
Interest!**



Remember:

**What is Best
for the Mother is
always Best for
the Fetus!**



Remember:

**YOU CANNOT HAVE A
HEALTHY BABY
WITHOUT A HEALTHY
MOTHER !**

