Physiologic Changes of Pregnancy, Pelvic Anatomy, and Labor Process

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Outline

- Physiologic changes of pregnancy
- Stages and phases of labor
- Normal labor progress
- Pelvic anatomy and the fetus’ negotiation of it
- Physical assessment of laboring woman
- Nursing care during uncomplicated first stage labor

Hormonal Mediators

- Human chorionic gonadotropin (HCG): secreted by blastocyst. Stimulates corpus luteum to produce estrogens and progesterone. Stimulates thyroid production. Rises fast in early pregnancy, then plateaus as placenta takes over estrogen & progesterone production
- Human Placental Lactogen (hPL): Secreted by the syncytiotrophoblast. Causes insulin resistance, increases availability of glucose for fetus, promotes lipolysis, available free fatty acids for maternal energy use as needed (ketosis). Promotes development of mammary glandular tissue
- Estrogens: Secreted by corpus luteum, and then by placenta. Stimulates growth of uterine muscle and uterine vasculature, breast tissue. Together with progesterone, inhibits LH and FSH. Effects vagina, vulva, and skin. Inhibits lactation during pregnancy

Physiologic Changes of Pregnancy

Hormonal Mediators

- Progesterone: Secreted by corpus luteum, and then by placenta. Maintains pregnancy by building up secretory endometrium, inhibiting uterine contractions, mediating immune changes. Relaxes, slows GI smooth muscle
- Relaxin: produced by corpus luteum and placenta. Inhibits uterine contractions, mediates collagen remodeling and softening of cervix
- Placental Growth Hormone: Secreted by the syncytiotrophoblast. Increases nutrient availability for fetus by promoting lipolysis and gluconeogenesis. Regulates maternal insulin-like growth factor 1
- Prolactin: released from anterior pituitary. Responsible for maturation of mammary ducts and areolae, initiation of lactation. Prolactin levels surge after delivery of placenta as estrogen levels drop

Cardiovascular Changes in Pregnancy

- HR increases 10-20 bpm
- Blood volume increases 50% (1.4 – 1.7 L)
- RBC mass increases 20-30% (Physiologic anemia of pregnancy)
- Cardiac output increases 30-50%
- Heart sounds: systolic murmur: > 90% of women
  – >3: 80%; diastolic murmurs: 18%
- Symptoms: Decreased exercise tolerance, fatigue, occasional orthopnea, syncope, and chest discomfort
Peripheral Vascular Changes in Pregnancy

- Systemic vascular resistance decreases 20%
- Varicosities
- BP decreases in early pregnancy to nadir ~16-20 weeks
- Hypercoagulation:
  - ↑ procoagulant factors: I (fibrinogen), VII, IX, IX, X
  - ↓ fibrinolytic factors
  - 5-6 x increased risk of thromboembolic events (1 in 1,500)
  - Protects against postpartum hemorrhage

Respiratory Changes in Pregnancy

- Oxygen consumption increases 15-20%
- Tidal volume increases 30-40%
- Minute ventilation increases 40%
- Expiratory reserve volume decreases 20%
- Total lung volume decreases 5%
- pCO2 ↓ mild respiratory alkylosis
- RR usually unchanged
- Diaphragm shifted upward 4cm, AP diameter of chest increases
- Substernal angle increases from 68 to 103 degrees
- Sx: nasal stuffiness, SOB

Renal Changes in Pregnancy

- Renal blood flow increases 35-60%
- GFR, creatinine clearance increases
- Serum creatinine: 0.40 – 0.73
- Proteinuria (>250 mg/24 hours is abnormal)
- Glycosuria
- Ureters become dilated, elongated, and more tortuous (curvy), R>L
- ↑ risk for pyelonephritis from asymptomatic bacteruria
- Decreased bladder capacity
- Urinary incontinence
- Increased bladder vascularity: microhematuria

Metabolic Changes in Pregnancy

- Increase in total body water of 6.5 to 8.5 L
- Colloid osmotic pressure decreases 20%
- Decreases sodium concentration
- Relative hyperinsulinemia, increases with GA
- Increased Thyroid hormone (T4, T3) and thyroid hormone binding globulin
- Calcium metabolism changes:
  - Fetus absorbs 21 grams of Ca, primarily in 3rd trimester
  - Increased intestinal absorption of Calcium
  - Increased vitamin D and calcitomin levels
  - Total serum Ca ↓ but ionized Ca levels remain steady
  - Maternal bone loss is negligible

Pregnancy Weight Gain Recommendations (IOM 2009)

