Trauma During Pregnancy

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• I have no commercial or financial relationship relevant to this presentation
Key Points:

1. To review the incidence and causes of trauma during pregnancy and its relationship to maternal death
2. Review the changes in physiology related to pregnancy
3. Management strategies for the pregnant trauma patient
Occurs in 6 to 7% of all pregnancies

- Mostly minor and will not present to North Oaks ED
  - MVA most common etiology
  - Falls second most common
    - Decreased balance secondary to a change in the maternal center of gravity
- MVA is the leading cause of non-obstetric maternal death
- Of the total number of injuries, 2 to 8% will require admission to an ICU setting
Incidence and Risks

- The arithmetic:
  - 4 million pregnant women in US yearly
  - @ rate of 6% = 240,000 incidents per year
  - @ rate of 5% = 12,000 ICU admits per year
  - The focus this lecture on the 12,000 major trauma cases, but we cannot lose sight of …
Incidence and Risks

- Fetal loss rate is 40% in critical maternal injury (~5% of total injuries).
  - The loss rate increases the more severe the injury
- Adverse pregnancy outcome rate is 4% when maternal injuries are “minor” (~95%)
- Therefore, more babies die as a result of lesser injuries due to the “numbers”
Incidence and Risks

- Maternal mortality from trauma is about 0.1% to 1.4%
  - 10 to 100 times higher over background US maternal mortality ratio
- Case fatality rate for hospitalized gravida is about 4%
- 27% of maternal deaths are injury related
  - MVA 44%
  - Homicide 31%
  - Unintentional injury 13%
  - Suicide 10%
Patient SS

- 21 year old primigravida at 32 weeks gestation is involved in a “moderate” MVA on I-12 in Robert
- EMT on scene 10 minutes post accident
  - Alert and oriented and “looks pretty good”
- Vitals:
  - B/P 80/40
  - Pulse 120
  - Temp 98.6
  - Weight 180 pounds
Pregnancy Physiology

- Blood loss at time of childbirth
- Blood volume increases by 50%
- Decreased systemic vascular resistance & increase pulse rate
Physiological Adaptation of Pregnancy

• Blood Volume
  • Increase
    • ~ 40% in singleton gestation
    • ~ 67% in twins
  • Peak at about 32 weeks
  • Estrogen plays a key role via upregulating production
    • Angiotensinogen, renin, and aldosterone

• Physiological anemia
  • Plasma volume > red cell mass
  • Mean hemoglobin
    • 2nd trimester 12.4 g/dl; 3rd trimester 10.9 g/dl
Physiological Adaptation of Pregnancy

• Cardiac Rhythm
  • Progressive increase over non-gravid state
    • Pulse increases 10 to 20 bpm
    • Peaks in late second and third trimester
  • Pregnancy lowers threshold for isolated rhythm disturbance
    • PAC
    • PVC
    • SVT
Physiological Adaptation of Pregnancy

- **Cardiac Output**
  - Increases during pregnancy
    - At conception and plateaus at 24 weeks
  - Maternal position can affect cardiac output
    - Left lateral position preferred
      - Supine decreases C.O. 14%
      - Lithotomy decreases C.O. by 30%
Physiological Adaptation of Pregnancy

• Aorto-caval compression
  • Patient becomes hypotensive
    • Pallor
    • Nausea
    • Dizziness
    • Diaphoretic
  • Can dramatically affect fetal heart rate
Physiological Adaptation of Pregnancy

• Colloid Oncotic Pressure
  • Circulating albumin concentration falls 12 to 20%
  • Edema of pregnancy

• More importantly!
  • The fall in colloid oncotic pressure can be hemodynamically significant when combined with generous infusion with crystalloid
    • The gravida is much more susceptible to pulmonary edema
Physiological Adaptation of Pregnancy

• Respiratory
  • Tidal volume increases 40%
  • Minute ventilation increases
  • Physiological hyperventilation
    • “Breathlessness of Pregnancy”
      • Begins early in gestation
<table>
<thead>
<tr>
<th>Physiologic Change</th>
<th>Clinical Implication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systemic Vascular Resistance Decreases</td>
<td>Misinterpreted at hemodynamic instability</td>
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<tr>
<td>Heart rate increases</td>
<td>Misinterpreted as early decompensation</td>
</tr>
<tr>
<td>Respiratory rate and tidal volume increase</td>
<td>Normal $P_{CO_2} = 30$ mm Hg</td>
</tr>
<tr>
<td>Minute ventilation and O₂ demand increase</td>
<td>Increase risk of hypoxemia and apnea</td>
</tr>
<tr>
<td>Diaphragm is elevated</td>
<td>Thoracostomy performed 1 to 2 spaces higher</td>
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<tr>
<td>Gastrointestinal motility decreased</td>
<td>Aspiration risk increases</td>
</tr>
<tr>
<td>Uterine enlargement occurs</td>
<td>Protects bowel lower abdominal penetrating T</td>
</tr>
<tr>
<td>Uterine blood flow increases</td>
<td>Risk of hemorrhage and retroperitoneal bleeding increases</td>
</tr>
<tr>
<td>Bladder is displaced to abdomen</td>
<td>More susceptible to injury</td>
</tr>
<tr>
<td>White blood cell count increases</td>
<td>Misinterpreted as infection</td>
</tr>
<tr>
<td>Increased levels of clotting factors</td>
<td>Increased risk of spontaneous venous thromboembolism</td>
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</table>
Fetal physiology

