CHAPTER

6

Emergency Medical Resuscitation in Pregnancy with Trauma

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Introduction

Trauma is currently the most common non-obstetric cause of morbidity and mortality during pregnancy. It is estimated that 6-7% of all pregnancies are complicated by significant trauma. This presents a unique situation for the emergency physician. Changes occur throughout pregnancy that can alter the presentation and treatment of injury. Additionally, there are potentially two lives at stake. While stabilization of the mother is the main objective, the life of the fetus must also be considered during the resuscitative measures. Current literature suggests that initial stabilization of the mother provides the best chance for fetal survival[1]. However, minor trauma to the mother may result in significant injury to the fetus. Thus careful fetal monitoring is essential to detect early signs of fetal distress. A collaborative effort involving the emergency physicians and staff along with specialists in trauma surgery, obstetrics and neonatology is essential to ensure the best outcome for both patients.

Anatomy and Physiology of Pregnancy

Many changes in the anatomy and physiology occur throughout pregnancy which can alter both the presentation, and management of injury. A sound knowledge of these changes will allow the physician to determine the severity of injuries and the appropriate treatment necessary early in the course of management.

Pregnancy induces numerous hemodynamic changes that can make patient assessment challenging. The heart rate will typically rise throughout the pregnancy reaching a maximum increase of 10-15 beats per minute by the end of the third trimester[1, 2]. Blood pressure decreases by 2-3 mm Hg systolic and 10-15 mm Hg diastolic during the first two trimesters; returning to normal during the third trimester[1, 2]. Progesterone induced smooth muscle relaxation results in decreased vascular resistance, and a 5 mm Hg decrease in central venous pressure by the third trimester[2, 3]. Depending on the patients pre-pregnancy values, all of these changes have the potential to mimic shock, in an otherwise stable patient. Additionally pregnant patients have a dilutional anemia due to a 50% increase in plasma volume, with only a 30% increase in red blood cell mass[1, 2]. This increase in circulating volume allows for a much larger blood loss before signs of maternal hypovolemia become apparent.

At end of the second trimester, cardiac output has increased by 30-50% to provide for the increasing demand of the growing uterus[1, 3]. There is a 10 fold increase in the blood flow to the pregnant uterus[1, 2]. The mothers total blood volume flows through the uterus every 8-11 minutes[2]. Thus minor trauma

Mean values for hemodynamic changes seen throughout pregnancy

	Pre-pregnancy	1st trimester	2nd trimester	3rd trimester
Heart rate (beats/min)	70	78	82	85
Systolic blood pressure (mm Hg)	115	112	112	115
Diastolic blood pressure (mm Hg)	70	60	63	70
Central venous pressure (mm Hg)	9.0	7.5	4.0	3.8
Femoral venous pressure (mm Hg)	6	6	18	18
Cardiac output (L/min)	4.5	4.5	6.0	6.0
Blood volume (mL)	4000	4200	5000	5600
Uterine blood flow (mL/min)	60	600	600	600
Hematocrit (%)	40	36	34	36

Table modified from Marx: Rosen's Emergency Medicine : Concepts and Clinical Practice, 6h ed. Ch 35 Trauma in pregnancy

to the uterus or pelvis can result in extensive hemorrhage.

By 20 weeks gestation the gravid uterus has reached the level of the inferior vena cava, and in the supine position can cause vena caval compression. This can result in supine hypotension commonly seen in pregnancy. This hypotension is due to the decrease in preload, resulting in a decreased cardiac output and ultimately low arterial blood pressure. Placing the patient in the lateral decubitus position relieves the pressure on the vena cava, and is considered the optimal position if the patient is greater than 20 weeks. If the patient is hypotensive and repositioning is not an option, the uterus can be manually displaced to the left allowing for greater blood return to the heart. This maneuver can also be used during cardiopulmonary resuscitation (CPR) to improve cardiovascular status.

The compression of pelvic veins by the enlarging uterus in addition to compression of the inferior vena cava can cause an increase in venous pressure below the uterus. This increase in pressure is the explanation for dependant edema, venous stasis, varicose veins, and hemorrhoids often seen in pregnancy. The increased venous pressure often results in rapid blood loss from injuries to the pelvis or lower extremities. Due to the increased pressure and poor venous return to the heart, intravenous lines in the lower extremities should be avoided if possible preventing the possibility of pooling in these vessels.

