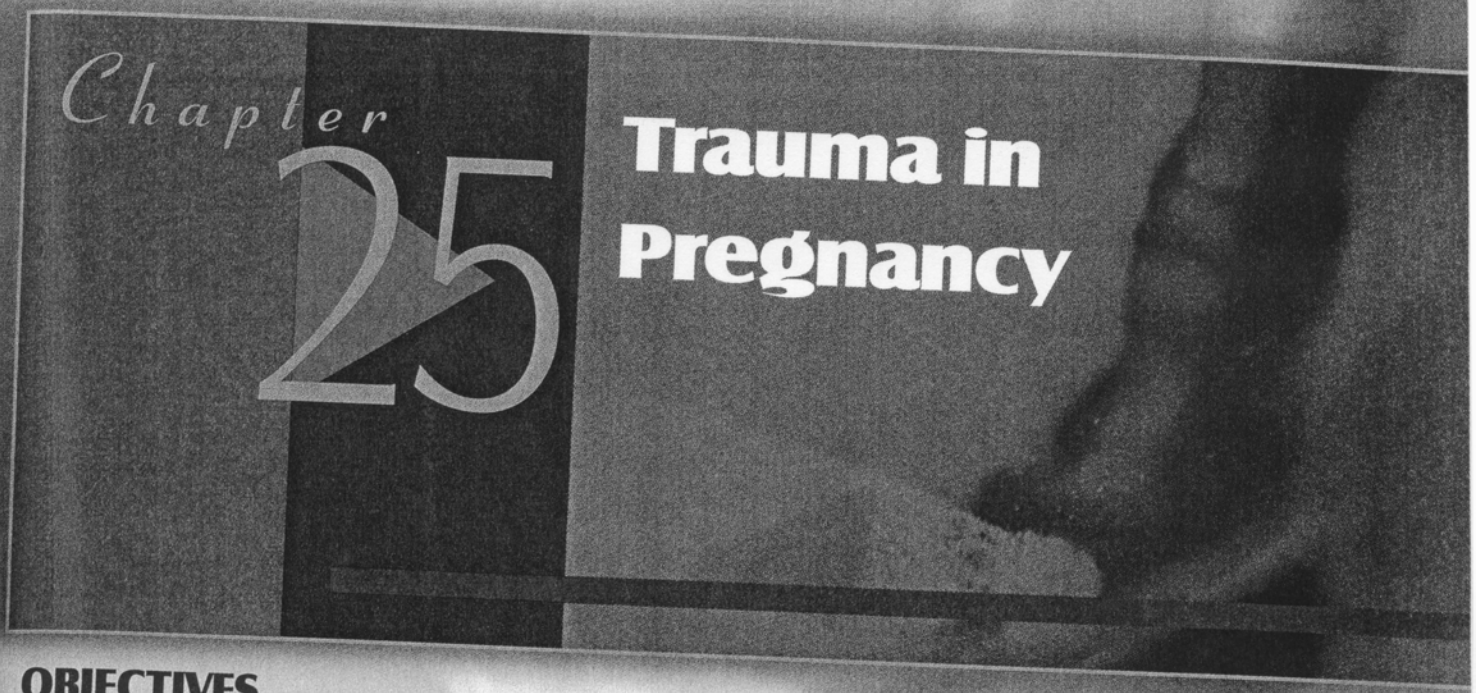
Chapter 25

Trauma in Pregnancy



OBJECTIVES

Upon completion of this chapter, the reader should be able to:

- Contrast the past epidemiology of pregnancy-related mortality and morbidity with the current and emerging etiologies of maternal deaths and differences in injury patterns and explain how these changes have implications for the paramedic, especially in an urban setting.
- Describe how the anatomy and physiology of the pregnant patient differ from those of the nonpregnant patient.
- Describe how the differences in the anatomy and physiology of the pregnant patient are relevant to the trauma assessment and explain the potential pitfalls of assessing the pregnant trauma patient.
- Discuss how the differences in the anatomy and physiology of the pregnant patient affect the out-of-hospital treatment of the pregnant trauma patient.
- Discuss how the differences in the out-of-hospital treatment of the pregnant trauma patient may affect basic trauma support (such as the differences in techniques of positioning), the method of notification of the receiving hospital, and how advanced life support may differ for the pregnant patient in traumatic arrest.
- Identify those factors that most threaten fetal survival.
- Describe the pathophysiology of the types of traumatic injury that are unique to the pregnant patient, including the pathophysiology of seemingly minor trauma.
- Discuss why the differences in the pathophysiology of minor trauma in the pregnant patient require in-hospital assessment and treatment to prevent adverse maternal and fetal outcomes.
- Discuss some of the differences in the out-of-hospital assessment of the pregnant patient, comparing these with in-hospital assessment of the pregnant trauma patient.
- Discuss some of the differences in the out-of-hospital treatment of the pregnant patient, comparing these with the nonpregnant trauma patient.
- Discuss some of the ways in which paramedic assessment and treatment of the pregnant trauma patient affects the in-hospital treatment.

