Objectives
- Identify pre/intra/postop and discharge priorities for the pediatric patient
- Discuss the difference between pediatric priorities from those of the adult patient
- Discuss the demographics of aging
- Identify both physiologic and pathologic organ system changes of aging using a systems approach
- Identify pharmacokinetic and pharmacodynamic changes that occur with aging
- Describe how to develop a perioperative care plan for the aging surgical patient
- Identify the physiologic changes of pregnancy and their impact on perioperative management
- Identify the goals of care for the patient undergoing OB related and non-OB related surgery

Definition of Pediatric
- 1. Neonate: Within first month of life
- 2. Premature neonate: Neonate born before 40 weeks gestational age
- 3. Infant: 1-12 months of age
- 4. Toddler: 1-3 years of age
- 5. Preschooler: 3-6 years of age
- 6. School aged: 6-12 years of age
- 7. Adolescent: 12-18 years of age

Physiologic Differences
- Pediatric Patients are NOT just miniature adults.

Cardiovascular System
- 1. Heart rate (see table)
- 2. Blood pressure (see table)
- 3. Cardiac output: dependent upon heart rate and circulating volume
- 4. Sympathetic (immature at birth) vs. Parasympathetic (mature at birth)...can result in bradycardia on intubation
### Normal Pediatric Heart Rates

<table>
<thead>
<tr>
<th>Age</th>
<th>Systolic</th>
<th>Diastolic</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newborn</td>
<td>120</td>
<td>100-150</td>
<td></td>
</tr>
<tr>
<td>1-7 days</td>
<td>135</td>
<td>100-175</td>
<td></td>
</tr>
<tr>
<td>7-30 days</td>
<td>160</td>
<td>115-190</td>
<td></td>
</tr>
<tr>
<td>1-3 months</td>
<td>140</td>
<td>125-190</td>
<td></td>
</tr>
<tr>
<td>3-6 months</td>
<td>140</td>
<td>110-180</td>
<td></td>
</tr>
<tr>
<td>6-12 months</td>
<td>140</td>
<td>110-175</td>
<td></td>
</tr>
<tr>
<td>1-3 years</td>
<td>125</td>
<td>95-160</td>
<td></td>
</tr>
<tr>
<td>3-5 years</td>
<td>100</td>
<td>65-130</td>
<td></td>
</tr>
<tr>
<td>8-12 years</td>
<td>80</td>
<td>55-105</td>
<td></td>
</tr>
<tr>
<td>12-16 years</td>
<td>75</td>
<td>55-100</td>
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</tbody>
</table>

### Normal Pediatric Blood Pressures

<table>
<thead>
<tr>
<th>Age</th>
<th>Systolic</th>
<th>Diastolic</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newborn</td>
<td>65</td>
<td>45</td>
<td>52</td>
</tr>
<tr>
<td>6 weeks</td>
<td>95</td>
<td>55</td>
<td>69</td>
</tr>
<tr>
<td>1 year</td>
<td>95</td>
<td>60</td>
<td>72</td>
</tr>
<tr>
<td>2 years</td>
<td>100</td>
<td>65</td>
<td>77</td>
</tr>
<tr>
<td>9 years</td>
<td>105</td>
<td>70</td>
<td>82</td>
</tr>
<tr>
<td>12 years</td>
<td>115</td>
<td>75</td>
<td>83</td>
</tr>
</tbody>
</table>

### Respiratory System

- **Anatomical Differences**
  - Large head, nonexistent neck
  - Large tongue, high glottis
  - Increased AP diameter
  - Obligate nose breathers
  - Narrow trachea: NO cuff
  - Diaphragmatic breathing

- **Supply and demand**
  - High demand for oxygen (3x adult)
  - Tidal volumes = adult (1ml/kg), so must compensate with rate differences

### Normal Pediatric Respiratory Rates

<table>
<thead>
<tr>
<th>Age</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newborn</td>
<td>40 breaths/minute</td>
</tr>
<tr>
<td>1 week</td>
<td>30</td>
</tr>
<tr>
<td>1 year</td>
<td>24</td>
</tr>
<tr>
<td>3 years</td>
<td>22</td>
</tr>
<tr>
<td>5 years</td>
<td>20</td>
</tr>
<tr>
<td>8 years</td>
<td>18</td>
</tr>
<tr>
<td>12 years</td>
<td>16</td>
</tr>
<tr>
<td>15 years</td>
<td>14</td>
</tr>
</tbody>
</table>

