PHYSIOLOGIC CHANGES OF PREGNANCY

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I. INTRODUCTION

"During pregnancy, multiple physiologic adjustments are made to maintain maternal hemostasis. In a non-pregnant patient, many of these alterations would be considered pathologic rather than physiologic. This lecture will present the adjustments and alterations in maternal physiology."

MATERNAL PHYSIOLOGY

II. CARDIOVASCULAR

A. Cardiac Output - is ↑ during pregnancy . 1.5l/min.

1. Cardiac Output = heart rate x stroke volume.
   CO = HR x SV

2. Output can be measured using direct Fick method, i.e.:

   Output of L. ventricle = $\frac{O_2 \text{ consumption (ml/min)}}{A_{02} - V_{02}}$

3. Pulse rate ↑ from 70 – 85
   a. Heart rate ↑ by catecholamines
      (1) Chronotropic
      (2) Inotropic

4. Stroke volume increases . 10%. Regulated by 2 mechanisms.
   a. Heterometric
   b. Homometric

5. ↑ CO, by ↑ SV = ↑ heart size

B. Mean arterial pressure - average pressure throughout cardiac cycle - decreased.

C. Total peripheral resistance - dependent upon arteriole diameter - ie., small changes in caliber = large changes in TRP.

$$R = \uparrow \frac{hL}{\pi r^4}$$

During pregnancy TPR is reduced.

D. Increased blood flow - distribution.
1. Uterus*
2. Kidney
3. Skin
4. Breasts

E. Pulmonary Pressure - same as non-pregnant levels, due to:
1. ↓ resistance to flow - vascular dilation
2. ↑ volume - capacitance

*3. RADIOGRAPHIC APPEARANCE - increased vascularity, enlarged pulmonary vessels.

F. Venous Pressure - ↑ in femoral pressure:
1. Weight of uterus of illac veins, inf. vena cava.
2. Hydrodynamic obstruction - due to ↑ uterine outflow.
*3. SUPINE HYPOTENSIVE SYNDROME

G. ECG Changes - elevation of diaphragm heart moved upwards and rotated forward, + enlarged. Therefore, one would predict change in the electrical axis of the heart. Deviation to the left in the electrical axis (15-28E).

H. Volume and Composition of Blood.
1. ↑ Plasma volume 40-50%.
2. ↑ RBC - 25-30%.
3. ↓Hematocrit
4. ↑ WBC
5. ↑ Fibrinogen
6. ↑ Sedimentation rate
7. ↑ Clotting Factors (VII, VIII, IX, X)
8. ↑ Serum alkaline phosphatase

III. <u>RESPIRATION</u>

A. Definitions
1. Tidal volume (TV) - amount of air moving into lungs with each inspiration.

2. Inspiratory Reserve Volume (IRV) - air inspired with maximal inspiratory effort in excess of tidal volume.

3. Expiratory Reserve Volume (ERV) - volume expelled by active expiratory effort after passive expiration.
4. Residual Volume (RV) - air left in lungs after maximal expiratory effort.

5. Vital Capacity - greatest amount of air that can be expired after maximal inspiratory effort. (timed vital capacity)

6. Respiratory Minute Volume (RMV) - amount of air inspired/minute.

7. Maximal Voluntary Ventilation - maximal amount of air that can be moved into and out of the lungs in one minute by voluntary effort.

B. During pregnancy the following occurs:
1. ↑TV

2. ↑ RMV - 40%

a. hyperventilation
b. respiratory alkalosis - compensated
c. ↓ alveolar CO_2 40mm Hg – 30mm Hg
d. ↑ sensitivity of brain stem respiratory centers to pCO_2 - progesterone.

IV. RENAL

A. Physiologic Changes:

1. Renal Plasma Flow (RPF) - equals the amount of a substance excreted/unit of time divided by renal arteriovenous difference. (PAH, DIODRAST)

$$RPF = \frac{U[x]\,V}{P[x]}$$

$$\text{Renal blood flow} = RPF \times \frac{1}{1\text{-hematocrit}}$$

RPF is raised throughout pregnancy by 200-250 ml/1-min.

2. Glomerular Filtration Rate (GRF) - of the plasma perfusing the glomeruli - about 20% reaches the tubular system of the kidney as an ultrafiltrate - i.e. , GFR.

$$GFR = \frac{U[x]\,V}{P[x]} = \text{Clearance}$$

a. ↑ creatinine clearance
b. ↑ urea clearance
c. ↑ uric acid clearance

3. Tubular Function:
   a. Na+ Excretion - progesterone inhibits reabsorption, however, increasing aldosterone levels counteract this effect.

   b. H_20 = although plasma osmolality is ↓ and ECF ↑, urine volumes are similar to non-pregnant volumes. Hypothalamic resetting of osmoreceptors.

   c. Glycosuria - normal in pregnancy.

   d. Aminoaciduria - due to high circulating levels of cortisol?

4. ↑ activity of renin - angiotensin - dissociation between pressor and renal effects.

5. ↑ aldosterone

6. ↑ erythropoietin

V. GASTROINTESTINAL - Decreased motility, delayed absorption ↓ gastric secretion, ↓ tone of cardiac sphincter (reflex esophagitis).

VI. ENDOCRINE

A. Steroids:

1. Progesterone - corpus luteum, fetal-placental unit.

a. hyperpolarization of smooth muscle membrane potential - ↓ tone.

b. ↑ temperature

c. ↑ respiratory rate

d. combined actions

e. breast development

2. Estrogens - ovarian, fetal-lacental unit.

a. combined actions with progesterone

b. connective tissue effects

c. liver - binding globulins ↑, serum enzymes ↑.

B. Protein Hormones:

1. HCG - human chorionic gonadotrophin - syncytial trophoblast

a. corpus luteum

b. diagnosis of pregnancy

c. fetal adrenal

2. hPL - human placental lactogen - syncytium

a. GH like activity like activity

b. diabetogenic

3. HCT - chorionic thyrotropin TSH like activity

C. Pituitary Hormones:

1. Anterior Lobe

2. ADH, Oxytocin

D. Adrenal Hormones:

1. Cortisol - increases

2. Aldosterone - increases

E. Pancreas - ↑/s cell function, placental insulinase