CARING FOR TWO: THE PREGNANT TRAUMA PATIENT

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OB/GYN; ADJUNCT EPIDEMIOLOGY

OBJECTIVES – TO REVIEW

- Epidemiology
- Pregnancy physiology
- Evaluation & management
  - recognizing shock
  - when to “get the baby out”
  - postpartum hemorrhage
  - perimortem C-section
  - radiologic studies
  - Rh isoimmunization
  - preeclampsia

TRAUMA IN PREGNANCY

- 6-8% of all pregnancies
- leading non-obstetric cause US maternal death

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Pregnant live births</th>
<th>Non-pregnant women</th>
<th>Study design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intimate partner violence*</td>
<td>8307</td>
<td>5299</td>
<td>Review</td>
</tr>
<tr>
<td>Motor Vehicle Crash</td>
<td>207</td>
<td>1104</td>
<td>Population based cohort</td>
</tr>
<tr>
<td>Falls</td>
<td>49</td>
<td>3029</td>
<td>Retrospective case-control</td>
</tr>
<tr>
<td>Fatal penetrating trauma</td>
<td>3.3</td>
<td>3.4</td>
<td>CDC</td>
</tr>
<tr>
<td>Homicide</td>
<td>2.9</td>
<td>2.3</td>
<td>Retrospective cohort</td>
</tr>
</tbody>
</table>

OUTCOMES - TRAUMA IN PREGNANCY

Increase:
- spontaneous abortion
- rupture of membranes
- placental abruption (40% of severe injuries) "like a potato chip inside of a tennis ball" (inelastic placenta and elastic myometrium); > 60% have no vaginal bleeding
- preterm delivery
- cesarean delivery
- uterine rupture
- fetal death
- maternal death

Fetal Viability dependent on gestational age:
- hCG: detectable 8-10 days after ovulation
- transvaginal ultrasound reliably detects gestational sac at 5-6 weeks or if hCG > 1500 (1st IRS)
- doppler: fetal cardiac activity audible at 10-11 weeks

Mortality ~ 50% at 23-24 weeks and among survivors, morbidity > 50%

NORMAL LAB VALUES

<table>
<thead>
<tr>
<th>LAB</th>
<th>NONPREGNANT</th>
<th>PREGNANT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creatinine</td>
<td>0.8-1.0 mg/dL</td>
<td>0.5-0.7 mg/dL</td>
</tr>
<tr>
<td>HCT</td>
<td>35-45%</td>
<td>&gt;32%</td>
</tr>
<tr>
<td>Hgb</td>
<td>12</td>
<td>10.5</td>
</tr>
<tr>
<td>Fibrinogen</td>
<td>150-300 mg/dL</td>
<td>300-600 mg/dL</td>
</tr>
<tr>
<td>Platelets</td>
<td>&gt;180,000</td>
<td>&gt;140,000</td>
</tr>
<tr>
<td>MCV</td>
<td>80-99 fl.</td>
<td></td>
</tr>
</tbody>
</table>
**ARterial Blood Gas Values (AVERAGE)**

<table>
<thead>
<tr>
<th>ABG (average)</th>
<th>Non-pregnant</th>
<th>Pregnant</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.40</td>
<td>7.44</td>
</tr>
<tr>
<td>pO$_2$</td>
<td>100 mmHg</td>
<td>100 mmHg</td>
</tr>
<tr>
<td></td>
<td>Maintain &gt;70</td>
<td></td>
</tr>
<tr>
<td>pCO$_2$</td>
<td>40 mmHg</td>
<td>28-32 mmHg</td>
</tr>
<tr>
<td>HCO$_3$</td>
<td>24 mEq/L</td>
<td>21 mEq/L</td>
</tr>
<tr>
<td>SaO$_2$</td>
<td>Maintain &gt;85%</td>
<td>Maintain &gt;95%</td>
</tr>
</tbody>
</table>

Kilpatrick SJ. UpToDate, 2013.