### Central Nervous System

- Progressive maturation of motor, sensory and intellectual functioning
- Autonomic (well developed)
- Parasympathetic (well developed)
- Sympathetic (matures at 4-6 months of age)

### GI System

1. Hepatic function is immature for first month of life
2. Salivation increased which may threaten airway
GU System

1. GFR and creatinine clearance diminished for first month of life
2. Urine output 0.5-1 ml/kg/hour (similar to adult)
3. Fluid overload and hypernatremia potential

Skeletal System

- Immaturity

Integumentary System

- Sensitivity
- Potential for hypothermia

Meaning of Hospitalization/Surgery

1. Separation
2. Loss of control
3. Fear of injury
4. Pain
- Infant: Crying, hard to comfort
- Toddler: Crying, aggression, uncooperative
- School-agers have experienced separation and understand

Preop teaching Methods

- Hospital Tour
- Play therapy
- Films and videos
- Models
- Written materials

Intraop Considerations

- Parent present?
- Induction based on level of cooperation
Let’s keep going for a minute…
We’ll come back to the post-op considerations…..

Preop Assessment: Ask the right questions
What name does the child go by?
What language does the child respond to best?

History of asthma?
When did child last use/neb inhaler?
Last hospitalization for asthma?
History of recent cold, croup or apnea?

Preop Assessment: Ask the right questions
- Immunizations up to date? Any recent exposures to communicable diseases?
- What bathroom words does the child use?
- What medications does the child take and for what purpose?
- Any loose teeth?
- Any developmental delays or concerns?
- Any special needs we should know about?

Preoperative Medications
- 1. Anticholinergics: prevent bradycardia and dry up secretions (atropine)
- 2. Sedatives: decrease apprehension and facilitate induction; decrease anesthetic requirement (midazolam)
- 3. Antiemetics: decreases aspiration and vomiting

Is there anything better than a preop med to reduce anxiety???

Pharmacologic Differences
- 1. Age-related differences in uptake
- 2. Increased intravascular volume
- 3. Receptor maturity
- 4. Decreased protein binding
- 5. Smaller fat and muscle stores
- 6. Relatively immature renal and hepatic systems

Anesthetic Choices and Techniques
- General anesthesia
  - Inhalation agents
  - IV agents (secondary)
  - Muscle relaxants

General anesthesia is the technique of choice due to rapid and smooth induction, rapid offset, minimal side effects.
Anesthetic Choice and Techniques

- Regional Anesthesia
  - Developmental issues
  - Anatomic considerations

Options
- Axillary blocks: forearm, hand
  - Ilioinguinal/iiliohypogastric: hernia
- Penile ring: circumcision
- Caudal: perineal/lower abdominal (preferred)
- Spinal: below the diaphragm (L4-5)
- Epidural: Limited

Postoperative Priorities

- Airway
  - Infant apnea
  - Post-intubation croup
  - Obstruction

- Hypothermia

Fluid Balance (Maintenance/hour)
- <10kg: 4ml/kg
- 10-20 kg: 40ml + 2ml for each kg > 10kg
- >20kg: 60ml + 1ml for each kg >20

Discharge

- Who are you really discharging???
In summary….

- Pediatric patients are not just miniature adults
- Specialized knowledge to provide specialized care

Geriatric Surgical Patients

- 12% of the Population
- 25% of your Surgical Schedule
- AKA
- Getting Older Really is a BIG DEAL!

What is “elderly”? 

