

# Trauma In the Pregnant Patient

Trauma occurs in 5-10% of all pregnancies and ranks first among nonobstetric causes of maternal mortality. As many as 20% of affected women require emergency surgery. Severity of maternal injuries determines maternal and fetal outcome.

## ANESTHETIC CONSIDERATIONS:

- ABC's assessed and managed with the patient in left lateral decubitus position or left lateral tilt.
- Possible difficult airway secondary to pregnancy + possible a/w or c-spine trauma. Aspiration risk /full stomach.
- Physiologic changes of pregnancy may alter the signs and symptoms of injury, and results of diagnostic tests.
- Two patients, but initial treatment priorities for an injured pregnant patient remain the same as for the nonpregnant patient.
- The best initial treatment for the fetus is optimal resuscitation of the mother and early assessment of the fetus.
- Maternal and fetal hypovolemic shock. Possible need for massive transfusion of the mother.
- Consider uterine evacuation for fetal indications or to improve hemodynamic stability in an unstable mother.
- In the event of cardiac arrest of the mother, the infant should be delivered by C-section within 5 minutes of the arrest.
- Rh immunoglobulin therapy to prevent isimmunization in all pregnant Rh-negative trauma patients.

## ANESTHETIC GOALS:

- To maintain maternal hemodynamic stability and optimize uteroplacental perfusion
- Protection of the brain, spinal cord and end-organs
- Detection of unrecognized injuries
- Maintenance of normothermia
- Correction of coagulopathy
- Avoidance of teratogenic drugs during first trimester
- Prevention of pre-term labour

## INITIAL EVALUATION AND MANAGEMENT SPECIFIC TO PREGNANT PATIENTS

- The primary goal in the initial management of the injured pregnant woman is the stabilization of the mother
- **Maternal resuscitation is the most effective method of fetal resuscitation**
- Evaluation and resuscitation should occur simultaneously
- Standard resuscitation and trauma guidelines apply in the pregnant patient, with two caveats:
  1. Beginning at 18 to 20 weeks' gestation, the effect of aortocaval compression must be considered, and the patient must not be allowed to lie supine without left uterine displacement
  2. Uterine evacuation may (or may not) increase the likelihood of fetal survival, depending on gestational age, but physicians should understand that uterine evacuation may also be necessary to facilitate resuscitation of the mother
- There are two distinct reasons to empty the uterus in pregnant trauma victims:
  1. Fetal compromise can result from inadequate uteroplacental perfusion due to hypovolemia, placental abruption, or uterine rupture. The presence of a nonreassuring FHR pattern that does not resolve with initial resuscitation of the mother (including adequate left uterine displacement) may prompt immediate delivery for fetal indications
  2. Uterine evacuation may improve hemodynamic stability in an unstable mother (e.g., one who is unresponsive to resuscitation, continues to bleed, or requires laparotomy). In these situations, delivery is performed as part of maternal resuscitation, and also offers a better chance of survival for the viable fetus.
- All pregnant Rh-negative trauma patients should be considered for Rh immunoglobulin therapy within 72 hours of injury, unless the injury is remote from the uterus

## Airway:

- The anatomic and physiologic changes of pregnancy (e.g., mucosal edema, decreased functional residual capacity, increased oxygen consumption) increase the difficulty and decrease the safety margin of airway management
- All pregnant patients involved in trauma should be considered as increased risk for pulmonary aspiration of gastric contents
- Immobilization of C-spines does not preclude provision of left uterine displacement, but care must be taken to maintain inline support and immobilization

## Breathing:

- If management of pneumothorax or hemothorax is required with chest tube insertion, because the diaphragm is displaced in a cephalad direction by the gravid uterus, chest tubes (e.g., for hemothorax or pneumothorax) should be inserted at a higher dermatomal level than in the nonpregnant patient to avoid damage to abdominal organs
- Maintain Paco<sub>2</sub> within the normal range for pregnancy, with use of the lowest possible airway pressures to minimize the risks of hypotension and barotrauma