<table>
<thead>
<tr>
<th>PREGNANCY BMI</th>
<th>BMI (kg/m²)</th>
<th>TOTAL WEIGHT GAIN (lb)</th>
<th>RATES OF WEIGHT GAIN ↑ 2ND AND 3RD TRIMESTER (lb/week)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt;18.5</td>
<td>28-40</td>
<td>1 (1-1.3)</td>
</tr>
<tr>
<td>Normal weight</td>
<td>18.5-24.9</td>
<td>25-35</td>
<td>1 (0.8-1)</td>
</tr>
<tr>
<td>Overweight</td>
<td>25.0-29.9</td>
<td>15-25</td>
<td>0.6 (0.5-0.7)</td>
</tr>
<tr>
<td>Obese (all classes)</td>
<td>≥30.0</td>
<td>11-20</td>
<td>0.5 (0.4-0.6)</td>
</tr>
</tbody>
</table>

Increased caloric need: ~300 kcal/day

Gastrointestinal Changes in Pregnancy

- Nausea and vomiting (50-80% affected)
- Appetite changes: food and smell aversions, pica
- Pylism
- Relaxed esophageal sphincter: heartburn
- Decreased GI motility can lead to constipation
- Delayed gastric emptying (c/o bloating)
- Hemorrhoids (varicosities)
- Liver changes:
  - Decreased albumin
  - Alkaline phosphatase increases 2-4 x
- Gall bladder: fasting & residual volumes increases, slower emptying rate: gallstone formation more likely
Neurologic Changes in Pregnancy
• Headaches may be more or less frequent
• Peripheral parasthesias: sciatica, carpal tunnel
• Eyes: cornea thickening, decreased intraocular pressure: visual acuity changes (myopic shift)

Integumentary Changes in Pregnancy
• Increased skin vasculature, blood flow
• Hair: in late pregnancy, more hairs in growing phase and less in resting phase. (proportionally > hairs entering resting phase causes hair loss 2-4 months pp)
• Striae gravidarum
• Pigment changes: nipples, areola, perianal and genital areas, linea nigra, melasma (mask)
• PUPPS

Immune System Changes in Pregnancy
• Decreased cellular immune response
• Increased humoral response
• Uterine leukocyte population changes: macrophages and NK cells predominate
• NK cells contribute to maintenance of pregnancy and maternal tolerance of the fetus
• Macrophages induce nitric oxide formation (relaxes uterine muscle) and help mediate labor onset via pro-inflammatory cytokines
• More susceptible to intracellular infections
• Influenza: higher risk for severe complications
• Autoimmune disorders: often reduction in symptoms, flare-ups

Musculoskeletal Changes in Pregnancy
• Ligaments soften d/t progesterone and relaxin
• Center of gravity changes
• Lordosis
• Rectus abdominus muscle may separate (diastasis recti)
• Widening of pubic symphysis
• Low back pain, SI, hip complaints are common
• Exercise is beneficial!

Psychological Changes
• Sleep changes
• Depression
• Anxiety
• Emotional vulnerability
• Critique of parenting
• Memory

Changes in Reproductive System
• Uterus:
  – grows from 50g to 1,000-1,500g organ
  – Hyperplasia and hypertrophy of myometrium up to mid-pregnancy, then thins
  – 1/6” of circulating blood volume present in uterine vasculature
• Cervix:
  – increased vascularity
  – increase in glandular tissue
  – increased mucous production
• Vagina:
  – hypertrophy of epithelium and muscle layers, increased vasculature
  – Connective tissue loosens and musculature relaxes
• Breasts:
  – Increase in size and nodularity, more prominent veins, darkening of areola, nipples more easily erectile
LET'S REVIEW SOME ANATOMY

Placental Anatomy

Uterine Anatomy

The Uterus at Term

Vulvar Anatomy
Pelvic Anatomy

Made up of 3 bones: ilium, ischium, and sacrum

Bony Pelvis

Pelvic Floor Musculature

NORMAL LABOR & DELIVERY

Labor Process Animation

Stages & Phases of Labor

- **First stage:** from beginning of cervical begins to thinning and dilation to complete dilation
  - **Latent phase:** 0 to 4-6 cm, effacement; hours to days
  - **Active phase:** 4-6 cm to complete; starts when effacement 90-100%, typically lasts 3-12 hours
- **Transition to second stage**
- **Second stage:** Full dilation to birth of the baby
  - Also has latent and active phases
- **Third stage:** birth of the baby to delivery of the placenta
**LABOR PROGRESS**