Thromboembolism is more prevalent in pregnancy. Venous stasis, expanded venous volume and an increase in fibrinogen and coagulation factors are the cause of thromboembolism during the latter part of pregnancy. If the trauma patient is confined to a bed, this can add to the risk, and add further complications to the injuries.

In addition to the hemodynamic changes seen in pregnancy, there are also alterations in respiration. These changes can have an effect on the patient's ability to compensate for injury, as well altering values on blood gas. The gravid uterus slowly pushes the diaphragm more cephalad as it enlarges. The growing fetus puts many new demands on the maternal system. There is an increase in metabolic rate and a 15% to 20% increase in oxygen requirements[1]. The combination of these changes cause a 40% increase in tidal volume, with a resultant 25% decrease in residual volume and functional residual capacity[1, 3]. The increase in tidal volume causes increased ventilation and a respiratory alkalosis, but renal compensation is typically able to maintain pH values near normal. These changes can be seen in the arterial blood gas as an increase in pO_2, and a decrease in both pCO_2 and bicarbonate. Consequently, the patient is less able to buffer pH changes or to compensate for respiratory compromise. This increases the risk of injury to the fetus due to maternal hypoxemia and acidemia.

In a similar manner to the rising diaphragm level, as the enlarging uterus enters the abdominal cavity, the abdominal viscera are also pushed cephalad. Accordingly, visceral pain may present in an

unusual pattern, and penetrating injury to the upper abdomen has the potential of causing significant damage to the intestines. The slow stretching of the abdominal wall desensitizes it to peritoneal irritation. Abdominal tenderness, rebound, and guarding may be absent or significantly reduced even in the presence of significant intra-peritoneal hemorrhage. Gastrointestinal motility slows and gastric sphincter response is reduced. This results in an increased likelihood of aspiration due to either an altered level of consciousness, or resuscitative efforts. Additionally, aspiration can be more damaging to the lungs due to the increased production of gastric acid during pregnancy.

By the third trimester the enlarged uterus has continued to push everything superiorly including the urinary bladder. Movement of the bladder out of the pelvis and into the abdominal cavity places it at increased risk of injury from trauma to the lower abdomen.

Epidemiology

Approximately 7% of all pregnancies will require medical treatment due to trauma.[4] While the number of trauma related deaths is equivalent for pregnant woman as for non-pregnant woman of reproductive age, trauma is associated with an increased rate of fetal demise. When blunt trauma causes death in utero, it is usually due secondary to pelvic fracture. A fractured pelvis can cause head injury to the fetus including skull fractures and intracranial hemorrhage. This risk is greatly increased near term when the fetal head is engaged.

Motor vehicle collisions are the number one cause of injury accounting for approximately 60% of blunt trauma in pregnancy.[5] Studies have shown that a pregnant woman is less likely to wear a seatbelt than any other motorist. In 2002, the National Highway Traffic Safety Administration reported a 75% rate of seatbelt use in the general public, while only 54% of pregnant females used seatbelts.[2, 5] It is a common misconception that in the event of an accident, wearing a seatbelt causes increased incidence of fetal injury. However, when a seatbelt is worn correctly during pregnancy there is no increase in risk to the fetus. The greatest predictors of fetal injury were crash severity and improper use of seatbelts. When a seatbelt is not used, the patient is twice as likely to experience vaginal bleeding, and begin labor within 48 hours following injury.[1, 2, 5] Fetal death occurs three to four times more often, due in large part to increase risk of maternal death after ejection from the vehicle. The American College of Obstetricians and Gynecologists support the proper use of a three point harness. The lap belt should be worn low over the hips (under the gravid uterus) and the shoulder strap should rest securely between the breasts, and to the side of the uterus. This configuration secures the mother, and causes the least amount of force to the uterus in a collision. There has also been evidence to support against disabling airbags during pregnancy. While pregnant, the mother should be seated as far back as possible, but the overall benefit of airbags is greater than the risks to both mother and fetus without this restraint device.

Falls are the second most common cause of injury. They account for 22% of blunt trauma injuries during pregnancy.[5] While other injuries seem to be evenly distributed throughout pregnancy, falls appear to have an increase in incidence after 20 weeks gestation, with the highest incidence occurring in the final 10 weeks before delivery. This is associated with the change in center of gravity as the mother approaches full term. Laxity of pelvic ligaments as well as fatigue near the end of pregnancy also contribute to the increased risk of falls. Maternal death from a fall is rare, but when it does occur it is typically due to significant head trauma. Falls are also less likely to cause significant fetal injury. They may result in premature contractions, but do not typically result in immediate labor and delivery.