“the fetal response to trauma depends on the severity of the injury, and the adequacy of placental perfusion”

Uterine perfusion is largely dependent on maternal blood pressure due to the uniqueness of the uterine arteries

- They lack autoregulation
- Already maximally dilated during pregnancy
- ~ 25% of Cardiac Output in the third trimester
Fetal physiology

In addition, trauma increases the risk of:
- Maternal hypotension
- Hypoxemia

Hypotension and hypoxemia increase the release of catecholamines which:
- Are potent vasoconstrictors of the uterine artery
- Catecholamines also stimulate uterine contractions
Therefore:

- “Normal maternal heart rate and blood pressure do not ensure adequate placental perfusion and fetal oxygenation” and “maternal vital signs can be poor indicators of the fetal condition”
- But, the species wants to go on and babies can frequently tolerate periods of hypoxia
Care of the pregnant trauma patient

• There are no reliable evidence to dictate:
  • Initial care of traumatized gravid patient
  • Type and duration of monitoring
  • Type of testing required
  • Follow up care of ongoing pregnancy
Care of the pregnant trauma patient

• Initial maternal stabilization takes priority over fetal assessment
• Transfer to a trauma center for severe cases
  • Preferably made at the scene
Care of the pregnant trauma patient

• Multidisciplinary approach is important:
  • Obstetrician
  • Maternal-fetal specialist
  • Trauma surgeon
  • Anesthesiologist
  • Neonatologist
  • Other surgical sub-specialist
Care of the pregnant trauma patient

• Prognostic Factors for mother
  • Higher ISS > 9
  • Lactate > 2 mmol/L
  • Glasgow Coma Score < 8
  • Lack of proper seat-belt use
  • Severe head injury
  • Injury to thorax, abdomen, lower extremity or spine

• Less highly correlated but increased risk:
  • Drug use
  • Shock on admission
Care of the pregnant trauma patient

- Prognostic factors for the fetus
  - Penetrating injury
  - Severe deceleration event
  - Maternal hypotension
  - Fibrinogen < 200
  - Contractions on tocodynamometer
Basic principles of trauma resuscitation during pregnancy

• Primary survey
• Resuscitation
• Secondary survey
• Laboratory and diagnostic studies
• Definitive treatment
“the basic principles of trauma management apply to the injured pregnant women”
Primary survey

- Identify life-threatening injuries
- Details of event
  - Mechanism of injury
  - Resuscitation efforts in the field
  - Medical history
- ABC’s of resuscitation
  - Don’t forget lateral tilt during resuscitation efforts
  - If the patient is on a back board, you can put a rolled towel under the board
ABCs of resuscitation

Airway

- Oxygen consumption increases during pregnancy
  - Adequate pre-oxygenation and re-oxygenation
- Decreased esophageal tone in pregnancy
  - Cricoid pressure during rapid sequence induction
ABCs of resuscitation

Circulation

- Blood volume increases by 50% during pregnancy
- Occurs early in gestation
  - Gravid women tolerate a greater amount of blood loss before hemodynamic compromise occurs
  - Pulse rate and blood pressure may not change appreciably until 30 to 35% of blood volume is lost
  - Tachycardia and hypotension are typically absent in the early phase of shock
Circulation con’t

Conversely, a gravida who has tachycardia and hypotension has lost a significant portion of her blood volume

- She will require aggressive resuscitation with fluids and blood products

- Can use the baby as “canary in the cage”

We are lucky as care givers as the vast majority of pregnant patients are young and healthy
ABCs of resuscitation

Circulation con’t

- Conversely, a gravida who has tachycardia and hypotension has lost a significant portion of her blood volume
  - She will require aggressive resuscitation with fluids and blood products
- Can use the baby as “canary in the cage”
- We are lucky as care givers as the vast majority of pregnant patients are young and healthy
Resuscitation

- Two large bore IVs preferred
  - Large bore = 14 or 16 gauge
  - Pregnant patient's typically have large dilated veins so insertion is usually easy

- Crystalloid for volume replacement
  - Lactated Ringer’s solution
  - 3:1 crystalloid to blood last

- Urinary catheter
  - 30 cc per hour
Military anti-shock trousers
- Use is controversial in pregnant patients
- Have not been well studied or widely used in pregnancy
- Lower compartments can be inflated, but…
  - This can increase bleeding from pelvic structures and this area is particularly vascular during pregnancy
- Abdominal compartments should not be inflated in second and third trimesters
  - Can compromise venous return
  - Exacerbate pulmonary compromise
Resuscitation