KEY TERMS

Abruptio placentae
Fetomaternal hemorrhage

Paramedics frequently encounter trauma in female patients of child-bearing age. On occasion, in the approach to the trauma patient, in the intensity of the moment, it may be difficult to remember the possibility of pregnancy and pregnancy-related modifications of management. As is often true in medicine, the problem that is not exposed or considered is often the most severe. Just as with any injured patient, this "unexposed part" of the trauma patient may hide critical information needed for adequate stabilization.

Failure to recognize a gravid uterus may seem to be a gross oversight; but there are other, more subtle, pregnancy-related changes that may remain hidden unless considered. These potentially serious "hidden injuries" are the less obvious alterations of anatomy and physiology during pregnancy, the placenta, and the physiology of the fetus. The paramedic is expected to "expose" the critical, hidden information essential to the management of a variety of situations.

Certain situations raise practical questions regarding patient management. For example, which injuries are more common or more severe during pregnancy? In multisystem major trauma, how is fetal survival most affected? Are certain medications, which are usually safe in pregnancy, contraindicated in the pregnant trauma patient? Can the fetus be at risk if the mother is stable after her injury? Is it ever appropriate for the paramedic to estimate fetal age? In a motor vehicle crash (MVC), could a seat belt actually do more harm than good for the fetus? How are circulatory and respiratory failure treated in a way to minimize fetal injury? What is the paramedic's approach to traumatic arrest in the pregnant patient?

Fortunately, the approach to the pregnant trauma patient is fundamentally the same as for all trauma patients: treat hypoxia, treat shock. The mainstay of treatment for all trauma patients is the orderly and rigorous attention to the ABCs. Stabilization of the maternal ABCs is the most effective intervention a paramedic can make in the pregnant trauma patient—for the protection of both mother and fetus.[1,2] After initial stabilizing interventions, consideration is given to the hidden or subtle ways in which pregnancy modifies assessment and treatment of trauma.

EPIDEMIOLOGY AND ETIOLOGY OF INJURY

During the last half of the twentieth century, there has been a substantial decline in the maternal mortality rate in the United States. The obstetric-related death rate has decreased dramatically; unfortunately, the trauma-related maternal death rate has not. The leading causes of maternal deaths have shifted significantly in recent years in much the same way as in the pediatric population; unintentional and intentional injuries have replaced other formerly common causes of death (Figure 25-1).

In years past, the leading causes of maternal death were infection, hemorrhage, and toxemia. In the United States, these three obstetric-related causes accounted for three-fourths of all maternal deaths. In 1942, a pregnant woman had a better chance of surviving the leading causes of maternal death if she resided in an urban locale (New York City).[1] But by 1992, in a similar urban setting (Chicago), a dramatic shift had occurred; trauma had become the leading cause of death during pregnancy. Today, a pregnant woman living in an urban setting is twice as likely to die from trauma than from all direct obstetric-related causes of death combined (Table 25-1).[1,3,4]

Fortunately, most trauma in pregnancy is minor trauma.[2] Major life-threatening trauma accounts for only a small percentage of all maternal injuries. The two most common causes of trauma (major and minor) during pregnancy are intimate partner violence and MVCs.[3,5,6] Major life-threatening blunt and penetrating trauma in pregnancy results from MVCs, assaults, falls, and burns. The prevalence of out-of-hospital maternal trauma has not been well described and needs further study. However, based on studies of pregnant patients in emergency department and primary care settings, it is predicted that the frequency and patterns of injuries in pregnancy encountered by an out-of-hospital paramedic will resemble those of the nonpregnant, age-matched population.[4,5,6]

Trauma is estimated to complicate from 7% to 23% of all pregnancies.[2,5] Prevalence studies vary widely regarding the frequency and patterns of trauma

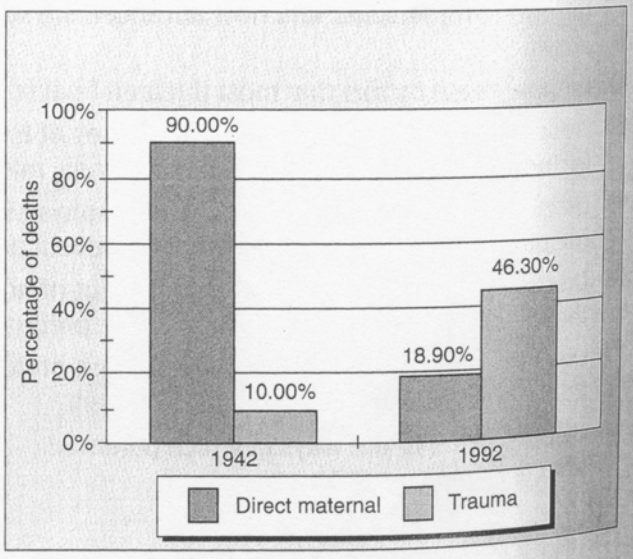


FIGURE 25-1 Changes in the leading causes of maternal death from 1942 to 1992.[1,3,4]