Physical abuse follows falls in order of prevalence during pregnancy, with an incidence of 17%.[1, 5] The abuser is most often someone well known to the patient; usually a boyfriend or husband. Greater than 50 per cent of abuse victims report an increase in the number of attacks during pregnancy than

experienced prior to pregnancy. Injuries to the face, head, breasts, and abdomen are most common. It is estimated that only 3% of patients are truthful about the mechanism of injury.[2] History of a fall is the most common explanation given by abuse victims. When the story does not appear to fit with the injuries seen on examination the physician should inquire about abuse, and suggest consultation with social services.

Penetrating injuries are the least common mechanism of injury during pregnancy. Gunshot wounds (the most prevalent) and knife wounds are second. Again the perpetrator is usually someone the patient knows and trusts, with a husband or boyfriend being most likely. However, a percentage of the gunshot wounds to the abdomen are self inflicted. This is typically an attempt by the mother to terminate an unwanted pregnancy. Due to the protective effect of the gravid uterus on the mother, penetrating trauma below the fundus of the uterus has a 70% rate of fetal demise and little risk of significant injury to the mother.[2, 5] Alternatively, penetrating trauma above the uterus nearly always results in maternal visceral injury with only 38% chance of fetal death. This is due to the increased concentration of abdominal viscera in the small area above the uterus.

Burns involving significant total body surface area (TBSA) are uncommon in pregnancy, but can present considerable risk to both the mother and fetus. Burns should be managed in the typical manner ensuring careful debridement, and appropriate dressings. Fluid replacement should be initiated based on the TBSA involved. Fetal demise due to maternal complications increases with increasing surface area involvement. The majority of the complications are due to infection of the burn and development of sepsis. A burn with a TBSA of 50% or greater has almost a 100% mortality rate for the fetus.[5] In addition to the burns, particular attention should be given to possible carbon monoxide levels. Fetal hemoglobin has a higher affinity for carbon monoxide than maternal hemoglobin. Fetal carboxyhemoglobin can reach critical levels without measurable maternal carboxyhemoglobin.

Injury Prevention

Prenatal care with proper safety instructions is the best preventative measure. Pregnant woman should be instructed about proper safety belt use and the benefit to both mother and child. Woman should be advised early in pregnancy about the many changes they will experience. These transformations in body habitus place her at increased risk of injury due to falls. The increased incidence of domestic violence during pregnancy warrants further investigation into certain injuries. Inquiries should be made in any case of trauma without a reasonable explanation. When there is suspicion of abuse consultation with social services can offer the mother safety for her and her child.

Complications of Trauma

Placental abruption from blunt trauma is responsible for a 60% fetal death rate.[1, 2, 5] This is second only to maternal death. In trauma, the elasticity of the uterus allows it to deform easily without injury. When the uterus changes shape, the inelastic placenta is torn from the uterine wall. This causes hemorrhage between the uterine wall and the placenta, and diminishes fetal oxygen and nutrient supply, as well as waste removal. Intrauterine hemorrhage leads to irritation of the myometrium and the uterus begins contracting. These contractions cause constriction of uterine blood vessels resulting in a greater decrease in blood flow to the already distressed fetus. There does not appear to be a correlation with abruption, and the location of the placenta. However, the extent of abruption does correlate with the rate of fetal loss. Even a small abruption can induce premature labor, but the larger the abruption, the greater the risk to the fetus. Signs and symptoms of abruption include vaginal bleeding, uterine tenderness, abdominal cramps, maternal signs of hypovolemia, and fetal tachycardia.

In addition to fetal compromise the mother faces multiple risks as well. Amniotic fluid embolus

can occur with placental abruption. This results in maternal respiratory distress, and is associated with a high mortality rate. Splitting of the placenta from the uterine wall results in the introduction of placental thromboplastin and uterine plasminogen activator into the maternal circulation. This is associated with a high maternal risk of developing disseminated intravascular coagulation (DIC). Similar to the effects of placental abruption on fetal demise, DIC is also directly correlated to the severity of the abruption. The most severe clotting disorders occur with greater percentage of placental abruption.