**Outline – Cases**

Injury from:
- #1 IPV (17-32% of pregnancies: physical, sexual, psychological)
- #2 MVA (> 50% of all physical trauma)
- #3 Fall
- #4 Penetrating trauma (36% of maternal mortality, direct to uterus 67% fetal mortality)


**Case #1**

Call from Medic One:
- 17 year old, about 8 months pregnant hit by her boyfriend in the abdomen with a bat
- Conscious with abrasions, bruises to arms, legs, torso, abdomen, face

- **Pulse 118, BP 155/85**
INTIMATE PARTNER VIOLENCE IN PREGNANCY

PREGNANCY INTIMATE PARTNER VIOLENCE

RISKS:
- Teens
- Substance abuse
- HIV positive
- Likely other family members are abused

RADAR
- Routinely screen every patient
- Ask - be direct, kind, without judgment
- Document findings
- Assess safety
- Review options, provide referrals

http://www.cdc.gov/reproductivehealth/violence/intimatepartnerviolence/ipvdp_slide.htm

PREGNANT TRAUMA PATIENT EVALUATION - CASE #1
TRAUMA EVALUATION – PRIMARY SURVEY

A - Airway
B - Breathing
C – Circulation
D – Disability
E – Estimated gestational age
F – Fetal heart tones

TRAUMA EVALUATION – SECONDARY SURVEY

• Routine Trauma Exam
• FAST
  • CEFM (continuous external fetal monitor (if >24 wks gest)
  • Placental location
  • +/- Vaginal exam

CASE #1

• Pulse 116, BP 168/110
• Primary and secondary survey negative including FAST
• Gestational age 32 weeks
  • Placenta fundal
• FHT 160s
CASE #1

FHR 160-170 with accels (normal 110-160)
Cervix closed, no vaginal bleeding, contracting

DIAGNOSIS PREECLAMPSIA

• BP > 140/90 (x2, 6 hours apart) with proteinuria
• Urine protein > 300 mg/24 hours
• Severe BP > 160/110 (x2, 6 hours apart)
• H/A, blurry vision, RUQ pain
• Labs: Cr Hct platelets LFTs

CASE #1

• Rh negative
• Cr 0.97, Hct 27, platelets 150, fibrinogen 230, AST 66
• Urine protein 3+
• Headache, blurry vision, RUQ pain
• Abdominal pain
• Tox screen: neg cocaine, pos cannabinoids
RH ISOIMMUNIZATION

• Can occur even in 1st trimester
• Only takes 1 fetal cell/50,000 maternal cells
• Easily preventable
• Rhogam is 300 mcg, which covers 30cc of fetomaternal hemorrhage

MANAGEMENT

• Call OB, Peds, Aneasthesia
• Start Magnesium sulfate 4gm IV load, 2 gm IV/hour
• Give Rhogam
• Assess for additional injuries (imaging)
• Continuous fetal monitoring

RADIOLOGIC STUDIES IN PREGNANCY

• CT EXAM OF CHOICE
• MRI NOT RECOMMENDED
• FLUOROSCOPY AS NEEDED
Fetal effects of radiation depend on timing of exposure and dose to fetus (which is less than dose to mom).

Death and malformation have a threshold – need to exceed certain level to get effect.

Increased risk childhood cancer is stochastic (determined by exposure plus additional random events).

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Fluoroscopy ~ 1 rad/minute

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RADIATION EXPOSURE IN PREGNANCY

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CASE #1
CT abdomen negative. Cervix closed. Late decelerations. Still contracting. **DIAGNOSIS?**

PLACENTAL ABRUPTION
- Clinical diagnosis
- Contractions most sensitive indicator
- May or may not have vaginal bleeding
- Leading cause of fetal death after trauma
- Uterine blood flow 600 ml/min 3rd trimester

CESAREAN DELIVERY
CASE #2

Call from Medic One:
"39 year old pregnant woman who was the restrained driver in a moderate-speed MVA. About 7 months pregnant. Air bags deployed. Conscious, alert, pelvic and LE fractures.
• Pulse 104, BP 116/68"

MVA IN PREGNANCY

• Approximately 1-3% of US pregnancies
• The majority of complications are recognized in the first 6 hours (mean ISS <6)*