**The Friedman Curve**

**Table 2. Duration of Labor in Hours by Parity in Spontaneous Onset of Labor**

<table>
<thead>
<tr>
<th>Cervical Dilatation (cm)</th>
<th>Parity 0</th>
<th>Parity 1</th>
<th>Parity 2+</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-4</td>
<td>1.8 (8.1)</td>
<td>—</td>
<td>1.4 (7.0)</td>
</tr>
<tr>
<td>4-5</td>
<td>1.3 (6.4)</td>
<td>1.3 (7.3)</td>
<td>1.4 (7.0)</td>
</tr>
<tr>
<td>7-8</td>
<td>0.5 (1.6)</td>
<td>0.4 (1.3)</td>
<td>0.4 (1.2)</td>
</tr>
<tr>
<td>8-9</td>
<td>0.5 (1.4)</td>
<td>0.3 (1.0)</td>
<td>0.3 (0.9)</td>
</tr>
<tr>
<td>9-10</td>
<td>0.5 (1.8)</td>
<td>0.3 (0.9)</td>
<td>0.3 (0.8)</td>
</tr>
<tr>
<td>Second stage with epidural analgesia</td>
<td>1.1 (3.6)</td>
<td>0.4 (2.0)</td>
<td>0.3 (1.6)</td>
</tr>
<tr>
<td>Second stage without epidural analgesia</td>
<td>0.6 (2.8)</td>
<td>0.2 (1.3)</td>
<td>0.1 (1.1)</td>
</tr>
</tbody>
</table>

Data are median (95th percentile).

**Zhang et al, 2010b Concluded:**

- Contemporary population with 30-35% cesarean rate, many performed for arrest of labor under prevailing definitions of the time, means length of labor may be underestimated.
- Multiparous progress no faster than nulliparous until after 6 cm.
- Inflection point for multiparous labor was 5-5.5 cm 50 years ago; now 6-6.5 cm.
- Nulliparous labors seem to have no inflection point.
- 6 cm rather than 4 cm is start of active phase.
Nulliparous Labor Curve for Different BMI Categories

Multiparous Labor Curve for Different BMI Categories

Induced vs. Spontaneous Labor Progress

Harper et al, 2012

Risk Comparison: Vaginal vs. Cesarean Delivery

Preventing Cesareans

- NTSG: nulliparous term singleton vertex
- Recommendations:
  - Prolonged latent phase (>20 hrs nulliparous; >14 hrs multiparous) should not be an indication for cesarean delivery
  - Slow but progressive labor in the first stage should not be an indication for cesarean delivery
  - Cervical dilation of 6cm should be considered the threshold for active phase in most women. Thus, before 6cm, standards of active phase progress should not be applied.
  - Cesarean delivery for active phase arrest in first stage should be reserved for women > 6cm dilation with ruptured membranes who fail to progress despite 4 hours of adequate uterine activity, or at least 6 hours of oxytocin administration with inadequate uterine activity and no cervical change.

Mechanisms of Labor: The 3 P’s

- Powers (uterine activity)
- Passenger (the fetus—mainly the head!)
- Passage (maternal pelvis)

From Safe Prevention of the Primary Cesarean Delivery, a joint Obstetric Care Consensus by the American College of Obstetricians and Gynecologists and the Society for Maternal-Fetal Medicine. March 2014
More Affecting Labor Progress: More P’s!

- Position
- Psyche
- Permission
- Physical environment
- Privacy
- Practices
- People
- Partners

Powers: Uterine Contractions

- Definition of “adequate” uterine pattern varies
- Typically, 2-5 contractions per 10 minutes
- Or, contractions Q 2-5 minutes, lasting 60-90 seconds
- Tachysystole: >5 contractions in 10 minutes
- Montevideo Units: ≥200
- Any contraction pattern that results in labor progress can be considered adequate

Passenger: The Fetus

- Fetal size (Cesarean recommended only if efw >5 Kg, or >4.5 Kg in diabetic mother)
- Lie: relation of longitudinal axis of fetus to longitudinal axis of the uterus (or the mother)
- Presentation: fetal part overlying the pelvis (cephalic or breech)
  - Malpresentation: any presentation other than vertex
- Attitude: position of fetal head in relation to fetal spine (degree of flexion or extension)
- Position: relationship of the fetal presenting part to the maternal pelvis
- Station: a measure of the descent of the bony presenting part through the birth canal

Fetal Lie

Anatomy of the Fetal Skull

- Occiput is normally used to denote position
- Mentum is used for position with face presentation
- Sacrum is used to denote position with breech presentations

Presenting Diameters of Average Term Fetal Skull

- Submentovertex (face): 9.5 cm
- Bicoronal (brow): 11.0 cm
- Biparietal (sides): 9.5 cm
- Suboccipitomental (vertex, occiput): 13.5 cm
**4 Pelvic Shapes**