Fetal hemorrhage can occur with any type of trauma. The fetus has a minimal blood supply, and anemia with death of the fetus can occur rapidly. There is a five fold increase in the rate of fetomaternal hemorrhage following trauma. Unlike placental abruptions, fetomaternal hemorrhage is related to placental location. An anterior placental attachment represents the greatest risk. In a patient who is Rh positive fetomaternal hemorrhage is inconsequential. However, when a patient is Rh negative and without prior sensitization, isoimmunization is a potential complication. This can place not only the current fetus at risk, but also subsequent pregnancies. Rh^{O}D immune globulin (Rhogam) should be administered within the first 72 hours following trauma in any unsensitized Rh negative mother. The Apt test or the Kleihauer-Betke (KB) test can be used to detect the presence of fetal blood in the maternal circulation.

Uterine rupture is rare, but is associated with nearly a 100% fetal mortality rate.[2] The probability of rupture increases as the pregnancy progresses and the uterine walls are stretched. Woman with a history of prior cesarean section are at highest risk if rupture. The most common cause of uterine rupture is motor vehicle collisions with a resulting pelvic fracture. Penetrating trauma although rare, also has the potential to cause uterine rupture. Uterine rupture should be considered when there is an inability to palpate the top of the uterus and fetal parts are easily felt through the abdominal wall. Management is considered on an individual basis. If the mother desires more children in the future, repair of the uterus can occasionally be accomplished. However, with extensive damage to the uterus or inability to repair damaged vessels, hysterectomy is the optimal treatment.

Development of a tension pneumothorax is more likely during pregnancy due to elevation of the diaphragm, and constant hyperventilatory state. The diaphragm may be elevated as much as 4 cm, and this must be considered if a thoracostomy tube is required to re-inflate the lung. In the second half of the pregnancy a thoracostomy tube should be inserted one or two intercostal spaces higher.

Pre-hospital Care

General treatment of the pregnant trauma patient is the same as that for a non-pregnant patient with a few exceptions. Any female of child bearing age should be assessed for the possibility of pregnancy. If greater than 20 weeks gestation, the possibility of supine hypotension is increased. These patients should be placed in the left lateral decubitus position to maximize blood return to the heart. If spinal precautions are indicated, the patient can be tilted 15 degrees to the left while immobilized on a backboard.[1] Even in the absence of respiratory distress, the patient should be given supplemental oxygen to compensate for the increased oxygen demand of the fetus. If pre-hospital transfusion is necessary, O negative trauma blood should be infused. Although rarely used, inflation of the abdominal portion of anti-shock trousers is contraindicated in pregnancy. Inflation can decrease blood flow to the uterus, and increases work load of the heart.

If possible, the patient should be transported to a trauma center that can handle both the mother and the fetus. Quick assessment of fetal viability can be obtained by palpating the fundal height. If the fundus is at or above the level of the umbilicus the fetus is estimated to be 20 weeks' gestation and potentially viable. Appropriate arrangements

should be made prior to arrival at the hospital in the event emergent delivery is required.

Initial Assessment

As in all trauma patients evaluation of airway, breathing, and circulation is primary. First priority should be resuscitation of the mother before evaluation of the fetus is initiated. However, estimation of gestational age is beneficial in determination of fetal viability. If the fetus is deemed non-viable treatment should be directed exclusively toward maternal well being.

Fetal age can be estimated by the fundal height of the uterus. Once the fundus reaches the level of the umbilicus, fundal height in centimeters is approximately equivalent to gestational age. (i.e. 24 cm, 30 cm and 34 cm measured from the symphysis pubis to the fundus is approximately 24, 30 and 34 weeks respectively). A fundal height at the level of the umbilicus is estimated to be 20 weeks gestation. Twenty-three to 24 weeks gestation is considered the minimum age for fetal viability. With this in mind, a fundal height greater than 3 to 4 cm above the umbilicus should be considered a potentially viable fetus.

