Baby Mama Trauma: Trauma in Pregnancy

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Objectives

• Describe the anatomic and physiologic changes of pregnancy and the subsequent effect on treatment
• Identify common mechanisms of injury for pregnant trauma victims and their unborn children, and incorporate strategies for screening and prevention
• Prioritize treatment and assessment methods for both patients
• Discuss injuries and conditions unique to the pregnant population and the optimal treatment of each
Introduction

- Trauma complicates 1 in 12 pregnancies
- Incidence has increased dramatically over the past 25 years
- Leading cause of nonobstetrical maternal death
- Severity of trauma not directly correlated with fetal outcome
- Compression of the abdomen from fall, intentional violence, low-speed MVC considered major trauma
- Adverse fetal outcomes of preterm delivery, low birth weight, and demise
Anatomic Changes of Pregnancy

- Uterine growth
  - Uterine blood flow 600 mL/min in 3\textsuperscript{rd} trimester
  - No autoregulation

- Compression of inferior vena cava
  - Decreased venous return, cardiac output by 25%

- Compression of aorta
  - Decreased uterine blood flow

- Must be accounted for during resuscitation
Fundal Height Measurement
Physiologic Changes of Pregnancy

- Result of hormonal and mechanical factors
- Cardiovascular
  - Cardiac output increases by 50% at 32 weeks
  - Increased heart rate 15-20 beats/min
  - Decreased blood pressure 5-15 mmHg
  - Plasma volume expands by 45% starting at 10 weeks
  - RBC volume increases by 18-30%
  - Decreased peripheral vascular resistance
Physiologic Changes of Pregnancy

- **Respiratory**
  - Increased tidal volume, respiratory rate
  - Decreased FRC
  - Compensated respiratory alkalosis
  - Oxygen consumption increases 20%

### Arterial blood gas values in pregnant and nonpregnant women

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Pregnant, mmHg</th>
<th>Nonpregnant, mmHg</th>
</tr>
</thead>
<tbody>
<tr>
<td>pCO₂</td>
<td>27 to 32</td>
<td>39 to 40</td>
</tr>
<tr>
<td>pO₂</td>
<td>100 to 108</td>
<td>95 to 100</td>
</tr>
<tr>
<td>pH</td>
<td>7.40 to 7.45</td>
<td>7.40</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>18 to 21</td>
<td>24 to 29</td>
</tr>
</tbody>
</table>
Physiologic Changes of Pregnancy

• Coagulation
  • Stasis and hypercoagulability
  • Increased clotting factors and fibrinogen

• Gastrointestinal
  • Decreased lower esophageal sphincter tone
  • Increased intraabdominal pressure
  • High risk of aspiration

• Renal
  • Increased GFR, renal blood flow
  • Serum creatinine 0.4-0.5 mg/dL
<table>
<thead>
<tr>
<th>Mechanism of injury</th>
<th>Estimated incidence/prevalence in pregnancy</th>
<th>Study design</th>
<th>Estimated incidence/prevalence outside of pregnancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor vehicle crashes</td>
<td>207/100,000 live births&lt;sup&gt;11&lt;/sup&gt;</td>
<td>Population-based cohort</td>
<td>1104/100,000 women&lt;sup&gt;699&lt;/sup&gt;</td>
</tr>
<tr>
<td>Falls and slips</td>
<td>48.9/100,000 live births&lt;sup&gt;24&lt;/sup&gt;</td>
<td>Retrospective case-control</td>
<td>3029/100,000 women&lt;sup&gt;100&lt;/sup&gt;</td>
</tr>
<tr>
<td>Burns</td>
<td>0.17/100,000 person-years&lt;sup&gt;27&lt;/sup&gt;</td>
<td>Retrospective case-control</td>
<td>2.6/100,000 person-years&lt;sup&gt;27&lt;/sup&gt;</td>
</tr>
<tr>
<td>Accidental poisoning</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Domestic violence</td>
<td>8307/100,000 live births&lt;sup&gt;101&lt;/sup&gt;</td>
<td>Review</td>
<td>5239/100,000 women&lt;sup&gt;644&lt;/sup&gt;</td>
</tr>
<tr>
<td>Suicide&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2/100,000 live births&lt;sup&gt;61&lt;/sup&gt;</td>
<td>Retrospective cohort</td>
<td>8.8/100,000 population&lt;sup&gt;102&lt;/sup&gt;</td>
</tr>
<tr>
<td>Homicide</td>
<td>2.9/100,000 live births&lt;sup&gt;61&lt;/sup&gt;</td>
<td>Retrospective cohort</td>
<td>2.3/100,000 women&lt;sup&gt;100&lt;/sup&gt;</td>
</tr>
<tr>
<td>Penetrating trauma&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.27/100,000 live births&lt;sup&gt;62&lt;/sup&gt;</td>
<td>N/A</td>
<td>3.4/100,000 women&lt;sup&gt;662&lt;/sup&gt;</td>
</tr>
<tr>
<td>Toxic exposure</td>
<td>25.8/100,000 person-years&lt;sup&gt;103&lt;/sup&gt;</td>
<td>Retrospective cohort</td>
<td>115.3/100,000 person-years&lt;sup&gt;104&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Literature relating to incidence of burns during pregnancy is limited to most severe cases admitted to burn units and referral centers. Rate for accidental poisoning during pregnancy could not be calculated from available published literature. Domestic violence incidence includes all forms of partner violence: sexual, physical, and psychological.