<table>
<thead>
<tr>
<th>Pelvic Shape</th>
<th>Gynecoid</th>
<th>Anthropoid</th>
<th>Android</th>
<th>Platypelloid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pelvic inlet</td>
<td>12 cm</td>
<td>&lt;12 cm</td>
<td>12 cm</td>
<td>12 cm</td>
</tr>
<tr>
<td>Anteroposterior diameter of inlet</td>
<td>11 cm</td>
<td>&gt;12 cm</td>
<td>11 cm</td>
<td>15 cm</td>
</tr>
<tr>
<td>Pelvic outlet</td>
<td>Wide</td>
<td>Divergent</td>
<td>Narrow</td>
<td>Straight</td>
</tr>
<tr>
<td>Side outlet</td>
<td>Straight</td>
<td>Narrow</td>
<td>Convergent</td>
<td>Wide</td>
</tr>
<tr>
<td>Sacral curve</td>
<td>Medium</td>
<td>Bowed</td>
<td>Forward (convex)</td>
<td>Narrow</td>
</tr>
<tr>
<td>Pubic arch</td>
<td>Not prominent</td>
<td>Not prominent</td>
<td>Not prominent</td>
<td>Not prominent</td>
</tr>
<tr>
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<tr>
<td>Anteroposterior diameter of outlet</td>
<td>15 cm</td>
<td>12 cm</td>
<td>&lt;15 cm</td>
<td>16 cm</td>
</tr>
</tbody>
</table>

**The Cardinal Movements**

- Engagement
- Descent
- Flexion
- Internal Rotation
- Extension
- External Rotation
- Expulsion
**ASSESSMENT OF THE LABORING WOMAN**

**Minimal Assessment of Any Pregnant Woman seen in L&D unit**

- Vital signs
- Fetal Heart Rate
- Uterine contractions

**Inform obstetric provider of presence of:**
- Vaginal bleeding
- Acute abdominal pain
- Fever
- Preterm labor
- Preterm rupture of membranes
- Hypertension (systolic >140 and/or diastolic >90)
- Non-reassuring FHR tracing (any Cat II or III tracing)

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**Review of Prenatal Record**

- Gestational age
- Singleton?
- Prenatal Labs: hct, plt, blood type, infections (HIV, Syphilis, chlamydia, gonorrhea, Hep B), GBS screen, GDM screen
- Ultrasounds
- Pregnancy problem list
- Significant PMH
- Allergies
- Birth plan: pain management, comfort measure plan
Labor Admission History Taking

- Onset and frequency of contractions; progression
- ROM?
- Vaginal bleeding: Bloody show vs. mucous plug vs. frank bleeding
- Fetal movement?
- History of allergies?
- Most recent ingestion of food or drink?
- Any recent use of medication?
- Preferences for labor & birth care (birth plan)

Labor Admission Assessment

- BP, P, RR, T (note P and BP normally increase in labor)
- Contractions: frequency, duration, and intensity
- Fetal well-being: FHR tracing (may or may not be an NST)
- Cervical dilatation and effacement (unless contraindicated [e.g., placenta previa])
- Fetal presentation and station of the presenting part
- Status of the membranes Intact or Ruptured
  - If ROM, time, amount, color, odor
- Date and time of the woman’s arrival
- Date and time of arrival of the provider
- Coping, emotional state
- Support persons

Leopold’s Maneuvers

Cervical Dilation & Effacement

Differentiating Active from “false” or Latent (or Prodromal) Labor

- Contraction pattern
- Cervical dilation: may need to reassess after 2 hours
- Bloody show
- ROM
- Discharge instructions for non-active labor

Ongoing Assessment in Labor

- VS at least every 4 hours
- FHR baseline, variability, the presence or absence of accelerations and decelerations, and pattern evolution over time.
- Uterine activity: contraction frequency, duration, and intensity along with uterine resting tone between contractions
  - Assess Q 30 min. during the active phase of the first stage of labor and Q 15 min. during the active pushing phase of the second stage of labor
  - Fetal risk status or response to labor may indicate need for more frequent assessment: Q 15 in active 1st stage, Q 5 min 2nd stage
- Maternal coping
- Labor progress: cervical dilatation/effacement/station as indicated
- ROM and fluid assessment
Intermittent Auscultation

- Use a Doppler
- Detect FHR baseline
- Detect FHR rhythm (regular?)
- Detect increases and decreases from FHR baseline
- Frequency of assessment: AWHONN recommends every 15 to 30 minutes in the active phase of the first stage of labor and every 5 to 15 minutes in the active phase of the second stage of labor
- Category I:
  - Normal FHR baseline between 110 and 160 bpm
  - Regular rhythm
  - Presence of FHR increases or accelerations from the baseline
  - Absence of FHR decreases of decelerations from the baseline

NURSING CARE IN 1ST STAGE LABOR

Food and Drink

- PO fluids and light food consumption safe in active labor
- Slowed gastric emptying

Non-Pharmacologic Comfort Measure in Labor

- Walking
- Positions
- Presence of calm, supportive labor support people
- Massage
- Environment: low lights, relaxing music, aromatherapy
- Water immersion
- Reassurance and support
- Focused relaxation

Laboring Positions

More Laboring Positions
Supported kneeling

The Peanut Ball

UP NEXT: SECOND STAGE!