Table 25-1
Causes of Death During Pregnancy in the Urban United States: Changes in the Last Fifty Years

New York City (1942)[4]		Chicago, Cook County (1992)[3]	
Leading Causes of Direct Maternal Death	**Percentage of Total**	**Leading Causes of Direct Maternal Death**	**Percentage of Total**
Infection	22.80	Homicide	26.40
Hemorrhage	16.40	MVC	9.50
Toxemia	5.10	Burns	3.10
Abruptio placentae	3.80	Falls	2.10

during pregnancy. For example, some studies have shown MVCs to be, by far, the most common mechanism of injury during pregnancy, while other studies have found that fatal and minor maternal trauma is most often the result of intimate partner violence.[3,4,6] Some disparity is due to differences in research design, with some studies describing the total numbers of injuries and some reporting fatal injuries and mortality rates. There may also be inconsistencies in the method of reporting occurrences of trauma in pregnancy. These discrepancies may be due to a lack of consistency in defining, recognizing, and reporting all forms of maternal trauma.[4] Recent studies show a high rate of intimate partner violence occurring in female emergency department patients.[7] Some investigators have pointed out that domestic violence has become a public health problem of epidemic proportions.[8] Yet it has been well documented that emergency care providers often fail to report, or worse fail to even recognize, domestic violence.[5,9–11] It is reasonable to assume that the paramedic will encounter more maternal trauma due to intimate partner violence than has typically been predicted in the past.

Trauma during pregnancy may endanger both mother and fetus. Pregnant women who experience life-threatening injuries have the same survival rate as nonpregnant women.[2] Maternal survival depends upon those factors affecting severity of injury: critical force, presence of shock, and presence of head, chest, abdomen, or pelvic trauma. As with nonpregnant patients, pregnant trauma victims die primarily from hemorrhagic shock and head injury.[12,13] In this group of pregnant patients with major trauma, fetal survival correlates most precisely with the severity of maternal injury.[2,12] Adverse pregnancy outcome in severely injured pregnant patients approaches 100% in maternal death, 80% in maternal shock, and 50% in other maternal serious injuries.[14] An adverse pregnancy outcome may also occur in up to 25% of *minor* trauma.[15–17] Fetal demise or **abruptio placentae** (separation of the placenta from the uterine wall) may result from seemingly trivial maternal injury. In maternal trauma (major and minor), except for the death of the mother, the highest mortality for the fetus results from abruptio placentae.[6] Because nearly 90% of all trauma during pregnancy is minor, the greatest percentage of pregnancy losses are due to minor injuries.[14] This distinction between severity and frequency is illustrated in Table 25-2.

In addition to the common causes of trauma during pregnancy, MVCs and intimate partner violence, another very common cause of blunt maternal injury during pregnancy is a simple fall.[2] As with the minor trauma of MVCs and partner violence, a simple fall

Table 25-2
Maternal and Fetal Survival in Trauma During Pregnancy[12,18]

Type of Trauma	Relative Frequency	Maternal Mortality (%)	Fetal Mortality If Maternal Death Occurs (%)
Life threatening	Rare (<10%)	3.90	100.00
Shock	Rare (<10%)	2.20	≥75.00
Head trauma	Rare (<10%)	1.70	≤50.00
Minor trauma	Common (>90%)	≤4.00	≤02.50
"Trivial" trauma	Common (>90%)	0.00	≤05.00

may be complicated by abruptio placentae in 1% to 5% of patients.[2,12,13] Therefore, despite the fact that the majority of pregnant trauma patients have only minor injuries, it is critical that the paramedic be aware that even minor maternal trauma can have catastrophic results for the fetus.[13] An understanding of the epidemiology of injury as well as the normal anatomical and physiological changes during pregnancy, including fetal and placental responses to trauma, guide management and prevent the pitfalls of treatment of the pregnant trauma patient.

ANATOMIC AND PHYSIOLOGICAL CHANGES DURING PREGNANCY

During pregnancy almost every organ system of the body undergoes changes. The normal maternal and fetal physiological changes greatly impact the management and assessment of the pregnant trauma patient. For example, how accurately do vital signs reflect maternal and fetal well-being? How do maternal respiratory physiological changes, intra-abdominal anatomical, and uterine changes affect fetal and maternal oxygenation? It is important to have a basic understanding of the normal cardiovascular, respiratory, intra-abdominal, pelvic, and fetal changes during pregnancy and to know how these alterations are relevant to the management of maternal and fetal trauma.