Motor Vehicle Collisions

- 207/100,000 live births
- Strong acceleration-deceleration forces
- Account for 50% of traumatic injuries during pregnancy
- Cause of 82% of fetal deaths
- 43% involve use of intoxicants
Seat Belt Use in Pregnancy

WHAT’S THE RIGHT WAY TO WEAR MY SEAT BELT?

**RIGHT**

1. **SHOULDER BELT**
   - away from your neck (but not off your shoulder)
   - across your chest (between your breasts)
   - be sure to remove any slack from your seat belt

2. **LAP BELT**
   - secured below your belly so that it fits snugly across your hips and pelvic bone

**WRONG**

1. **SHOULDER BELT**
   - NEVER place under your arm or behind your back.

2. **LAP BELT**
   - NEVER place over or on top of your belly
Falls

- More common in pregnancy due to joint laxity, weight gain, postural instability
- 1 in 4 fall at least once
- Majority of hospitalizations occur in 3rd trimester
- Lower extremity fracture most common injury
- Increase placental abruption (8x), preterm labor (4.4x), fetal distress (2.1x), fetal hypoxia (2.9x)
Thermal Injury

- Low incidence, more common in developing countries
- Massive fluid shifts
- Significant physiologic stress
- $\geq 40\%$ TBSA burn: Mortality approaches 100%
Intimate Partner Violence

- Most common form of intentional trauma
- Triples rate of preterm birth, 5.3 x increase in low birth weight
- 10-30% of women sustain serious injuries
- Abdomen is the most common target
Risk Factors for IPV

- Substance abuse
- Low socioeconomic status
- Low maternal education level
- Unintended pregnancy
- History of domestic violence
- History of witnessed violence as a child
- Unmarried status
Screening for IPV

- Vague or suspicious history of trauma
- Frequent ED/office visits
- Depression
- Substance abuse
- Partner insistent on being present during history and exam
Screening for IPV

• Framing statement
  • “Violence can be a problem in many people's lives, so I now ask every patient about trauma or abuse they may have experienced in a relationship.”

• Ensure privacy and confidentiality

• Limit questioning to a few open ended questions

• Terms like "victim," "domestic violence," "abused," or "battered" should be avoided
Suicide

- Accounts for 20% of postpartum maternal deaths
- Risk factors: Depression, substance abuse, domestic violence, death of fetus or child
- Unsuccessful attempts pose harm to mother and fetus
Fetal morbidity related to consequences of maternal trauma

Early and aggressive maternal resuscitation directly results in improved fetal outcomes

Fetal mortality increases with severity of maternal injury
  - Maternal shock
  - Direct fetoplacental injury
  - Pelvic fracture
  - Maternal brain injury
  - Hypoxia
Prehospital Management

- Initial assessment identical to any injured patient
- > 20 weeks gestation should be transported to a thoroughly capable center
- Supplemental oxygen: Maintain $\text{SaO}_2 > 95\%$
- Liberal fluids
- Uterine displacement
Vena Cava Compression Syndrome
Uterine Displacement

Graphs showing changes in heart rate, stroke volume, and cardiac output during pregnancy and postpartum. The graphs compare supine and lateral positions.
Primary Survey

• ABCs of trauma care identical to all patients
• Airway
  • Physiologic oropharyngeal edema
  • Cricoid pressure
  • Lower doses of neuromuscular blockers
• Breathing
  • Avoid hypoxia
• Circulation
  • Avoid hypotension
  • 2 large bore IV’s
  • Avoid femoral access
  • Avoid vasopressors
Secondary Survey

- Complete obstetric and prenatal history
- Head to toe physical examination
- Laboratory evaluation
  - CBC
  - CMP
  - Coagulation profile
  - Type and crossmatch
- Keep the patient(s) warm!
- Obstetrical consultation
Vaginal Examination

• Avoid digital exam over 20 weeks until placenta previa excluded
• Speculum exam
  • Bleeding
  • Amniotic fluid: pH 7.0-7.5
  • Cervical effacement and dilation
  • Fetal presentation
• Avoid repeated exams
Radiography in Pregnancy

- Based on suspicion of injury
- Greatest fetal risk between 8-15 weeks gestation
- Exposure to < 5 rad has no association with fetal abnormalities or pregnancy loss
- FAST: Equal specificity and sensitivity
Fetal-Placental Unit Evaluation