<table>
<thead>
<tr>
<th>Citation</th>
<th>Country</th>
<th>Rate</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vivian-Taylor 2012</td>
<td>Australia</td>
<td>3.5/1000</td>
<td>96% undelivered</td>
</tr>
<tr>
<td>Kvarnstrand 2008</td>
<td>Sweden</td>
<td>2/1000</td>
<td>Mortality: maternal 1.4/100,000; fetal 3.7/100,000</td>
</tr>
<tr>
<td>Schiff, 2005</td>
<td>Washington</td>
<td>0.6/1000</td>
<td>(hospitalized) 83% undelivered, Risks: abruption, PTD, cesarean, fetal death</td>
</tr>
<tr>
<td>Weiss, 2001</td>
<td>US states</td>
<td>N/A</td>
<td>3.7 fetal deaths/100,000</td>
</tr>
</tbody>
</table>

*Towery (UCD). J Trauma 1993;35:731-36

PREGNANCY AND MVA

• Direct blow to abdomen and severe injuries are predictors of worse outcomes
• Preterm labor and abruption are the most common obstetric complications
• Uterine rupture, direct fetal injury, fetal death less common
MINOR MVA TRAUMA IN PREGNANCY

Maternal Outcomes following MVA in Washington State 1989-2001†

<table>
<thead>
<tr>
<th></th>
<th>No Crash</th>
<th>Crash Severe Injury ISS≥9</th>
<th>Crash No Injury ISS=0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>17,274</td>
<td>84</td>
<td>189</td>
</tr>
<tr>
<td>Pre-term labor</td>
<td>7%</td>
<td>13%</td>
<td>51%</td>
</tr>
<tr>
<td>Ref.</td>
<td></td>
<td>RR=1.6</td>
<td>RR=7.9*</td>
</tr>
<tr>
<td>Abrupton</td>
<td>1%</td>
<td>1%</td>
<td>8%</td>
</tr>
<tr>
<td>Ref.</td>
<td></td>
<td>RR=1.0</td>
<td>RR=6.6*</td>
</tr>
<tr>
<td>Cesarean</td>
<td>20%</td>
<td>31%</td>
<td>24%</td>
</tr>
<tr>
<td>Ref.</td>
<td></td>
<td>RR=1.5</td>
<td>RR=1.3</td>
</tr>
</tbody>
</table>


MINOR MVA TRAUMA IN PREGNANCY

Maternal Outcomes following MVA in Washington State 1989-2001†

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<tbody>
<tr>
<td>Number</td>
<td>17,274</td>
<td>84</td>
<td>189</td>
</tr>
<tr>
<td>Delivery &lt;37 wk</td>
<td>8%</td>
<td>5%</td>
<td>14%</td>
</tr>
<tr>
<td>Ref.</td>
<td></td>
<td>RR=1.6</td>
<td>RR=1.8*</td>
</tr>
<tr>
<td>Fetal distress</td>
<td>9%</td>
<td>20%</td>
<td>12%</td>
</tr>
<tr>
<td>Ref.</td>
<td></td>
<td>RR=2.1*</td>
<td>RR=1.1</td>
</tr>
<tr>
<td>Fetal death</td>
<td>0.3%</td>
<td>2.5%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Ref.</td>
<td></td>
<td>RR=9.0*</td>
<td>n/a</td>
</tr>
</tbody>
</table>

CASE #2

Patient arrives in ED:
- HR 125, BP 100/60.
- Awake, alert, complaining of abdominal pain, leg pain.
- Reports she is “just over 7 months” pregnant.
- This is her first pregnancy.
- She is on backboard in left lateral tilt.
- Rh positive

CV PHYSIOLOGY OF PREGNANCY

FIGURE 2. Hemodynamic alterations of pregnancy. CO indicates cardiac output; COP, colloid osmotic pressure; PVR, pulmonary vascular resistance; SV, stroke volume; SVR, stroke volume resistance.

CV PHYSIOLOGY IN PREGNANCY - SHOCK

- CV changes in pregnancy - difficult to diagnose shock.
- Vasoconstriction decreases uterine blood flow ~30%, commonly resulting in fetal hypoxia and fetal bradycardia (2 patients).
- Do not rely solely on maternal vital sign changes to aggressively manage 2 patients.
- If traditional signs and symptoms of hypovolemic shock are exhibited, fetal mortality can be as high as 85%.
- Hypovolemic shock most often will not be present in pregnant trauma patient until >30% of the total blood volume is lost.