CARDIOVASCULAR CHANGES

During pregnancy there is a tremendous increase in cardiac output (CO). Maternal blood volume expands by 50%, and the heart rate increases by 15–20 beats per minute (bpm). The resulting CO is 1,000–1,500 mL/min greater during pregnancy.[2] This extra reserve of CO makes detection of internal bleeding very difficult. As much as 35% of maternal blood volume may be lost before the usual signs of shock are exhibited.[19]

The large increase in maternal blood volume is not matched by a similar increase in total hemoglobin. Therefore, in order to maintain the same maternal and fetal oxygenation, this high output state must be maintained.

It is difficult to define the normal nonpreeclamptic pregnant blood pressure (BP); BPs have some normal variation prior to pregnancy. During the first 6 months of pregnancy, the BP will be lower than the prepregnant pressures. There is a drop in the systolic pressure of up to 4 mm Hg and a decrease in the diastolic pressure of up to 15 mm Hg—associated with a lowering of peripheral vascular resistance. During the last 3 months of pregnancy, the BP returns to prepregnant levels. A BP reading, by itself, is not a precise reflection of adequate perfusion and oxygenation, especially in the pregnant patient.

During the last half of pregnancy, the position of the enlarging uterus may greatly influence CO and BP. A gravid uterus' compression of the inferior vena cava reduces venous return and preload. After the eighth month, there may be total obstruction of caval venous return. This may reduce CO by as much as 28%, and systolic BP may fall 30% when the patient is supine.[20,21] Conversely, by removing the gravid uterus from the inferior vena cava (by displacing the uterus to the left or by placing the patient on her left side), CO may increase up to 25%.[22]

During early hypovolemia in the pregnant patient, there may be no significant increase in heart rate, drop in BP, or skin changes typical of shock. However, in maternal blood loss, uterine vasoconstriction occurs early, even before other signs and symptoms of blood loss are recognized.[19] The uterus has no ability to increase uterine blood flow by self-regulation. As a result, it is possible for life-threatening compromise of fetal oxygenation and perfusion to occur without evidence of maternal shock.[19] The fetal response to inadequate uterine blood flow may be bradycardia or tachycardia. The first indication of early maternal shock, therefore, may be an abnormal fetal heart rate.

RESPIRATORY CHANGES

During pregnancy there is a 20% reduction in maternal functional lung capacity and residual volume, resulting in a marked lowering of the oxygen reserve. The causes of this reduced reserve are the elevation of the diaphragm and a 15% increase in oxygen expenditure by the placenta, the fetus, and the maternal organs.[19] The reduction in oxygen reserve during pregnancy is partially compensated for by an increase in the respiratory rate and tidal volume. Therefore, the consequent normal respiratory state during pregnancy may also be thought of as "high output." One consequence of this increase in minute ventilation is a decrease in the $PaCO_2$. During the last half of pregnancy, the normal $PaCO_2$ is 30 mm Hg.[20] The normal increased minute ventilation and decreased $PaCO_2$ are compensated for by an increased excretion of bicarbonate by the kidneys. A $PaCO_2$ of 40 mm Hg, considered to be normal in the nonpregnant patient, reflects improper ventilation of the pregnant patient.[19] Inadequate ventilation may result in maternal acidosis, fetal acidosis, and fetal hypoxia.

GASTROINTESTINAL AND INTRA-ABDOMINAL CHANGES

During the course of pregnancy, the uterus grows from 7 cm (2.76 inches) to 36 cm (14.2 inches). In the first 3

months of pregnancy, the uterus is relatively protected by the pelvis and there is minimal displacement of the other intra-abdominal contents by the uterus. After the third month, the uterus extends out of the pelvis and displaces the intra-abdominal organs toward the diaphragm. The rate of growth of the uterus is roughly 1 cm per week of gestation, measured from the symphysis pubis. As this occurs, the uterus and bladder become abdominal organs and are more susceptible to injury. In blunt abdominal trauma, after the third month, the uterus may have a protective, "airbaglike" effect on the other intra-abdominal organs.[2,23]

The growing uterus causes a gradual expansion of the peritoneum and abdominal musculature. As a result, there may be significantly altered or even absent pain patterns, and the physical examination becomes unreliable. Major intra-abdominal organ injury may occur without the usual signs of peritoneal irritation: tenderness, guarding, and rigidity.[2,19]

During pregnancy the gastric muscle tone is decreased and there is delayed gastric emptying. This places the pregnant trauma patient at risk for aspiration, particularly the patient with an altered level of consciousness.

FETAL RESPIRATION AND CIRCULATION

Within 2 weeks after fertilization the embryo attaches to the uterine wall. Villi, or fingerlike projections, form an attachment between the uterine wall and the placenta. This uteroplacental connection is a "Velcro-like" vascular linkage. Through this vascular connection all gas exchange between fetus and mother occurs. Fetal survival depends upon maintaining both uterine blood flow and the anatomical integrity of the uteroplacental connection.