Fundal height related to gestational age

Fundal height	Average gestational age
Pubic symphysis	12 weeks
Umbilicus	20 weeks
Xiphoid process	36 weeks

If oxygen supplementation was not initiated prior to arrival, it should be initiated immediately, and continued until hypoxemia, hypovolemia and fetal distress have all been ruled out. Hypoxia can occur rapidly due to the decreased oxygen reserve, and the increased oxygen consumption seen in pregnancy. The threshold for intubation should be low. Securing the airway will maintain proper oxygenation and reduce the risk of aspiration. Due to slowed gastric emptying, and increased risk of aspiration, gastric decompression should be initiated early as well. Intravenous access should be obtained with administration of sufficient replacement fluids (preferably lactated ringer's solution). Pregnancy causes a baseline hypervolemia and this should be considered in the calculation of replacement fluids. Since circulating maternal volume is dramatically increased, and signs of hypovolemia may not become apparent until significant hemorrhage has occurred. In a hypovolemic state the body responds with self preservation, and the maternal blood supply is shunted to essential organs and away from non-essential organs. The uterus is non-essential, and extensive fetal compromise can occur before the mother shows signs or symptoms of shock. Vasopressors can impair uterine perfusion, and should be avoided if possible. However, if after crystalloid infusion vasopressors are still warranted, they should not be withheld.

Following the primary survey and initial stabilization of the mother the physician should proceed to the secondary survey. The secondary survey should be similar to that performed on any other trauma patient with a few added details. Careful examination of the abdomen is essential. The enlarging uterus displaces the intra-abdominal organs making localization of injury more difficult. There is also a decreased reaction to peritoneal irritation with reduction of tenderness, rebound, and guarding. However, valuable information can be obtained by the presence or absence of uterine contractions, uterine tenderness or vaginal bleeding.

The condition of the fetus can be assessed at this time beginning with verification of fetal heart tones. In the absence of fetal heart beat upon presentation to the emergency department chances of fetal resuscitation is poor. In this situation, full attention should be focused on the mother and treatment of her injuries. If fetal heart tones are present, and the mother is stable, continued evaluation of the fetus is warranted. Fetal heart rate should be between 120 and 160 beats per minute.[1, 6]. Placental injury, maternal hypoxia, hypovolemia, or hypotention can all result in fetal hypoxia. Hypoxia can present with fetal bradycardia. Fetal tachycardia may be due to fetal hypoxia as well, but fetal hypovolemia

should also be considered. Bedside ultrasound is ideal for assessment of the fetus (discussed in more detail later).

A sterile speculum examination should be performed to assess possible injury to the genital tract, vaginal bleeding, rupture of membranes, and cervical dilation and effacement. If vaginal bleeding is noted, an ultrasound to rule out placenta previa should be done prior to speculum or bimanual examination. If there is a large amount of vaginal fluid present, it should be tested for amniotic fluid. An alkaline pH is suggestive of amniotic fluid, and can be confirmed by the presence of ferning (branch-like crystals) on microscopic examination.