## Circulation:

- Pregnancy-associated increases in circulating blood volume and cardiac output along with decreased systemic vascular resistance provide some maternal protection from hemorrhage
  - The pregnant woman compensates well, and can lose as much as 1.5 to 2 L of blood (35% of her circulating blood volume) before exhibiting the classic signs of hypovolemia
  - Therefore, when compensation fails, she will have lost significantly more blood from hemorrhage than a nonpregnant woman with similar findings
  - Because of the concomitant physiologic anemia of pregnancy, the pregnant woman with signs of hypovolemia is likely to have a serious deficit in oxygen-carrying capacity
  - Maternal compensation often occurs at the expense of the fetoplacental unit, and a nonreassuring FHR tracing may be the first sign of maternal hypovolemia
  - An abrupt decrease in maternal intravascular volume may result in a profound increase in uterine vascular resistance, reducing fetal oxygenation despite reasonably normal maternal vital signs
  - Aortocaval compression is never more hazardous than in the hypovolemic, hypotensive pregnant woman, highlighting the importance of continuous left uterine displacement
- Crystalloid fluid resuscitation and early type-specific blood administration are indicated to support the physiologic hypervolemia of pregnancy
- Avoid administering vasopressors to restore maternal blood pressure, because they further reduce uterine blood flow, resulting in fetal hypoxia
- The upper extremities are the preferred sites for initial venous access; two large-bore peripheral venous catheters should be inserted as quickly as possible

- In the setting of uncontrollable hemorrhage in nonobstetric patients, the use of tranexamic acid and recombinant factor VIIa (rFVIIa) has been advocated; However, concerns regarding increased risks of thromboembolism highlight the need for more data before definitive recommendations can be made about the appropriate clinical use of rFVIIa in pregnant patients – It should be considered in a pregnant woman only if all standard therapies have failed.
- There is a growing consensus that cell salvage is safe in obstetric patients, although debate continues regarding the utility of cell salvage in the obstetric setting
  - If cell salvage is used at cesarean delivery, attempts must be made to limit the collection of amniotic fluid, and a leukocyte depletion filter should be used

#### **Traumatic Brain Injury:**

- Neurologic assessment is important because a reduced level of consciousness can reflect intracranial pathology, intoxication, metabolic disorders (e.g., diabetes), the postictal state of eclampsia, or hypovolemia\
- Mechanical hyperventilation to a PaCO<sub>2</sub> between 25 and 30 mm Hg only provides a short-lived reduction in ICP in nonpregnant patients; Hyperventilation is disadvantageous for the fetus because it can decrease uterine blood flow by decreasing maternal cardiac output and blood pressure, and perhaps by causing uteroplacental vasoconstriction
- Mannitol and furosemide are used for acute reduction of ICP prior to more definitive management in nonpregnant patients; Both mannitol and furosemide cross the placenta and, theoretically, could increase fetal plasma osmolality and decrease intravascular volume
  - In general, however, concern regarding fetal effects should be overridden by the immediate needs of the mother
- It is possible in a pregnant woman with irreversible brain damage or brainstem death, for the pregnancy to be prolonged to achieve delivery of a viable infant, usually by cesarean delivery
  - Guidelines for the management of hypotension and mechanical ventilation in pregnancies complicated by fatal maternal brain injury have been published

#### **Preeclampsia and Eclampsia:**

- Although hypertension is one of the cardinal features of preeclampsia, it is not always apparent early in the disease process, and it can also be masked by hypovolemia
- Unexpectedly high (or normal) blood pressure measurements in the presence of significant blood loss, proteinuria, elevated serum urate or liver enzyme levels, unexplained thrombocytopenia, or the new onset of seizures should raise the suspicion of underlying preeclampsia or eclampsia
- Seizures after traumatic head injury in a pregnant woman present a difficult diagnostic problem because eclamptic seizures are a clinical diagnosis of exclusion
  - Supportive evidence for eclampsia includes proteinuria (although this could result from trauma), increased serum urate and liver enzyme levels, thrombocytopenia not explained by hemorrhage, and a previous diagnosis of preeclampsia
  - Whenever eclampsia is strongly suspected, intravenous magnesium sulfate should be administered