- Goal:
  - Monitor initial response to treatment
  - Optimize intravascular volume
  - Optimize oxygen delivery
  - Adequate maternal resuscitation is of paramount importance to fetal survival
Secondary survey

- Complete obstetric examination with initiation of fetal heart rate monitoring
  - 24 weeks is generally considered viability
    - Prior to 24 weeks would utilize intermittent monitoring if heart tones are present
    - Continuous fetal monitoring if gestation is after 24 weeks
      - Be careful if patient is tachycardic; maternal heart rate can give a false positive of a fetal heart rate
      - Changes in fetal heart rate are frequently the earliest sign of compromise of the fetus
  - Consult MFM
Secondary survey

- Gestational Age calculation
  - Umbilicus is 20 weeks
  - Patient history
    - LMP
    - Past Ultrasound
    - Due date
    - “I’m five months”
  - Just order a stat ultrasound! It’s easier and more accurate
Secondary survey

- Common causes of CNS impairment
  - Alcohol intoxication
  - Diabetic ketoacidosis
  - Narcotic and barbiturate use
  - Cerebral vascular accidents
  - Hypovolemia

- Painless vaginal bleeding
  - Abruptio placenta
  - Placenta previa
<table>
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<tr>
<th>Common Laboratory Studies for Pregnant Trauma Patients</th>
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<tr>
<td>CBC with platelets</td>
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<tr>
<td>Type and Match</td>
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<tr>
<td>Coagulation profile</td>
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<tr>
<td>Complete metabolic profile</td>
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<tr>
<td>Serum glucose</td>
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<tr>
<td>ABGs</td>
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<tr>
<td>Urinalysis</td>
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<tr>
<td>Urine toxicology screen</td>
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<tr>
<td>Kleihauer-Betke stain</td>
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</table>
Diagnostic imaging

- Ultrasound
- Diagnostic radiography
  - Radiation exposure should be considered when caring for pregnant patients but NOT for pregnant trauma patients
  - Fetal risk is negligible from x-rays
  - Necessary tests should not be omitted because the patient is pregnant
Definitive treatment

- Maintain hemodynamic stability
- Monitor fetal heart rate
- Balanced general anesthesia does not increase fetal risk
- DVT prophylaxis as per the American College of Chest Surgeons
Obstetric complications

- **Abruptio placenta**
  - Minor injuries 1 to 5%
  - Major injuries 5 to 40%
- **Severity of vehicle damage, placental location, and severity of maternal injury cannot predict abruption with accuracy**
- **Mechanism of action; increased IUP**
  - Inertia
  - Shearing
  - Squeezing
Obstetric complications

- Placental abruption con’t
- Classic signs:
  - Vaginal bleeding
  - Abdominal pain
  - Uterine tenderness
  - Uterine contractions
  - Tetanic uterus
Obstetric complications

- Placental abruption con’t
  - Uterine contractions and non-reassuring fetal heart tones are the most sensitive predictors of placental abruption
  - Ultrasound assessment is a poor predictor
- Blood loss can be great
- DIC is common
- Hysterectomy is sometime required
Obstetric complications

- Placental abruption con’t
  - CBC, platelets, and coags
  - Corticosteroids for maturity between 24 and 34 weeks
  - Hysterotomy not thought to be of benefit at less than 24 weeks
Peri-mortem Cesarean Section

- Typically, the operation should not be performed in anticipation of a cardiopulmonary arrest, but only after CPR has been initiated.
- Limitations of CPR in pregnancy:
  - Placental bed acts as a shunt decreasing $O_2$ to maternal tissue
  - Left lateral tilt makes CPR more difficult
  - Pregnancy increases $O_2$ consumption
Benefit of cesarean section

- Increases venous return to heart by relieving vena cava compression
- Allows auto-transfusion from lower extremities
- Increases the chance of intact neonatal survival
  - Less than five minutes from arrest is best
  - No documented intact fetal survivors past 35 minutes post maternal collapse
Peri-mortem Cesarean Section

- CPR initiated > 24 weeks
  - Plan to intervene for both mother and fetus as soon as possible
  - “Four Minute Rule”
- CPR initiated at 20 to 24 weeks
  - ??????
Peri-mortem Cesarean Section

- Technique
  - Don’t waste time
    - Sterile field
    - Instrument tray
    - Ultrasound
  - Midline incision from two finger breadths above the pubic symphysis to the umbilicus
  - Uterine incision
    - Classical vs low transverse
When a pregnant patient arrives with major trauma treat her like she is not pregnant
- Except for remaining aware of physiologic changes of pregnancy
- Do not worry about effects of diagnostic radiation
- With CPR ongoing, empty the uterus
- Be confident! Be aggressive!