Two characteristics of this uteroplacental unit put the fetus at risk in trauma. First, there is no uteroplacental autoregulation of its circulation. That is, there is no fetal or placental method of increasing blood flow. Perfusion is dependent upon maternal systolic blood pressure. Second, the uteroplacental connection is at risk for separation because the placenta is relatively fixed and inelastic in relation to an elastic and compressible uterus.[2,19] Forces of direct trauma or deceleration cause differing placental and uterine rates and distances of movement. This results in a shearing disruption of the uteroplacental connection[19,24] (Table 25-3).

PATHOPHYSIOLOGY

Trauma is the leading cause of death in women of child-bearing age. The mechanisms of fatal injury are nearly the same for both the pregnant and the nonpregnant populations. Maternal and fetal trauma may be blunt or penetrating, with hemorrhagic shock and head injury being the chief causes of maternal death.[2] Although certain injuries, such as uterine rupture, splenic rupture, and retroperitoneal hemorrhage occur more often during pregnancy, serious life-threatening trauma appears to have the same mortality rate in pregnant and nonpregnant women.[2]

Blunt and penetrating trauma may also result in premature rupture of membranes, uterine injury, premature labor, direct fetal injury, and fetomaternal hemorrhage. The two most common causes of fetal death as a result of life-threatening, major trauma are maternal death and abruptio placentae.[12,13] Abruptio placentae, which occurs in up to 50% of major trauma, is a more common cause of fetal death than direct fetal injury, maternal burns, penetrating abdominal injuries, and fetomaternal hemorrhage combined. Because of the frequency of minor trauma, fetal deaths due to minor trauma occur more often than those resulting from life-threatening trauma.[2,12] Minor trauma may result from falls, intimate partner violence, and seat belt injuries.

The first priority in managing the pathophysiology of maternal and fetal trauma is the stabilization of the pregnant patient. Regardless of how the different anatomic and physiological changes of pregnancy affect assessment and treatment, this patient needs aggressive ventilatory and circulatory interventions. Recognizing and treating the pathophysiology of maternal hypoventilation and shock, including vena caval occlusion, minimize fetal injury.

MAJOR TRAUMA

MATERNAL HEMORRHAGIC SHOCK

Major trauma resulting in life-threatening injury is rare in pregnancy. When maternal death does occur, the most frequent pathophysiology is hemorrhagic shock. In multisystem trauma, even with the presence of shock, maternal survival rate is very high (greater than 90%).[2,12,25] By contrast, fetal survival is low, with an adverse outcome in about 50% of major trauma.[2] If traumatic maternal hemorrhagic shock occurs, the fetal mortality rate is 80%.[2,25] In traumatic hypovolemia, the best chance of survival for the fetus is vigorous volume resuscitation of the mother, followed by definitive surgical intervention as indicated.

PLACENTAL ABRUPTION

Abruptio placentae is the separation of the placenta from its uterine attachment. Nontraumatic spontaneous abruptio placentae is extremely rare. In trauma,

Table 25-3
Anatomic and Physiological Changes During Pregnancy and Implications for Trauma Management

Anatomic or Physiological Parameter or Organ System	Nonpregnant Patient	Pregnant Patient	Pregnant Patient		
			Anatomic and Physiological Dynamics	Anatomic and Physiological Observations	Application in Management
Heart rate (HR)	80	95	High output	HR increases 5–10 beats	Increased HR cannot be used as an early reliable sign of hypovolemic shock
Blood pressure (BP)	110/70	100/50	Low peripheral vascular resistance	BP decreases 10%–15%	Evaluating hypovolemic shock is more difficult, particularly midtrimester
Respiratory rate (RR)	12–18	18–25	High O_2 demand, low O_2 reserve	RR increases 4–8 breaths/min, causing $PaCO_2$ to drop	"Normal" RR of 12 and $PaCO_2$ of 40 mm Hg may cause acidemia and hypoxia
Arterial blood gases (ABGs)	pH: 7.40; $PaCO_2$: 40	pH: 7.43; $PaCO_2$: 32	Low $PaCO_2$	Pregnant $PaCO_2$ should be 30–32 mm Hg	$PaCO_2$ of 40 mm Hg may mean acidemia
Circulation					
Vena cava	Normal venous return		Low venous return	Uterine compression of inferior vena cava decreases venous return	Placing patient in left lateral recumbent position or manual uterine displacement is necessary to prevent worsening shock
Blood volume	4.2 liters	6.0 liters	High output	Blood volume increases by 50%	Blood loss may be difficult to estimate
Red cell mass	37%	32%	High output	Plasma volume increases more than hemoglobin, causing "anemia of pregnancy"	"Decreased hemoglobin efficiency" is offset by a compensatory hyperventilation
Gastric	Normal gastric output		Low gastric output	Gastric motility decreases, causing delayed gastric emptying time	To minimize risk of aspiration, consider nasogastric tube and/or endotracheal airway
Abdomen: Fetal				Abdominal contents displaced from lower abdomen in later pregnancy	Penetrating trauma to the abdomen is likely to cause fetal and placental injury

unfortunately, the frequency of abruptio placentae is particularly worrisome. Complete abruptio placentae is universally fatal for the fetus unless an immediate caesarian section (C-section) is performed. Potentially lethal maternal risks associated with traumatic abruptio placentae are hemorrhage and disseminated intravascular coagulation (DIC).