#### **Cardiac Arrest and Perimortem Cesarean Section:**

- When cardiac arrest occurs in a pregnant woman, standard ACLS resuscitation guidelines apply, with two important modifications:
  1. Attempts must be made to minimize aortocaval compression by maintaining left uterine displacement
    - Use of a sandbag under the right hip, a human wedge (i.e., tilting the patient on the bent knees of a kneeling rescuer), or the Cardiff wedge – a large wedge-shaped board on which resuscitation takes place, will still allow effective chest compressions with left uterine tilt
  2. As part of the process of maternal resuscitation in the second half of pregnancy, the infant should be delivered, usually by cesarean delivery
    - “4-minute rule” – perimortem cesarean delivery to begin within 4 minutes of maternal cardiac arrest, so that the infant is delivered within 5 minutes of cardiac arrest (outcomes beyond 5 min very poor for both mom and baby)
    - This approach increases the likelihood of both maternal and neonatal survival
    - Isolated case reports of infant survival after more than 20 minutes of maternal cardiac arrest support the performance of a perimortem cesarean delivery in any case of maternal cardiac arrest, with continued evidence of fetal cardiac activity, beyond 24 weeks’ gestation
- In cases of cardiac arrest during the second half of pregnancy, cesarean delivery aids resuscitation of the mother by:
  1. Minimizing the aortocaval compression from the pregnant uterus, thereby increasing venous return
  2. Reducing maternal oxygen consumption
  3. Aiding ventilation
  4. Allowing cardiopulmonary resuscitation (CPR) to be performed with the patient in the supine position
- If CPR has not been effective within 4 minutes in the tilted position, cesarean delivery should be performed immediately
- CPR should continue during and after surgery, and unless the operating room is very close to the area of maternal collapse, it is likely that the delivery will have to be performed where the cardiac arrest occurred (e.g., labor and delivery room, emergency department)
- If cesarean delivery is required, endotracheal intubation is not likely to require anesthetic drugs
  - However, if cardiac output improves after further resuscitation, awareness can occur, and anesthesia should be provided as needed and tolerated
  - The presence of hypotension does not uniformly prevent awareness in young patients, and administration of anesthetic and/or amnestic agents should be considered after a positive hemodynamic response has been observed

#### **HISTORY AND PHYSICAL**

- See considerations of the trauma patient seminar – thorough head to toe exam in primary and secondary surveys
- The physician should look for evidence of uterine contractions, ruptured membranes, and placental abruption (abdominal pain, uterine tenderness, and vaginal bleeding)

#### **INVESTIGATIONS**

- The physiologic changes of pregnancy may alter the results of diagnostic tests so it is important to know normal values in pregnancy (see Table 54-1 on next page)

## Initial Laboratory Analyses for the Pregnant Trauma Victim

- Blood type, cross-match, and Rh status
- Complete blood count (hemoglobin measurement, white blood cell count, platelet count)
- Prothrombin and partial thromboplastin times
- Fibrinogen (or fibrin degradation products) concentration
- Serum electrolyte and urate levels
- Liver function tests
- Serum amylase level
- Blood glucose level
- Blood lactate level
- Toxicology screen
- Arterial blood gas measurements (pH, PaO<sub>2</sub>, PaCO<sub>2</sub>, bicarbonate, base deficit)
- Kleihauer-Betke assay
- Urinary protein, blood, bilirubin, and glucose levels
- Urine osmolality or specific gravity

- The Kleihauer-Betke acid elution assay is used to detect and quantify the extent of fetomaternal hemorrhage (i.e., fetal blood entering the maternal circulation)
  - It is traditionally used in Rh-negative women to detect transplacental hemorrhage that can lead to Rhesus isosensitization if Rh(D) immune globulin is not administered
  - Sequential Kleihauer-Betke testing helps detect ongoing fetomaternal hemorrhage and the need for multiple doses of Rh(D) immune globulin.
- The pregnant trauma patient often requires a radiographic skeletal survey and may also need special radiographic procedures to diagnose specific injuries
  - Despite fears about potential harm to the developing fetus from exposure to ionizing radiation, the risks of radiation-induced teratogenesis, malignancy, or gene mutation are small
  - The fetus is at greatest risk for teratogenesis during the first trimester
  - When possible, lead shielding should be used over the pelvis to protect the fetus during radiographic investigations
  - The small fetal risk is almost always outweighed by the potential benefit to the mother (and, by extension, the fetus) of appropriate imaging
  - Fetal risk of malformations is considered low with total radiation exposures of less than 50-100mGy (5-10 rads)
  - Individual radiographic examinations produce very low levels of exposure
  - CT produces higher levels of radiation exposure than plain radiographs, but even abdominal and pelvic CT scanning usually produces estimated fetal exposures below those typically associated with adverse fetal/neonatal outcomes
- Magnetic resonance imaging (MRI) avoids the risk of fetal radiation exposure, but it is too slow and impractical for the seriously injured, unstable patient who needs ongoing resuscitation and monitoring
- Ultrasonography is a useful diagnostic tool in patients with blunt abdominal trauma and has largely replaced diagnostic peritoneal lavage for the detection of intra-abdominal hemorrhage
  - Sensitivity and specificity of ultrasonography in pregnant patients are similar to that seen in nonpregnant patients, although the technique is less sensitive in detecting retroperitoneal and hollow viscus injuries
  - As a screening test for intra-abdominal hemorrhage, ultrasonography is most sensitive in the first trimester, but it has also proved useful in a limited number of third-trimester patients, despite the greater uterine size and displaced intra-abdominal viscera
  - An additional advantage is the ability to image the fetal heart or detect a previously undiagnosed intrauterine pregnancy
- Diagnostic peritoneal lavage has become a largely obsolete investigation with the better availability of reliable and noninvasive ultrasonography and rapid CT scanning
  - If this evaluation is necessary in a pregnant patient, the needle should be inserted above the umbilicus