PHYSIOLOGY IN PREGNANCY

- Diaphragm elevates 4 cm: 25% decrease FRC
- Hyperventilation – respiratory alkalosis
- Decreased GI motility
- Increase gastric acid production
- Renal blood flow increased
- Bladder displaced cephalad

TRAUMA EVALUATION – PRIMARY SURVEY

A - Airway
B - Breathing
C – Circulation
D – Disability
E – Estimated gestational age
F – Fetal heart tones
GESTATIONAL AGE

BPD x 4 = approximate GA

CASE #2

- Pulse 112, BP 108/68
- ABC = OK
- D= Open tib-fib fracture, pelvic fracture, multiple abrasions and contusions
- Pelvic fracture -increase fetal head injury, 25-35% fetal mortality, 9% maternal mortality, bladder & urethral injuries
- Fundus measures 8 finger-breathths above umbilicus
- EGA 29 wk
- Fetal heart tones 160s

TRAUMA EVALUATION – SECONDARY SURVEY

- Routine Trauma Exam
- FAST
- CEFM (if >24 wks gest)
- Placental location
- +/- Vaginal exam
CASE #2

- FAST exam small amount fluid in abdomen
- Pulse 126, BP 102/61
- Fundus measures 8 finger-breadths above umbilicus
- Placenta fundal
- Fetal monitor placed
- Small amount bleeding and pool of fluid in vagina

RUPTURE OF MEMBRANES

- Increases risk of abruption, infection
- Increased risk cord prolapse

CASE #2

- Labs return: Hct 21 Platelets 130 Fibrinogen 190

DIAGNOSIS?
**INDICATIONS FOR CESAREAN DURING X-LAP**

- Risk of fetal distress exceeds that of prematurity
- Uterine rupture
- Gravid uterus interferes with adequate exploration or repair of maternal injuries
- Imminent maternal death
- Abruption and maternal DIC with intracranial bleeding

**CASE #2 MANAGEMENT**

- Transfuse, 2 large bore IVs
- X-lap: general surgery, OB, ortho, urology, pediatrics
- Cesarean delivery (liter blood in uterus behind placenta)
- Postpartum hemorrhage

**POSTPARTUM HEMORRHAGE**

- Pitocin – 30 units/L
- Methergine 0.2 mg intramyometrial
- Misoprostol (cytotec, PGE1) 800 mcg per rectum
- Hemabate (carboprost, 15-methyl PGF2-alpha) 1 ampule IM or intramyometrial (0.25 mg)
- Fluids wide open
- Call bleeding emergency
CASE #3

Call from Medic One:
- 42 year old due date next month fell down stairs
- Conscious with abrasions, bruises to arms, legs, face
- Pulse 118, BP 105/65
- c/o chest pain

FALLS IN PREGNANCY

PREGNANT TRAUMA PATIENT EVALUATION - CASE #3
TRAUMA EVALUATION – PRIMARY SURVEY

A - Airway
B - Breathing
C – Circulation
D – Disability
E – Estimated gestational age
F – Fetal heart tones

CASE # 3

• Pulse 112, BP 108/68
  • ABCD = OK
  • Fundus measures 38 cm
  • EGA 36 wk
  • Fetal heart tones 150s
  • Placenta low lying

TRAUMA EVALUATION – SECONDARY SURVEY

• Routine Trauma Exam
• FAST
• CEFM (if ≥24 wks gest)
• Placental location
• +/- Vaginal exam
EXTERNAL FETAL MONITORING

- Should be placed ASAP
- Should include maternal pulse oximetry
- At least 4 hours, unless
  - Abdominal tenderness
  - Contractions ≥ 6/hour in any one of 1st 4 hours
  - If present, monitor 24 hours

CASE #3

- Normal fetal heart tracing for 4 hours without contractions
- EKG shows Q waves in leads III and aVF, inverted t waves in III, nonspecific ST changes
- FAST, CT abdomen and pelvis, CXR, labs normal, Rh +

DIAGNOSIS AND MANAGEMENT?