Abruptio placentae is estimated to occur in up to 6% of minor trauma and in up to 50% of major maternal injury.[1,2,6,12] Fetal/neonatal death associated with maternal trauma is more commonly the result of abruptio placentae than any other injury in pregnancy.[23] Only maternal death has as frequent an association with fetal death in trauma.[2]

In falls and blunt abdominal trauma, there may be deceleration or direct uterine deformation. This impacts both the uterus and the placenta. The uterus is made up of muscle fibers; the placenta has a consistency that is relatively stiff. When the movement of the elastic uterus becomes greater than that of the inflexible placenta, it creates a shearing separation of the placenta from the uterus. This injury may occur with major or minor maternal trauma. Separation of the placenta results in fetal hypoperfusion leading to hypoxia, acidosis, and eventually death. Maternal complications include bleeding from the uteroplacental separation site and, rarely, release of placental or intrauterine material into maternal circulation. This injected material (tissue factor) may be thromboplastic and cause a rapid consumption of maternal clotting factors. This maternal bleeding disorder, known as DIC, has an associated mortality of 85%. Fortunately, this complication is rare. If, however, a partial abruptio placentae goes unrecognized, then the incidence of this bleeding disorder is higher.[1]

Recognition of possible abruptio placentae begins with a clinical suspicion based on the patient presentation. The single most important out-of-hospital finding is a mechanism of injury comparable with abruptio placentae; no other information is as valuable. The typical abruptio placentae signs and symptoms are vaginal bleeding, uterine tenderness, uterine rigidity, and fetal distress (tachycardia and bradycardia). These findings may be difficult to assess or even absent.

The typical signs and symptoms of abruptio placentae are also relatively inaccurate in the hospital setting. The most accurate assessment for abruptio placentae is in-hospital electronic monitoring for uterine contractions.[1,6,23,26] This monitoring is highly sensitive in detecting abruptio placenta.[1,6] Abruptio placentae usually occurs early after maternal trauma; therefore, electronic monitoring should begin as soon as the mother's condition is stabilized.[1] There are two guidelines for the paramedic. First, all pregnant patients (more than 20 weeks) with a mechanism of injury consistent with possible abruptio placentae should be transferred for electronic monitoring.[23] Second, in pregnant trauma patients, any medications that alter uterine contractions are contraindicated. Magnesium and terbutaline stop uterine contractions and therefore interfere with the ability of electronic monitoring to rule out abruptio placentae.[1,19]

INTERNET ACTIVITIES

Visit the e-medicine Web site at http://www.emedicine.com. Click on the Emergency Medicine on-line book and select Obstetrics and Gynecology. Then click on Abruptio Placentae. Review the chapter on the management of abruptio placentae.

BLUNT ABDOMINAL INJURIES

Blunt abdominal trauma in pregnancy may result in several serious intra-abdominal injuries: peritoneal bleeding resulting from laceration of the spleen or liver, retroperitoneal bleeding, abruptio placentae, uterine injury, and rarely, rupture of the diaphragm. Conversely, because of the hydraulic effect of the uterus, certain organs are less likely to be injured by blunt abdominal trauma.[1,2,23]

The likelihood of splenic injury and retroperitoneal hemorrhage is greater in blunt abdominal trauma to the pregnant patient. Both of these injuries may lack the typical abdominal signs and symptoms of serious injury. However, the mortality rate for these life-threatening abdominal injuries appears to be the same in pregnant and nonpregnant women.[2] This may be the result of early recognition and aggressive treatment of the hemorrhagic shock associated with serious abdominal injuries.

Up to 40% of major maternal trauma with life-threatening abdominal injuries will have abruptio placentae.[14] Minor blunt abdominal trauma may occur in restrained/lap belt injury, unrestrained MVC injury, falls onto the abdomen, and intimate partner violence. As discussed earlier, up to 5% of minor trauma is complicated by placental abruption.[14] With respect to the placenta and the fetus, "minor" abdominal trauma is *never* minor.

