O. M.G.

- Presents to ED
- 50 pound weight gain in 35 weeks
- Elevated respiratory rate with shortness of breath on exertion
- Edema of lower extremities
- Varicosities noted in both legs
- 2 GM drop in hemoglobin noted
- Complaining of exhaustion and inability to sleep

Plan of care

- IV to provide access?
- Blood work?
- Pulmonary testing?
- Cardiac workup?

No Worries: She's Pregnant! Physiologic Changes

Kathy Mahoney, PhD, MSN, RNC-OB, EFM, APN

Terms

- Gravida
- Para
  - TPAL
- Nullipara
- Primipara
- Multipara
- Grandmultipara
- Spontaneous vaginal delivery
- Operative vaginal delivery
- Cesarean delivery
- c/hys
- Episiotomy

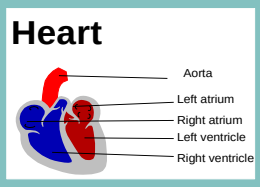
Patient Education is Key

- A very pregnant woman with painfully swollen ankles comes into the unit wearing 4 inch heels. When the nurse questioned her about her choice of footwear she replied

- My OB told me to elevate my feet

Cardiovascular

- Enlargement
- Hemodynamic Changes
  - Blood Volume
  - Cardiac Output
    - Stroke Volume
    - Heart Rate



Review of physiological changes

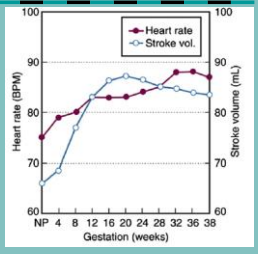
- Cardiovascular
  - Hemodynamic
  - Anatomic
  - Electrical changes

Blood Volume Changes

- Most directed by placental function
- More placentas = more volume
  - Actions resulting from estrogen impact on Na retention
- ⇑ Na + ⇑ Steroid + nitric = ⇑ renal renin ⇒ ⇑ aldosterone secretion = ⇑ total body water

Blood Pressure

- Blood pressure = Cardiac output x SVR
- Even with the ⇑ in CO, maternal BP is ⇓ due to the lower SVR
- Physiological explanations
  - Mediated by progesterone smooth muscle relaxation
  - Increase in NO response that mediates smooth muscle relaxation



(Ouzounian & Elkayam, 2012)

Blood Pressure

- Overall decrease is usually 5-10 mmHg
- Nadir generally at mid pregnancy and returns to pre pregnancy levels at term
- Position matters

Hemodynamic Adaptations for Pregnancy Troiano, Harvey, Flood-Chez, 2013)

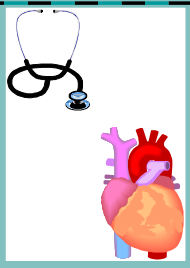
Heart Rate	20% inc. by 3rd trimester (15-20 bpm)
Blood Volume	40-50% inc.
Cardiac Output	30-50% inc.
Systemic Vascular Resistance	Dec. by 21%
Pulmonary Vascular Resistance	Dec. by 34%
Blood pressure	Dec. in 1st Trimester, normalizes by 3rd

Anatomic Cardiac Changes

- ⇑ ventricular wall mass
- ⇑ end diastolic volume
- End diastolic pressure remains the same
- Dilated maternal heart but no decrease in ejection fraction

Ausculatory Changes

- Exaggerated Split in first sound
- Extra Heart Sounds
  - S3
  - S4
- Murmurs
  - Systolic
  - Diastolic



Electrical Changes

- L axis deviates d/t displacement of heart
- May have nonspecific ST segment and T wave changes
  - Changes should not affect function.

Changes in Regional Blood Flow

Table 2
Changes in regional blood flow during normal pregnancy

Organ	Change	Comments
Uterus	Increased	Increase from 50 mL/min at 10 wk to 1200 mL/min at term
Kidneys	Increased	30%–80% increase with 50% increase in GFR. Returns to nonpregnant state at term
Extremities	Increased	Flow to hands greater than flow to feet
Skin	Increased	Results in warm skin, clammy hands, nasal congestion
Liver	Unchanged	—
Brain	Unchanged	—
Breast	Increased	May cause flow murmurs

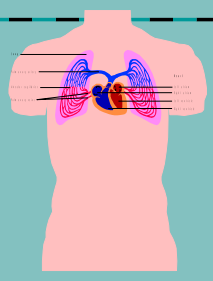
(Ouzounian & Elkayam, 2012)

Respiratory Adaptations

- Chronic hyperventilation ⇒ due to inc. oxygen consumption of 20-30% at term
- Inc. in Intra-abdominal pressure
  - Elevates diaphragm 4 cms
  - Dec. lung length
  - Inc. intrathoracic pressure
  - Ribs flare
  - Inc. A/P diameter

Respiratory System

- Rate
- Tidal Volume
- Diaphragm
- CO2



Let's Stop Right Here!