Management

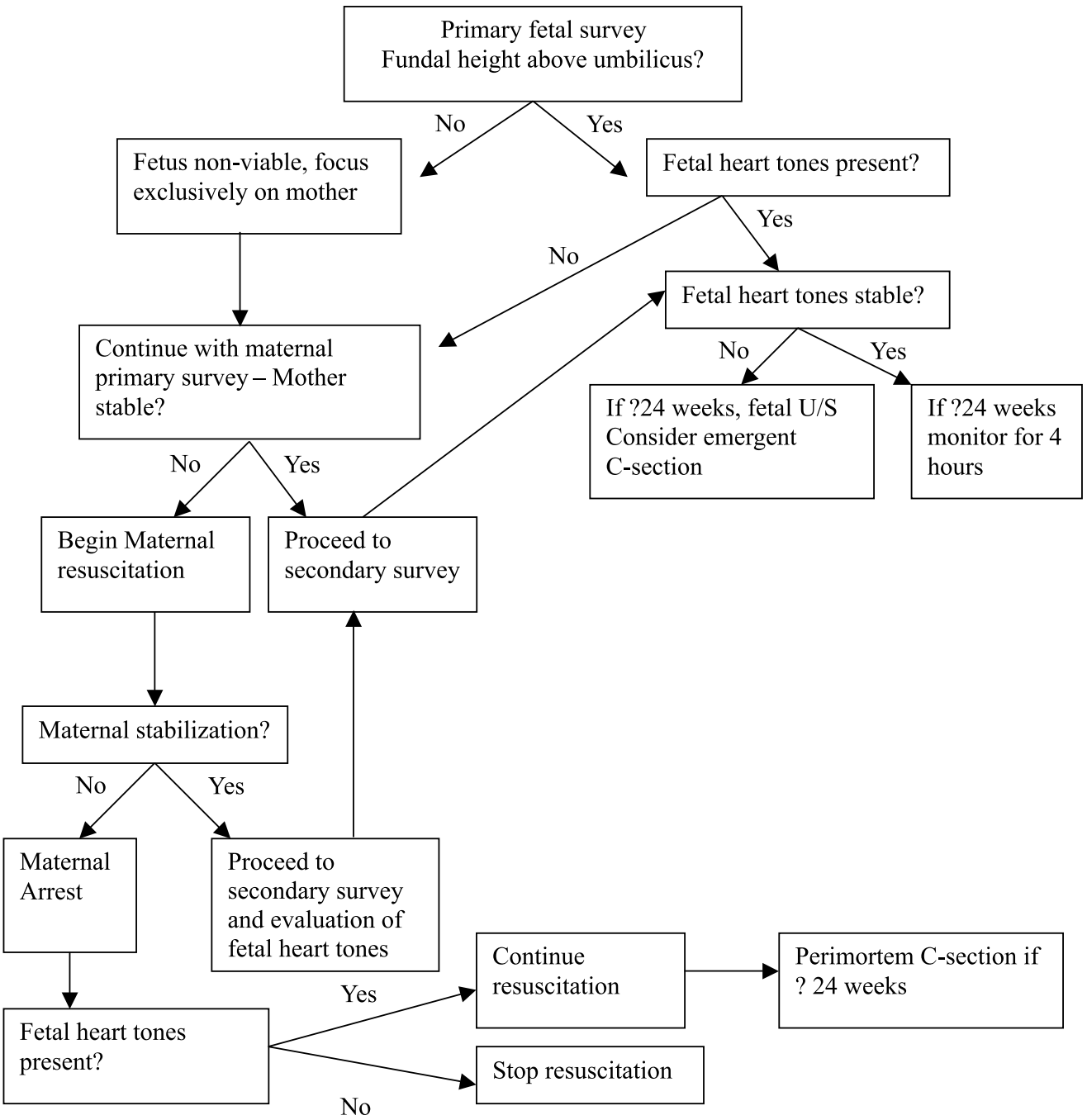
Following the initial assessment and stabilization, further testing should be performed based on clinical findings. No necessary diagnostic test should be withheld due to potential adverse effects on the fetus. The mother is the primary patient, and her survival is the best predictor of fetal survival.

Ultrasound has been the standard of care for the evaluation of the fetus throughout pregnancy. It is non-invasive and has no deleterious effects on the fetus. A focused abdominal sonographic examination for trauma (FAST) is often used in general trauma victims to identify intra-peritoneal fluid. With minimal training, emergency physicians can assess a patient with great accuracy. Its use in pregnancy yields similar results with the added benefit of evaluation of the uterus and fetus. This bedside ultrasound can be used to assess fetal movement, size, gestational age, heart rate, placental location, and amniotic fluid volume. Unfortunately the ability of ultrasound to detect placental abruption, uterine rupture or bowel perforation is poor.[2]

Radiography is often required for the diagnosis and treatment of injuries sustained in trauma. Although the developing fetus is more susceptible to the effects of radiation, the risks are minimal, and directly effected by gestational age, and level of exposure. Fetal loss is seen with radiation exposure during the first 2 weeks of pregnancy. The greatest potential for malformation secondary to radiation occurs during organogenesis; weeks 2 to 8 of development.5, 6 Beyond 20 weeks it is believed that radiation exposure has little consequence on the developing fetus. When exposure is kept to a minimum, the related risks are trivial. A cumulative radiation dose less than 10 rads during development has not shown an increase in fetal loss, malformation, or mental retardation.[5, 6] However, it has shown to be associated with a small increase in the number of future childhood neoplasms. A radiation dose of 15 rads or more has shown a slightly higher risk of all of these complications. Plain films are estimated to deliver less than 1 rad per film to the fetus.[5, 6] Shielding of the uterus when possible can minimize this exposure. Computed tomography (CT) represents a higher exposure risk, but again appropriate shielding can reduce this risk significantly. CT of the head and chest can easily be performed with a fetal exposure of less than 1 rad. Abdominal and pelvic CT scans should be done judiciously. If possible they should be avoided in early pregnancy as they can deliver anywhere from 3 to 9 rads depending on variation in individual scanners, and technique used.[5, 6]

With the increased availability of CT and MRI, diagnostic peritoneal lavage (DPL) has fallen out of favor with many emergency medicine physicians. It is invasive has the potential for complications. Nevertheless, when the FAST exam is equivocal, DPL has been shown to be a safe and effective alternative to CT scan in the diagnosis of intra-peritoneal hemorrhage in the pregnant patient. This is most important during the first trimester when radiation exposure presents the most deleterious effects to the fetus. DPL can be used to determine if a trauma patient is in need of an emergent laparotomy. It is suggested, that an open supra-umbilical approach be used to avoid potential damage to the uterus and fetus.