PELVIC FRACTURE

In MVCs, pelvic fracture is especially dangerous in the pregnant patient. In pregnant women involved in fatal MVCs, pelvic fracture with hemorrhagic shock is the cause of death in nearly 20%.[25]

A marked increase in pelvic vascularity predisposes the pregnant trauma victim to both intra-abdominal and retroperitoneal life-threatening bleeding. There is an increased risk of hemorrhagic shock that is associated with blunt abdominal trauma and with pelvic fracture.[2] Retroperitoneal hemorrhage is commonly associated with pelvic fracture. The retroperitoneal space has the capacity for a volume of greater than 4 liters, accounting for the frequent correlation of hypovolemic shock with pelvic fracture.[14,23]

Pelvic fracture may cause uterine injury or direct fetal injury, and fracture of the maternal pelvis may be associated with many of the same injuries found in the nonpregnant female: laceration of the urethra, vagina, bladder, or ureter; fat embolism; and lumbar spine fracture.[2]

PENETRATING ABDOMINAL INJURY

Penetrating abdominal trauma during pregnancy has a surprisingly low incidence of nonuterine injury and a maternal mortality of less than 5%.[14] Nonuterine injuries occur in only 20% of penetrating maternal wounds (compared to an organ injury rate of 75% in the nonpregnant patient).[14,27] This may be explained by the fact that the uterus and fetus act as a defense for nonuterine maternal organs and/or by the fact that the trauma is frequently directed at the fetus. Not surprisingly the fetal injury rate is extremely high (93%) and the fetal mortality rate is 60%.[14,19] The most common wounds are knife and gunshot wounds, often associated with intimate partner violence, attempts to cause abortion, and aggravated assault.[1]

TRAUMATIC ARREST IN PREGNANCY

Traumatic arrest is always a difficult challenge for the paramedic. The clinical and ethical decisions and the pronouncement of death in the field are guided by accepted protocol. For the pregnant patient, the nature of the cardiopulmonary arrest and the decisions regarding cardiopulmonary resuscitation differ significantly from those of the nonpregnant patient. There are unique, out-of-hospital considerations for the second half of pregnancy.

Maternal traumatic arrest occurs when maternal vital signs have disappeared (and when an injury incompatible with life has occurred). Fetal vital signs may or may not be present immediately after maternal arrest. The best chance of survival for a fetus is aggressive resuscitation of the mother. If, however, the mother is in cardiopulmonary arrest, the paramedic should immediately determine if this patient is a candidate for emergency C-section upon hospital arrival. Fetal viability is not the paramedic's sole concern; maternal resuscitation may be enhanced by emergency caesarian delivery.[1] Maternal survival has occurred after "postmortem" C-section.[28] A number of factors may favor maternal resuscitation, with removal of uterine vena cava compression probably being the most significant.[19] A perimortem C-section should be considered for any traumatic arrest during pregnancy. If after 1–4 minutes of advanced life support there is no return of maternal pulse and blood pressure, then emergency caesarian criteria should be considered. The two criteria favoring fetal (and perhaps maternal) survival are (1) time since the loss of maternal circulation and (2) fetal age. A shorter time from maternal arrest to delivery yields a greater chance for fetal survival and an improved chance of a neurologically intact newborn.[19] Fetal survival after 25 minutes of maternal arrest has not been reported.[29] The paramedic estimates fetal age by assessing the fundal height of the uterus (see Assessment). A fetal age of 25 weeks or greater is the gestational age considered viable.[1,19]

In the traumatic maternal arrest, as soon as possible, the paramedic should communicate with on-line medical direction and the receiving hospital. Immediate communication is essential. If maternal traumatic arrest is not specifically addressed in protocols and standing orders, in these instances the paramedic cannot legally or ethically terminate cardiopulmonary resuscitation (CPR) in the pregnant patient. In the event that an emergency caesarian delivery is to be performed, early notification of the receiving hospital facilitates preparations for determination of fetal viability, confirmation of fetal age, and surgery in the emergency department. The fetus has the highest chance of survival if an emergency C-section is performed within 5 minutes after loss of maternal vital signs.[2,23] But, if fetal vital signs are present in the emergency department, the procedure is indicated regardless of the duration of maternal arrest.[2,30]

MINOR MATERNAL TRAUMA

As discussed earlier, poor pregnancy outcomes occur in up to 5% of minor trauma.[2,14] The pregnant patient who sustains minor or even trivial injury often appears perfectly stable. Frequently, the patient is ambulatory at the scene and may even request to sign a refusal-of-transport release. In the pregnant patient, dismissing injuries as "minor" or "trivial" risks missing serious injury that may cause fetal death and, on rare occasion, maternal death. Failure to transport a pregnant patient is a decision weighted with serious medicolegal concerns.