- “The advanced age of 50” is a contraindication for surgery (1907)
- Elective surgery is not justified for persons over the age of 50 (1927)
- Age raised to 70 (1937)
- In 1985, one study evaluated the risks of surgery in patients over the age of 100

Definition of Geriatric

- Young-old 65-75
- Old 75-85
- Old-Old 85+

Physiology of Aging

- Random mutation of DNA
- Cumulative abnormalities
- Biological clock
- Genetic program of life expectancy
- Failure of Growth Substance
- Aging Factor

Mutation of DNA/Abnormalities

- Errors begin to occur in DNA replication or in RNA translation.
- Cumulative abnormalities then develop which become incompatible with cellular function and survival of the organism
Biological Clock

- Cells are strictly programmed by genetics for a set number of replications, after which cell death and deterioration occur.
- On average, replication is limited to 50 times. The limit on replication is exceeded only in cancer, where replication proceeds unchecked.

Failure of Growth Substance

- Cells survive as long as they are capable of producing an un-yet identified “growth substance” or slowing production of an “aging factor”
- Once growth substance is no longer produced, or the amount of aging factor is increased, aging occurs.
- If there could be a way to prolong production of “growth substance”, and to minimize “aging factor”, aging might be prevented.

Question: True or False

- The human body reaches its physiologic prime at age 40.

Unfortunately: TRUE!

There is a 1% per year decline in organ system functioning after the age of 40.

Physiologic Changes Associated with Aging

A Systems Approach

Cardiovascular Changes

- Loss of large artery elasticity
- Decrease in organ perfusion
- Myocardial changes
- Progressive valve incompetence
- Hemodynamic alterations
- Heart rate changes
- Coronary artery disease
Respiratory Changes

- Anatomic changes
  - Increased AP diameter
  - Kyphosis
  - Thoracic wall rigidity
- Physiologic Changes
  - Decreased VC and lung capacity
  - Increased residual volume
  - VQ changes

\[ \text{PaO}_2 = 100 - (0.4 \times \text{Age[yrs]}) = \text{mmHg} \]

Example: Patient is 44
\[ \text{PaO}_2 = 100 - (0.4 \times 44) = 82.4 \text{ mmHg} \]

Example: Patient is 84
\[ \text{PaO}_2 = 100 - (0.4 \times 84) = 66.4 \text{ mmHg} \]

Central Nervous System Changes

- Decrease in neuronal density
- Decrease in nerve conduction
- Compromised thermoregulation
- Decreased anesthetic requirements
- Arteriosclerotic changes

Gastrointestinal Changes

- Decrease in salivation
- Decreased motility
- Weakened gag reflex
- Decreased LES tone
- Decreased absorption of nutrients and drugs
- Malnutrition and vitamin deficiencies

Hepatic Changes

- Decrease in hepatic blood flow
- Decrease in microsomal enzyme activity
- Reduced first pass metabolism

Renal and GU Changes

- Decreased GFR
- Decreased in bladder capacity
- Decreased sphincter tone
- Prostatic enlargement
- Slowed response time to correct fluid and electrolyte imbalances
Glomerular Filtration in Aging

- 1ml/min/year decline in CRT Clearance

\[ \text{CrCl} = \frac{(140 - \text{age}) \times \text{wt (kg)}}{72 \times \text{serum CRT}} \]

44 year old female
\[ \text{CrCl} = \frac{(140 - 44) \times 70}{72 \times 0.4} = 236.6 \]

84 year old female
\[ \text{CrCl} = \frac{(140 - 84) \times 70}{72 \times 0.4} = 138.0 \]

Musculoskeletal Changes

- Osteoporosis-Risk Factors
- Muscle atrophy
- Limited range of motion

Changes in Body Composition

- Decrease in subcutaneous fat
- Increase in overall body fat
- Compromised thermoregulation
- Altered skin pigmentation-Pallor

Endocrine Changes

- Decrease in plasma renin by 30%-50% which will then result in a decrease in aldosterone

- Remember the effects of the RAAS

- Think about what happens when the RAAS doesn’t work efficiently

Endocrine Changes

- Decreased glucose tolerance
- Decreased insulin synthesis
- Decreased insulin secretion
- Increased insulin resistance
- Impaired glucose utilization

- While impaired glucose tolerance is normal…. Diabetes is not.