- Placental Abruption
  - 1-6% of minor injuries, up to 50% of major abdominal injuries
  - Shear force/strain, tensile failure/contrecoup
  - Oxygen transfer to fetus compromised resulting in fetal distress or death
  - Vaginal bleeding
  - Ruptured membranes
  - Contractions
  - Uterine tenderness, rigidity
  - Abnormal fetal heart rate, rhythm
  - Ultrasound
    - Low sensitivity
    - Subchorionic hematoma
Fetomaternal Bleeding

• Reported in 2.6-30% of pregnant trauma patients
• Kleihauer-Betke Test
  • Detects and quantifies fetal blood in maternal circulation
• Fetal anemia, hydrops, and death
• Isoimmunization of Rh negative mothers
• Anti-D immune globulin (RhoGam)
  • Dosing based on KB results
Fetal Heart Rate Monitoring

- All women > 24 weeks gestation
- Minimum 4-6 hours for minor trauma
- Extended monitoring (24 hours)
  - Frequent contractions
  - Vaginal bleeding
  - Ruptured amniotic membranes
  - Abdominal pain
  - Coagulopathy
  - Non-reassuring fetal heart rhythm
Risk Assessment for Delivery

• If potential for preterm delivery, administer corticosteroids
  • Concern for preterm labor, abruption, premature rupture of membranes
  • Need for non-emergent maternal surgical procedure
• Avoid tocolytics in trauma patients (may mask abruption)
• Discuss mode of emergent delivery with involved staff
  • Access to equipment for cesarean if patient off L&D
  • NICU equipment immediately available
  • Anesthesia consult
Management of Specific Injuries

• Neurological Injury
  • Associated with adverse fetal outcomes
  • Hypothermia and Mannitol contraindicated
  • Hypertonic saline proven to be safe

• Thoracic Injuries
  • Treatment identical
  • Diaphragmatic elevation

• Thermal Injuries
  • Aggressive fluid resuscitation
  • Consideration for early delivery
Pelvic Fractures

- Most common maternal injury that results in fetal death
- Dilated retroperitoneal vessels increase risk of hemorrhage
  - High doses of radiation with angioembolization
- Operative fixation considered safe
- Most women can attempt vaginal delivery
  - Adjacent to GU tract
  - Severe lateral compression
  - Markedly displaced fractures
Penetrating Abdominal Trauma

- First reported in 1600’s
- Favorable maternal outcomes
  - Protection from gravid uterus
- Fetal mortality 73%
- Maternal injuries take priority
- Viability determines approach to fetus
Blunt Abdominal Trauma

• Primary focus is evaluation and management of maternal shock
• Same principles as non pregnant trauma victims
• Non operative management of solid organ injuries acceptable
• Delay in treatment leads to worse fetal outcomes
Uterine Rupture

- Less than 1% of pregnant trauma victims
- Direct impact with substantial force
- More common with uterine scarring, increased gestational age
- Extensive hemorrhage
- 10% maternal mortality, fetal mortality near 100%
Trauma Laparotomy

- Hemorrhage and contamination control
- Uterus retracted inferiorly to evaluate maternal organs
- Uterine injury
  - Determine viability
  - Repair vs hysterectomy
CPR in Pregnancy

- Manual left lateral, upward displacement of uterus
- Compressions slightly cephalad due to anatomic displacement
- Consider Cesarean delivery within 4 minutes if no return of spontaneous circulation
- Delivery within 5 minutes
Cesarean Section following Injury

1. Save the Mother
   • Potential benefit if > 20 weeks gestation
   • Management of maternal injuries

2. Save the Mother and Baby
   • Beneficial if > 24 weeks

3. Save the Baby
Perimortem Cesarean Section

- Establish viability
- Complete CPR sequence
- Vertical midline incision through all layers of abdominal wall and uterus
- Remove fetus, clamp cord
- Remove placenta
- Continue CPR
Figure 1. Flow diagram of 114,952 consecutive trauma admissions yielding more than 441 pregnant female patients, 32 of whom underwent cesarean section for trauma, delivering 33 infants (including one set of twins).

Direct Fetal Injury

- Incidentally found on maternal evaluation
- Anatomic Fetal Survey
- Fractures, internal bleeding
- Significant injuries typically fatal
- Consultation with neonatologist
Summary

• Anatomic and physiologic changes related to pregnancy need to be considered when evaluating pregnant trauma victims.
• Diagnostic tests or treatments required to save the mother’s life should be undertaken, even if disadvantageous to the fetus.
• Displacing the uterus is critical to maximizing effectiveness of resuscitation of pregnant trauma victims.
• Fetal heart rate measurement is the minimal fetal assessment needed to determine fetal compromise.
• Close consultation between trauma surgeon and obstetrician is vital to the care of the pregnant mother and child.