Routine laboratory tests are an important part of the management of any trauma patient. In



Decision making algorithm for trauma in pregnancy - adapted from algorithm Marx: Rosen's Emergency Medicine: Concepts and Clinical Practice, 6th ed. Ch 35 Trauma in pregnancy

pregnancy, some laboratory values change, and this should be considered in the interpretation of results (see table for normal values in pregnancy). There are also many indications for additional tests in the

Laboratory values in pregnancy compared to controls

	Pregnancy values	Normal values
Hematocrit (%)	32-42	35-47
White blood cell count (/¼)	5,000-12,000	4,500-11,000
ESR (mm/hr)	78	<20
Arterial pH	7.40-7.45	7.35-7.44
Bicarbonate (mEq/L)	17-22	21-28
PCO_2 (mmHg)	25-30	35-45
Fibrinogen (mg/dL)	> 400	200-400
Prothrombin Time (sec)	11.2	13.5

Table from information obtained in ch. 35 Trauma in Pregnancy - Marx: Rosen's Emergency Medicine: Concepts and Clinical Practice, 6th ed.

pregnant trauma patient. As in the typical trauma patient, a complete blood count (CBC) should be obtained. A fibrinogen level should be added for the pregnant patient. Special attention should be given to the platelet value, and the fibrinogen level. If these values are low, the possibility of DIC should be considered and further evaluation is needed.

The CBC will also often indicate an elevated white blood cell count. This coupled with an elevated erythrocyte sedimentation rate (ESR) would typically suggest an infectious process in the non-pregnant patient, but are entirely normal in pregnancy.

An arterial blood gas can provide valuable information about a patient's respiratory status. A PCO_2 of 40 is within the normal range for the non-pregnant patient, but is concerning in many pregnant trauma patients. This value is indicative of poor ventilation and possible respiratory acidosis which can lead to fetal distress.[6]

Every patient with the potential of fetomaternal hemorrhage should have blood type with Rh status determined immediately. When fetomaternal hemorrhage is suspected in an unsensitized Rh negative patient, the Kleihauer-Betke (KB) or the Apt tests may help in the diagnosis and management. The KB test provides a quantitative estimate of fetal blood cells present in the maternal circulation. This is used for appropriate dosing of Rh-immune globulin. Acid elution of the sample causes the loss of hemoglobin in the maternal red blood cells causing them to appear pale (ghost cells). Fetal red blood cells are stained in the process and have a bright pink appearance on microscopic examination. Fetal cells are counted, and an estimate of fetal to maternal blood transfusion can be made. The standard dosing of Rh-immune globulin is an initial 300¼g followed by an additional 300¼g for every 30mL of estimated fetal blood transfused. This test should be repeated in 24-48 hours to evaluate for continued fetomaternal hemorrhage.[1, 2] The KB test is very advantageous when significant fetomaternal hemorrhage occurs, but the sensitivity of the test drops substantially when there is less than 5¼L of fetal blood. The presence of as little as 0.1¼L of fetal blood can lead to isoimmunization of the mother.[1, 2] The Apt test is a qualitative test used for the identification of any amount of fetal blood in the maternal circulation. When the Apt test is positive in an Rh negative mother, a single 300¼g dose of Rh-immune globulin should be administered to prevent sensitization.[1]

Fetal Monitoring

After the initial assessment of the fetus and determination of gestational age, any fetus estimated to be greater than 20 weeks gestation (potentially viable) should be observed with fetal tocodynamometry. Fetal monitoring should be initiated immediately even if treatment of the mother is not complete. Early signs of fetal distress include tachycardia, loss of beat-to-beat or long term variability or late decelerations. The fetus is more vulnerable to adverse conditions, and fetal distress could be an indication of impending maternal destabilization.