Sensory Changes

- Reduction in afferent innervation
- Visual acuity and peripheral vision decrease
- Decrease in accommodation
- Dry eyes
- Decreased sensitivity to sound
- Sense of smell and taste altered
- Decreased tactile sensation and response to pain
Immunologic Changes
- Increase in formation of autoantibodies
- Decrease in natural antibodies

Laboratory Changes
- Related to chronic diseases and medications
- Potassium, sodium and hemoglobin

Pharmacologic Changes in Aging
- Vascular volume decreases by 20-30%
- Less efficient protein binding
  - More “free” drug
- Changes in body composition
- Decreased renal and hepatic clearance

Decreased Vascular Volume
- 20-30% decline in vascular volume
- Medications injected into a smaller circulating volume, thereby increasing the volume of distribution and causing a higher than expected plasma drug concentration

Protein Binding
- Only “free drugs” are capable of exerting an effect.
- All anesthetic agents are bound to plasma proteins to some extent.
- In aging, plasma proteins, particularly albumin, decrease.
- Result is more “free drug” and greater pharmacologic effects.

Changes in Body Composition
- Loss of skeletal muscle (lean tissue)
- Percentage of lipid increases, esp. with women
- Result is an increase in lipid storage sites, and increased reservoir for drug deposition for lipid soluble drugs.
- Result is an increased time for drug elimination, increased drug levels, prolonged drug effects.
Renal and Hepatic Function

- Major effect on drug action is in clearance
- Renal blood flow declines and loss of glomeruli causes slowed elimination of drugs and metabolites.
- Hepatic blood flow decreases, reducing first pass clearance, causing higher blood levels of agents and prolonged drug effects.

Aging does not equal Disease

- Glucose intolerance is normal aging…diabetes mellitus is a disease
- Cognitive decline is normal aging….dementia is a disease
- It is important to distinguish normal aging from disease. This is done through history, PE and labs.

Aging increases likelihood of surgery

- 24% of all surgeries are performed on patients greater than 65
- Physiologic decline contributes to surgeries such as: Valve replacement TURP Hip stabilization Cataract extraction/Lens implantation

ASA Classification System

I: Healthy with no systemic disease
II: Mild systemic disease without limitations
III: Severe systemic disease with functional limitations
IV: Severe systemic disease that is an ongoing threat to life
V: Patient unlikely to survive for more than 24 hours with or without surgery

Concomitant Disease becomes the rule rather than the exception

- 78% of patients had CV abnormalities
- 30% had mental alterations
- 14% had pulmonary alterations
- 12% had endocrine alterations
- 10% had neurologic alterations

Pathophysiologic Changes

- CV Abnormalities: HTN, CAD, CHF
- CNS Abnormalities: Parkinson’s, Alzheimer’s, CVA, Dementia
- Pulmonary abnormalities COPD
- Endocrine abnormalities Hypothyroidism, DM
Disease Management often involves Medications

- Lipitor
- Digoxin
- NTG
- Indur
- Norvasc
- Vasotec
- Procardia
- Pepcid
- Prevacid
- Fosamax
- K-dur
- Glucophage
- Synthyroid
- Zoloft

Medications often equal side effects and the need for more medications!

Pathophysiology increases likelihood of surgery more than physiology

- Cardiac: CABG, valve
- Pulmonary: Bronchoscopy, lung surgery
- Renal: TURP, cystoscopy
- Neuro: Crani for bleeds secondary to falls

Preoperative Assessment

- Patient safety
- Patient interview
- Patient history
- Physical exam
- Patient supports

The Day of Surgery

- Time
- Communication Strategies
- Environmental aids
- Involve patient supports

Surgical Options

- Outpatient
- Inpatient
- 23 hour stay
- Same day admit
- Home assistance
Anesthetic Options

- General
- Regional
  - Spinal
  - Epidural
- Local
- IV Conscious Sedation

Premedication

- Rationale
- Choice of agents
- Route of administration

Post-Surgical Care Nursing Diagnoses

- High risk for hypothermia
- Altered cardiac output: Decreased
- Altered comfort: Pain
- Ineffective individual coping
- Fluid volume deficit
- Fluid volume overload
- High risk for infection

Post Surgical Care Nursing Diagnoses

- Knowledge deficit
- Impaired physical mobility
- High risk altered respiratory function
- Ineffective airway clearance
- Ineffective breathing patterns
- Impaired gas exchange
- Self care deficit

Remember, the person to whom you are providing care is someone’s mother/father/grandparent.