**TABLE 54-1 – Physiologic Changes of Pregnancy\***

Parameter	Effect of Pregnancy
<b>Cardiovascular</b>	
Cardiac output	↑ by 35%-50%
Blood pressure	↓ by 5%-15% in second trimester; subsequently approaches baseline at term
Systemic vascular resistance	↓ by 35% at midpregnancy; then increases slightly but remains ↓ by 20% at term
Heart rate	↑ by 15%-25%
Central venous pressure	Unchanged
<b>Hematologic</b>	
Blood volume	↑ by 30%-50%
Hemoglobin	↓ to 10-12 g/dL
White blood cell count	↑ by 10%-50%, marked ↑ in labor
Coagulation factors	↑ I, VII, VIII, IX, X, XII
<b>Respiratory</b>	
Functional residual capacity	↓ by 20%
Tidal volume	↑ by 35%-45%
Respiratory rate	No change or slightly ↑
Chest radiograph	Elevated diaphragm, leftward rotation of heart, no lung field changes
<b>Metabolic</b>	
Oxygen consumption	↑ by as much as 60%
pH	↑ to 7.42-7.46
P <sub>a</sub> CO <sub>2</sub>	↑ to 100-107 mm Hg (may decrease near term)
P <sub>a</sub> CO <sub>2</sub>	↓ to 28-32 mm Hg
HCO <sub>3</sub>	↓ to 19-22 mEq/L
Base deficit	↑ by 2-3 mEq/L
<b>Gastrointestinal</b>	
Gastric emptying	Normal, but ↓ with labor and opioids
Lower esophageal sphincter	↓ competence
<b>Renal</b>	
Renal blood flow	↑ by 80%-75%
Glomerular filtration rate	↑ by 50%
Blood urea nitrogen	↓ to 8-9 mg/dL
Serum creatinine	↓ 0.5-0.6 mg/dL
<b>Musculoskeletal</b>	
Symphysis pubis	Widened
Sacroiliac joints	Widened

↑, increase; ↓, decrease.

#### ANESTHETIC SETUP

- Difficult airway cart, may need FOB for awake intubation
- Emergency drugs, warming devices, rapid infusers/Level 1, blood (consider massive transfusion protocol)
- **Maternal monitoring:** standard CAS monitor + temp, FHR and uterine activity monitoring, urine output, an arterial line is indicated for labile or low blood pressure or persistent hypoxemia +/- CVP, PAC, TEE
- **Fetal monitoring:** FHR should be monitored continuously, and both baseline FHR and FHR variability should be assessed

#### OPTIMIZATION

- Resuscitation for hemodynamic instability prior to anesthetic unless patient is not responding to resuscitation efforts and surgical control of hemorrhage is required
- Obstetrics consultation should be obtained since fetal distress can occur at any time and without warning
- Possible ICU consult