- Cardiac issues of concern
  - Arrythmia
  - Cardiomyopathy
  - Congenital Anomalies
- Development of Pre-eclampsia
- Respiratory issues of concern
  - Asthma
  - COPD
  - ARDS

Medication Issues

- Anti hypertensives
- Anti arrythmics
- Aspirin
- Inhalers

Effects of Pregnancy on Medications

Table 1. Physiological changes during pregnancy: effects on drug disposition [10–16].

Parameter	Consequences
Delayed gastric emptying and increased gastric pH	Altered drug bioavailability and delayed time to peak levels after oral administration
Increased cardiac output	Increased hepatic blood flow; increased elimination for some drugs
Increased total body water, extracellular fluid	Altered drug disposition; increased V_d for hydrophilic drugs
Increased fat compartment	Decreased elimination of lipid-soluble drugs; increased V_d for hydrophobic drugs
Increased renal blood flow and glomerular filtration rate	Increased renal clearance
Decreased plasma albumin concentration	Increased free fraction of drug
Altered CYP450 and UGT activity	Altered oral bioavailability and hepatic elimination

UGT, uridine diphosphate glucuronosyltransferase; V_d, volume of distribution.

(Pariente, G et al, 2016)

Gastrointestinal Changes

- Uterine contents will alter the GI assessment by displacement
- Pain assessments are affected
  - Appendicitis: pain displaced superiorly and laterally depending on the stage of pregnancy
- Abdominal wall laxity: confounds assessment for rigidity
- May not be able to palpate masses

Gastrointestinal Changes

- Reflux
  - Compression of esophagus by uterus and relaxation of sphincter exacerbate sympotoms
- Increased risk of aspiration
- Decreased secretion of gastric acids
- Decreased gastric motility
  - Constipation
  - Hemorrhoid formation

Gastrointestinal Changes

- Appetite increases
- Motility of GI tract dec
- Gall Bladder emptying greatly ⇓

Urinary System

- Inc in size by ≈ 1 cm
  - Inc in vasculature
  - Inc in interstial volume
  - R ureter usually more dilated than L
- Inc in renal plasma flow until ≈ 34 weeks
- Inc in hypefiltration without increase in glomerular pressure

Urinary System

- GFR inc by 50% and maintains until end of pregnancy
  - Best measured by creatinine clearance
  - Levels ⇑ from 120 mL/min – 150-200 mL/min
- Most urinary changes due to relaxin and ⇑ secretion of NO

Let's Stop Right Here!

- Gall Bladder issues
  - Sludge
  - Stones
- End Stage Renal Failure
- Urinary reflux
- Pyelonephritis
- UTI
- Hyperemesis

Musculoskeletal Changes

- Fetus does not rob the mother's system of calcium: fetus able to get calcium needs through a change in intestinal calcium metabolism
- Maternal calcium levels fall due to dec albumin levels (calcium bound to albumin)
- Pregnancy and lactation are times of bone and skeltal turnover and remodeling

Musculoskeletal Changes

- Lordosis
  - Increased anterior convexity of the spine
  - Keeps center of gravity over the legs
- Sacroiliac joints and pubic symphysis loosen due to relaxin
- Marked widening of symphysis
- Falls precautions

Endocrine Changes

- Thyroid
  - Free T_3 and T_4 levels are slightly reduced but have no clinical significance
  - TSH slightly ⇑
- Adrenal
  - Aldosterone rises significantly throughout pregnancy
  - Angiotension II ⇑
  - Renin activity ⇑
  - Corticosteroid levels ⇑
- Pituitary
  - ⇑ in prolactin
  - FSH and LH undetectable
  - Serum growth hormone ⇑
- Posterior pituitary
  - Oxytocin: peaks at term
  - ADH unchanged but dec in Na+ alters thirst response

Endocrine Changes

- Lipids
  - ⇑ in cholesterol and triglycerides
    - LDL ⇑ by 50% at term
    - HDL ⇑ in first ½ and then fall to 15% ⇑pre preg levels at term
  - Accommodates needs of developing fetus
- Calcium transferred to fetus and ⇑ needs met by dietary intake of mother
- ⇑ peaks in 3rd trimester and needs met by ⇑ calcium stores laid down in fist trimester of pregnancy

Endocrine Changes

- Glucose
  - Pregnancy is insulin resistant state that is more progressive as pregnancy advances
  - Directed by diabetogenic hormones from placenta
    - Progesterone, placental lactogen, human growth hormone, cortisol and prolactin

Let's Stop Right Here!