If conditions of fetal distress persist, and the fetus is greater than 23 weeks, emergent cesarean delivery may be required. Often delivery of the fetus will result in maternal stabilization due to the resolution of cardiovascular compromise caused by the gravid uterus. A minimum of 4 hours of monitoring is needed to determine potential risk to the fetus. If the patient is experiencing fewer than 3 contractions per hour during the initial evaluation, the prognosis is excellent. Four or more contractions

per hour require extension of the monitoring period to at least 24 hours to ensure the fetus does not destabilize. Greater than 7 contractions per hour on tocodynamometry (even in the absence of other clinical findings) is suggestive of placental abruption and warrants continued monitoring, and further investigation.[5]

Perimortem Cesarean Delivery

In the event that all attempts at maternal resuscitation have failed a decision to perform a cesarean section must be made. Gestational age greater than 23 weeks is the recommended cut-off for immediate delivery. A fetus younger than 23 weeks has an extremely poor prognosis. These instances of perimortem delivery are rare, and chances of fetal survival are poor. The earlier the fetus is delivered following maternal arrest has a direct impact on fetal survival. Currently it is suggested that cesarean section be performed 4 minutes after initial maternal arrest. This is based on the evidence that a fetus delivered within 5 minutes from initiation of CPR had the best chance of survival. Those deliveries occurring more than 5 minutes after cardiopulmonary arrest were unlikely to result in a normal viable infant.[1, 2] Resuscitative efforts should continue during preparation for, and throughout delivery of the fetus. In some circumstances delivery of the fetus can result in maternal recovery due to release of vena caval compression, and improved cardiac return.

Disposition

The disposition of the pregnant trauma patient depends on the condition of the mother and the fetus. In major trauma the mother should be admitted under the care of a trauma surgeon. The trauma service can then consult with obstetrics for proper care of the fetus. If the mother has no significant injury but the mechanism of injury suggests the potential for serious injury the trauma service should also be the primary team. The absence of maternal injury but presence of fetal distress, or potential fetal distress, the mother should be admitted to the obstetric service. An obstetrician with the ability to perform an emergent cesarean section should be readily available. Any patient admitted with a viable fetus should have continuous fetal monitoring. Patients with minor injuries and no signs of fetal distress can typically be discharged. If greater than 24 weeks gestation, discharge should be delayed until the fetus has been monitored for 4 hours without signs of distress. When a patient is discharged, careful instructions should be given to follow-up with an obstetrician.

Summary

Trauma has the potential to complicate any pregnancy at any stage. Treatment can be complex. The pregnant trauma patient should be treated as any other patient with concentration on the ABC's of resuscitation. There does not appear to be a difference in morbidity and mortality between pregnant and non-pregnant patients. However, fetal outcome can be greatly improved by appropriate emergency management of the mother. Distress observed during monitoring of a viable fetus can give early indications of maternal destabilization. Additionally, knowledge of the signs of fetal distress, and immediate delivery when necessary has significantly improved fetal prognosis. A few important points to remember when managing a pregnant trauma patient are described below. Increased fetal survival is directly related to maternal survival. The maternal anatomy and physiology are affected by pregnancy. Changes in the cardiovascular system, respiratory system, and digestive system can complicate evaluation and treatment of the patient. The gravid uterus can cause compression of vessels and poor venous return, as such; proper positioning of the mother can have dramatic affects on resuscitation. No necessary test should ever be withheld because of potential adverse effects on the fetus, but when possible an alternate test should be considered.

Trauma can complicate any pregnancy, and in the most common non-obstetric cause of morbidity and mortality in pregnancy. Treatment can be complex

due to the changes that occur to the mother, and the presence of a second, unseen life that is also at risk. Physicians have to be aware of the management protocols and fundamental differences as regards resuscitation in these circumstances. Pregnancy does not increase the risk to the mother when trauma occurs, but fetal morbidity and mortality can be greatly increased. Stabilization of the mother should always be the primary goal, and is the best predictor of fetal survival. Knowledge of the maternal-fetal unit as a whole can be beneficial to the clinician in the evaluation and treatment of injuries incurred during trauma. When the changes to the cardiovascular, respiratory and gastrointestinal systems are kept in mind, interpretation of the signs and symptoms of impending deterioration can be better accomplished. Simple training can allow the physician to evaluate the patient and the potential viability of the fetus with ultrasound at the bedside. Nonetheless, no test necessary for the diagnosis and treatment of the mother should ever be withheld.

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