#### MANAGEMENT OF ANESTHESIA

##### Induction:

- Most drugs commonly used in anesthetic practice are considered safe for use during pregnancy
- The anesthetic technique depends on the nature of the maternal injuries and the preference of the anesthesia provider, and does not diverge greatly from that in the nonpregnant trauma patient
- To minimize the adverse effects of aortocaval compression, left uterine displacement (or leftward tilt of the operating table) should be maintained, beginning at 18 to 20 weeks' gestation
- Electronic FHR monitoring should be performed before and after surgery to assess fetal well-being
- Pregnant women are at increased risk for pulmonary aspiration and should receive antacid prophylaxis if possible and if time permits
  - Following denitrogenation (so-called preoxygenation) with 100% oxygen, rapid-sequence induction of anesthesia with cricoid pressure is preferred, although awake fiberoptic intubation is an option in some instances
  - Alternative airway tools (e.g., gum elastic bougie, McCoy laryngoscope, laryngeal mask airway in various sizes) should be available for management of the difficult airway
- Although hypovolemia precludes the administration of usual doses of anesthetic agents, young patients might experience intraoperative awareness during paralysis and light anesthesia, even in the presence of severe hypotension
  - Standard doses of **etomidate** (0.3 mg/kg) or **ketamine** (1 to 1.5 mg/kg) provide better blood pressure support than thiopental
  - Propofol is relatively contraindicated in bleeding trauma victims because of its vasodilatory and hypotensive effects
  - Administration of a bolus of fluid prior to induction of anesthesia might ameliorate the hypotensive effects of induction agents
  - Large doses of ketamine (greater than 2 mg/kg) may increase uterine tone and decrease uteroplacental perfusion, but smaller doses are less likely to have adverse effects on the uteroplacental circulation
- Opioids (e.g., fentanyl) can be used to supplement a reduced dose of hypnotic agent

##### Maintenance:

- Ventilation can be difficult in patients with chest trauma, and techniques to minimize barotrauma should be employed (e.g., small tidal volumes, minimal peak inspiratory pressures, avoidance of PEEP)
- In pregnant patients, volatile halogenated agents are easily titrated, reduce the risk of intraoperative awareness, and decrease uterine activity by relaxing uterine smooth muscle
- The use of nitrous oxide may be limited or avoided because of the need for a high inspired oxygen fraction or by the presence (or risk) of air-filled cavities such as pneumothorax

- Intraoperative monitoring is recommended when possible, particularly when gestational age exceeds 24 weeks and cesarean delivery is likely to result in a viable fetus
  - During general anesthesia, decreased FHR variability reflects the transplacental transfer of anesthetic agents and is not necessarily a cause for concern
  - However, sustained fetal tachycardia or bradycardia or recurrent FHR decelerations suggest fetal compromise.
  - Fetal heart rate abnormalities can signal the need to (1) optimize maternal oxygenation, ventilation, and acid-base status; (2) expand maternal blood volume; (3) increase maternal perfusion pressure by administration of a vasopressor; (4) increase maternal oxygen-carrying capacity through transfusion of red blood cells; (5) relieve aortocaval compression by increasing left uterine displacement or repositioning surgical retractors; and/or (6) perform cesarean delivery.
- Uterine activity should be monitored in the perioperative period to facilitate the early diagnosis of preterm labor, which may be treated with a tocolytic agent
- An obstetrician should be immediately available to perform cesarean delivery of a viable fetus when severe fetal compromise occurs during surgery or if the maternal condition demands it

#### **Emergence:**

- Women with severe injuries after trauma, particularly with major fluid shifts or continuing blood loss, unresolved coagulopathy, or multiorgan injury, should remain intubated, ventilated, and anesthetized at the end of the procedure and should be transferred to a critical care unit for subsequent management

#### **COMPLICATIONS**

- Placental abruption, PROM
- Amniotic fluid embolization
- DIC
- Isoimmunization from fetomaternal hemorrhage
- Pregnancy is a hypercoagulable state, and once acute coagulopathy due to trauma has resolved, the patient is at increased risk of thromboembolic events, especially if the injuries cause immobility
  - Pregnant women with fractures have a ninefold higher risk of thrombotic events
  - Thromboprophylaxis must be considered after hemostasis is secured and the patient is hemodynamically stable

#### **PATHOPHYSIOLOGY**

- Head injury and hemorrhagic shock account for most maternal deaths secondary to trauma
- Placental abruption and maternal death are the most common causes of fetal death secondary to trauma
- Even minor trauma increases the risk of placental abruption, preterm labour, and low birth weight
- Domestic violence and depressive illness should be considered in the evaluation of maternal trauma

#### **REFERENCES**

- Chestnut Chpt 54
- ATLS Manual

**Spine Trauma/Paraplegia/Quadriplegia – see neuro section**