- **Diabetes**
  - Type 1
    - Absolute insulin deficiency
    - Insulin and medical nutrition therapy (MNT)
    - Usually occurs in people less than 30 years of age but may develop at any age
  - Type 2
    - Insulin resistant and relative insulin deficiency
    - MNT, insulin, oral medications, exercise
    - Onset usually beyond childbearing years in past
    - Obesity, PCOS, increasing rates in children and young adults
  - Gestational Diabetes Mellitus
    - Carbohydrate intolerance of any degree with onset during pregnancy
      - Type A1: Diet controlled
      - Type A2: Insulin controlled

Pregestational Classifications: White

Class	Age at Onset		Duration (Years)	Vascular Disease ?	Need Insulin?
A_1	GDM			0	0
A_2	GDM			0	+
B	>20 (B1)		<10 (B2)	0	+
C	10-19 (C1)	OR	10-19 (C2)	0	+
D	<10 (D1)	OR	>20 (D2)	+	+
F	Any		Any	+ Nephropathy	+
R	Any		Any	+ retinopathy	+
T	Any		Any	+ Transplant	+

Gabbe, S (2007) and White (1949) Adapted, Institute for Algorithmic Medicine, UMBSN, Texas (2006)

Let's Stop Right Here!

- Thyroid Disease
- Poly cystic ovarian syndrome
- Adrenal disease
  - Congenital adrenal hyperplasia
- Poor nutrition

Immunological Changes

Immunological Changes

Laboratory Changes

- Decreased hemoglobin
  - Dilutional anemia
- Mild leukocytosis
- Inc alk phos 2-4 times that of non pregnant
- Mild hyponatremia
- Elevated sedimentation rate
- Albumin falls by 25%
- Total protein falls

Laboratory Changes

- Procoagulant factors are markedly increased
  - Factor I (plasma fibrinogen) omc om 1st tri and peak in 3rd at levels 50% higher than non preg
- Decrease in natural inhibitors of coagulation
- Dec in fibrinolytic activity
- Pt, PTT and thrombin should remain in normal limits
- Hypercoagulability is a common state in all pregnant women

Laboratory Changes

- Dec BUN, serum creatinine, and uric acid* until term when they approach pre pregnancy levels

Stroke Risk

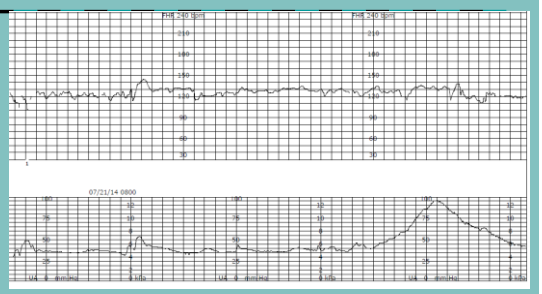
- Risk of stroke in postpartum patients is highest the first 6 weeks postpartum
- Hypercoagulability the culprit
- New research indicates that the thromboembolitic risk may extend in high risk patients to 12 weeks postpartum

Pregnancy and the Flu

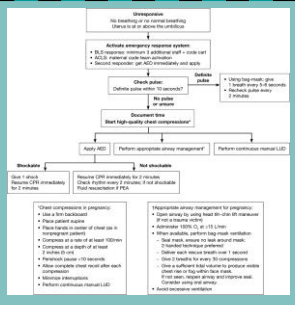
- Standard of care is to administer flu vaccine during pregnancy regardless of gestational age.
- Pregnant women have a six fold risk of dying from the flu than any other population

Message from the Fetus & Uterus

- Baseline Heart Rate
  - 110-160
    - Above 160: Tachycardia
    - Most common cause: maternal temp
    - Below 110: Bradycardia
    - Most common cause: prolonged gestation
- Accelerations
- 15 BPM for 15 seconds from base to base
- Contractions are expected at term!



Maternal Cardiac Arrest Algorithm



Maternal Cardiac Arrest: Medications

- When death is the alternative, nothing is contraindicated

Maternal Cardiac Arrest: Evidence Based Interventions

- 1. Place pt. supine and displace uterus to relieve aortocaval compression (Class I; Level of Evidence C).
- 2. Administer100% oxygen by face mask to treat or prevent hypoxemia(Class I; Level of Evidence C).
- 3. Intravenous access should be established above the diaphragm (Class I; Level of Evidence C).
- 4. Precipitating factors should be investigated and treated (Class I; Level of Evidence C).

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