CASE #4

Call from Medic One:
- "28 year old GSW to back, 29 weeks pregnant"
- Became unresponsive 1 min ago, VS prior HR 118, BP 105/65
- Positive fetal heart tones
- CPR ongoing, arrival 2 minutes"

RARE COMPLICATIONS – FETAL OUTCOMES

• Fetal mortality up to 70% in GSW to abdomen, survivors 90% morbidity
• Uterine rupture rare - occurs <1% trauma but highest fetal mortality – identify by shock and baby palpable in abdomen
• < 1% fetal mortality in blunt trauma

MANAGEMENT ON ROUTE

• Maintain SpO₂ as close to 100% as possible, even if the patient is not showing signs or symptoms of hypoxia. Fetus is very vulnerable to hypoxia.
• Anticipate, prevent and treat shock.
• Maintain CPR.
• Ask for OB, pediatrics, anaesthesia to be waiting at the door
MATERNAL RESUSCITATION

- CPR non-pregnant achieve 30% normal CO
- Pregnant at term, lying flat on back, 30% of the CO of a non-pregnant woman, 9% normal CO. Supine hypotensive syndrome occurs at > 20 weeks, resulting in decreased preload because uterus presses IVC
- CPR on a slant is significantly less effective than when a woman is flat
- A pregnant uterus consumes 20-30% of CO

TRAUMA EVALUATION – PRIMARY SURVEY

A - Airway
B - Breathing
C – Circulation
D – Disability
E – Estimated gestational age
F – Fetal heart tones

CASE #4

- Intubated
- PEA arrest
- GSW entry left lower back
- Fundal height 10 finger breadths above umbilicus
- BPD – 8 EGA=7
- Fetal heart 60 by ultrasound
- Blood in abdomen
TRAUMA EVALUATION – SECONDARY SURVEY

- Routine Trauma Exam
- FAST
- CEFM (if > 24 wks gest)
- Placental location
- +/- Vaginal exam

MATERNAL RESPONSE

Katz V, AJOG 2005

12 perimortem C-sections
5 neonatal survivors
All started > 5 minutes

Katz AJOG 2005 (all published cases)
38 perimortem C-sections (only 8 trauma)
28 procedures, 34 survivors (3 twins, 1 triplet)
No reports of worsened maternal CV status after cesarean
24 had timing noted:

FETAL SURVIVAL

Dijkman BJOG 2009 (Holland)
- 12 perimortem C-sections
- 5 neonatal survivors
- All started > 5 minutes

Katz AJOG 2005 (all published cases)
- 38 perimortem C-sections (only 8 trauma)
- 28 procedures, 34 survivors (3 twins, 1 triplet)
- No reports of worsened maternal CV status after cesarean
- 24 had timing noted:
GUIDELINES PERIMORTEM CESAREAN

For maternal indications:
• After 4 minutes of non-productive CPR, in gestations over 20 weeks

For fetal indications:
• Ideally after 4 minutes of non-productive CPR in gestations over 24 weeks, but up to 30 minutes after maternal death if fetus is alive

PERIMORTEM C-SECTION

ALGORITHMS
THANK YOU

Caroline Mitchell, MD
Heather Evans, MD
Eileen Bulger, MD
Susan Stern, MD
Kirk Shy, MD
HMC Algorithm OB Trauma Management

Pregnant trauma patient arrives in ER (not undergoing active CPR)

Trauma team conducts primary survey, including FAST exam

OB uses US to assess presence of pregnancy, presence of fetal heartbeat and gestational age

GA is less than 24 weeks

• No monitoring necessary
• Rh typing should be done

GA is 24 weeks or greater (BPD > 6cm)

No fetal heartbeat

Fetal heartbeat < 90

Fetal heartbeat > 90

• No monitoring necessary
• Rh typing
• Consider abortion if mom unstable
• Continue with normal trauma eval

• To OR for C-section

• CEFM
• Rh typing
• Normal trauma eval
• OB to consider speculum exam and cervical check as part of secondary survey

HMC Algorithm Perimortem Cesarean

Maternal CPR begun prior to arrival

Never VS

VS in field, blunt trauma

VS in field, penetrating trauma

On arrival in ER confirm pregnancy (US), measure fundal height (at/above umbilicus)

If OB team present, potential US for BPD to assess GA (4 x BPD)

ER attending

OB Team

≥ 24 weeks (6 cm BPD) and living fetus

C-section in ER (for maternal indication)

At same time

ED thoracotomy

If OB not present, C/S by ER or Trauma attending

> 20 weeks (fundsus at umbilicus OR BPD > 5 cm)

C-section in ER (for fetal indications)