Treat them as you would your own.
And Baby Makes Two!

**Physiologic Changes of Pregnancy**

**Cardiovascular System**
- Maternal blood volume: 35%-40% ↑
- Plasma volume: ↑ from 40ml to 70ml/kg
- Red cell volume: ↑ from 25ml to 30ml/kg
- Cardiac output: 30-50% ↑
- Heart rate: 15% ↑

**Vena Caval Compression**

**Respiratory System**
- Minute ventilation: 50% ↑
- Tidal volume: ↑
- Blood oxygen levels: ↑ by 5-10mmHg
- Carbon dioxide levels: ↓ to ~32mmHg
- FRC: ↓ by 15-20% at term
- Dyspnea: 60-70% of women will complain
- Enlarged mucosa: Risk of easy bleeding
CNS
• Anesthetic sensitivity
  Requirements for inhalation agents ↓ by 40%
  Less local for spinal and epidurals (due to acid-base changes or hormonal changes of CSF?)
• Engorgement of epidural veins
  ↑ risk of intravascular injection

“Pregnant Brain”

Renal System
• Renal blood flow: ↑ by 50-60%
• GFR: ↑ by 50-60%
• Creatinine clearance: ↑
• BUN/CRT levels: ↓ by 40%
  Normal BUN 8-9mg/dl in pregnancy (15.0)
  Normal CRT 0.46mg/dl in pregnancy (1.0)
• Effects of progesterone: Smooth muscle relaxant
• Effects of ↑ aldosterone:
  Fluid retention
  Glycosuria (<100G/day)
  Proteinuria (<300mg/day) within normal limits

GI System
• GE sphincter compromised:
  ↑ reflux, regurgitation and aspiration and decreasing gastric emptying
• Considered to be “full stomach” patients
• Progesterone as a smooth muscle relaxant also decreases gastric emptying

Hepatic System
• Hepatic blood flow: No change in pregnancy
• Enzymes: Slight increase in LDH, Alk Phos and/or cholesterol

Coagulation Factors
• Hypercoagulability: All factors except XI and XII are increased, increasing the risk of thromboembolic events.
Reproductive Tract Changes

- Uterine weight: Increases from 50-70 grams to 1000-1200 grams
- Uterine blood flow: Increases from 50ml/minute to 700ml/minute, using 10% of cardiac output.

Non-OB Surgery during Pregnancy

- Protection of the mother
- Maintenance of uterine blood flow
- Maintain fetal oxygenation
- Avoid teratogenic drugs
- Prevent preterm labor

Protection of the Mother

- Maintaining maternal oxygenation and perfusion
- Protecting the maternal airway during intubation

Maintenance of Uterine Blood Flow

- Will be secure if maternal perfusion is adequate
- Left lateral tilt to prevent hypotension
- Fetal monitoring to detect distress secondary to hypoxemia

Fetal Monitoring

- Maternal perfusion
- Left lateral tilt
- Fluid administration
- Oxygen for Mom

Maintain fetal oxygenation
Avoid Teratogenic Drugs

- Avoid exposure, especially during first trimester
- Many, and the majority of risks, are unknown

A--Adequate, well-controlled studies in pregnant women have not shown an increased risk of fetal abnormalities to the fetus in any trimester of pregnancy.

B--Animal studies have revealed no evidence of harm to the fetus, however, there are no adequate and well-controlled studies in pregnant women. OR Animal studies have shown an adverse effect, but adequate and well-controlled studies in pregnant women have failed to demonstrate a risk to the fetus in any trimester.

C--Animal studies have shown an adverse effect and there are no adequate and well-controlled studies in pregnant women. OR Animal studies have been conducted and there are no adequate and well-controlled studies in pregnant women.

D--Adequate well-controlled or observational studies in pregnant women have demonstrated a risk to the fetus. However, the benefits of therapy may outweigh the potential risk. For example, the drug may be acceptable if needed in a life-threatening situation or serious disease for which safer drugs cannot be used or are ineffective.

X--Adequate well-controlled or observational studies in animals or pregnant women have demonstrated positive evidence of fetal abnormalities or risks. The use of the product is contraindicated in women who are or may become pregnant.

Avoid Preterm Labor

- Risk of preterm labor is greater than the risk of fetal anomalies
- Due more to surgical disease as opposed to surgery or anesthetic exposure
- 8.8% of women will develop preterm labor

Stopping Preterm Labor with Tocolytic Therapy

Ritodrine (Yutopar) or Terbutaline (Brethine)
Ritodrine and Terbutaline are β adrenergic agents
Maternal hypotension, tachycardia, chest pain, arrhythmias, headache and hyperglycemia
Fetal tachycardia, asphyxia

Mag Sulfate (MgSO4)
Maternal weakness, respiratory insufficiency, decreased DTR, cardiac failure
Fetal hypotonia, drowsiness, gastric motility and hypocalcemia

Anesthetic Options for Non-OB Surgery during Pregnancy

- General anesthesia
- Regional anesthesia

PACU Assessment of the OB Patient following non-OB surgery

- Post-anesthetic assessment
- Post-surgical assessment
- Assessment of the fetus
<table>
<thead>
<tr>
<th>OB surgery during Pregnancy</th>
<th>Caesarean Delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Caesarean delivery</td>
<td>• 4-6% of all deliveries</td>
</tr>
<tr>
<td>Termination of Pregnancy</td>
<td>• Prevent/treat fetal distress</td>
</tr>
<tr>
<td></td>
<td>• Indications: CPD, failure to progress, malpresentation of the fetus, hemorrhage, placenta previa, prolapsed cord, pre-eclampsia-eclampsia, fetal distress</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Anesthetic Options</th>
<th>General Anesthesia</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Dependent upon reason for surgery, degree of urgency, desires of the patient, judgment of anesthesiologist and OB</td>
<td>• Advantages</td>
</tr>
<tr>
<td></td>
<td>Rapid induction</td>
</tr>
<tr>
<td></td>
<td>Less maternal hypotension/instability</td>
</tr>
<tr>
<td></td>
<td>Better airway control</td>
</tr>
<tr>
<td></td>
<td>Anxious Mom</td>
</tr>
<tr>
<td></td>
<td>• Disadvantages</td>
</tr>
<tr>
<td></td>
<td>Maternal aspiration</td>
</tr>
<tr>
<td></td>
<td>Potential for vena caval compression</td>
</tr>
<tr>
<td></td>
<td>Potential for failed intubation</td>
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<tr>
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<td>Fetal exposure</td>
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<table>
<thead>
<tr>
<th>Regional Anesthesia</th>
<th>Local Anesthesia</th>
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</thead>
<tbody>
<tr>
<td>• Advantages</td>
<td>• Advantages</td>
</tr>
<tr>
<td>Awake Mom</td>
<td>BAM-done-baby out</td>
</tr>
<tr>
<td>Little to no aspiration risk</td>
<td>Usually combined</td>
</tr>
<tr>
<td>No neonatal depression</td>
<td>with ketamine</td>
</tr>
<tr>
<td>Spinal: rapid, reliable</td>
<td>• Disadvantages</td>
</tr>
<tr>
<td>Epidural: Labor and delivery use</td>
<td>Not all OB skilled in</td>
</tr>
<tr>
<td>Less hypotension than spinal</td>
<td>this technique</td>
</tr>
<tr>
<td>“Leveling” possible</td>
<td>The “OMG” factor</td>
</tr>
<tr>
<td>• Disadvantages</td>
<td></td>
</tr>
<tr>
<td>Takes time to place/perform</td>
<td></td>
</tr>
<tr>
<td>Maternal hypotension</td>
<td></td>
</tr>
</tbody>
</table>
RhoGam

Pre-Eclampsia
Hypertension, edema, proteinuria

Eclampsia

- Systolic BP >160mmHg
- Diastolic BP >110 mmHg
- MAP >120 mmHg
- Proteinuria > 5Gm/24 hours
- Oliguria <500ml/24 hours
- Pulmonary edema
- Cyanosis
- Visual disturbances
- Headache
- Epigastric Pain

In summary...

- Baby does make two if baby is still there
- Use your OB nurses as resources
- If a baby was the outcome: Support
- If a baby was not the outcome: Support

Questions?

References