Two common injuries often considered minor are falls and seat belt injuries. Because of the frequency of

these injuries, they account for the greatest number of adverse pregnancy outcomes.[14]

FALLS

Falls during pregnancy are common; 80% of falls occur in the last 2 months of pregnancy, and falls occur more often during the last 2 months of pregnancy than during any other period in a woman's life.[2,12,19,23] The unsteadiness produced by a change in the center of gravity, a loosening of pelvic ligaments, respiratory alkalosis, and easy fatigability all contribute to the increased incidence of falls.[19,24] Approximately 2% of maternal deaths result from falls.[3] Fortunately, the majority of falls cause no significant maternal injury. However, as previously noted, abruptio placentae and fetal death may result from a simple fall on the buttocks.[2]

SEAT BELT INJURIES

Despite more than 25 years of scientific evidence, many of the nonparamedic public still have a total misunderstanding of the safety of seat belt use during pregnancy.[13] There is a misconception that the use of seat belt restraint systems may be of no help or may even be harmful to the fetus in MVCs during pregnancy. Nothing could be further from the truth. There have been repeated published reports specifically addressing the question of whether seat belt restraint systems are protective or harmful to the fetus in severely injured pregnant women.[12,13,23,31–33] Any (either two-point lap or three-point) use of seat belt restraints is a protection against maternal death, which is a leading cause of fetal death. The three-point restraint system further reduces the risk of both maternal and fetal injury during pregnancy.[33]

Maternal and fetal injuries resulting from the seat belt itself do occur. Blunt abdominal maternal injuries have been previously discussed. Placental seat belt injuries may result in abruptio placentae and fetal death. However, the incidence of abruptio placentae is not increased by the use of seat belts.[13,23] In deceleration injuries, three-point restrained pregnant women are at a lower risk for abruptio placentae than those in a two-point or lap belt.[32] Proper use of the lap belt portion (across the pelvis, not the abdomen) of the three-point restraint during pregnancy may further reduce the risk of fetal injury.

OTHER TRAUMA

FETOMATERNAL HEMORRHAGE

Fetomaternal hemorrhage is the transplacental transfusion of fetal blood into the maternal circulation. The incidence and severity of fetomaternal transfusion are not necessarily correlated with the degree of maternal trauma.[2] Ninety percent of fetomaternal hemorrhage is uncomplicated; however, when complications occur, they may be lethal for the fetus. The principal complications are Rh sensitization of the Rh-negative mother and fetal hemorrhagic shock.[1] An early in-hospital recognition of fetomaternal hemorrhage may prevent fetal exsanguination or an Rh incompatibility disorder in the mother. An Rh incompatibility disorder, which may be fatal for the fetus, can be easily prevented with administration of anti-Rh immunoglobulin.[19]

UTERINE INJURY

Isolated abdominal trauma or multisystem trauma during pregnancy may result in uterine injury that causes premature labor, premature rupture of the amniotic sac, uterine rupture, and the previously described abruptio placentae.

Uterine rupture is extremely rare, occurring in less than 1% of pregnant trauma patients.[1] This injury, which is unique to pregnancy, usually occurs only with major trauma. There are frequently other life-threatening injuries. Thus, patients with uterine rupture may present to the paramedic with signs of multisystem trauma, intra-abdominal bleeding, an asymmetrical abdomen, and an ill-defined uterine fundus.[23] If hypovolemia and concurrent injuries are well managed, maternal survival is likely. In uterine rupture, maternal mortality is less than 10%; however fetal mortality is nearly 100%, a much higher mortality than in the more commonly occurring abruptio placentae. Generally, uterine rupture occurs only after an enormous amount of direct uterine trauma.

SEXUAL ASSAULT

An estimated 2% of sexual assault victims are pregnant at the time of assault.[34] (The exact incidence of rape during pregnancy has not been well documented. It is estimated that more than 80% of all sexual assaults go unreported.[1]) The majority of assaults take place prior to the fifth month of pregnancy. Oddly, the traumatic injuries inflicted upon pregnant assault victims seem to be no more common than in nonpregnant rape victims.[34]

The paramedic caring for the pregnant rape victim should approach the patient in much the same way that nonpregnant rape victims are managed. The paramedic's responsibility is to care for both the physical and psychological needs of the patient. With the careful attention to the emotional well-being of the woman,

the paramedic should determine if there is an indication for trauma assessment and treatment.

THERMAL INJURY

Rarely, a paramedic may care for a pregnant burn patient. Women who sustain burn injuries during pregnancy have the same (perhaps surprisingly) survival rate as nonpregnant women. If a pregnant patient's burn is greater than 50% total body surface area, then the maternal mortality is approximately 70%.[35]

Fetal survival usually parallels the percentage of burned surface area and survival of the mother; for the severely burned woman, fetal prognosis is very poor. Often the pregnant woman has spontaneous premature labor within several days and delivers a stillborn infant.[35] If the mother's prognosis is poor, the fetus has little chance of survival. However, in rare circumstances, a woman's deterioration may jeopardize a viable fetus. In these unusual cases, a C-section may be performed.[36] The potential maternal and fetal benefits of a perimortem cesarean delivery have been discussed earlier.[19,23] The chances for successful revival in any critically ill, hypovolemic pregnant patient may be improved by removal of caval compression by the fetus.[37] Emergency C-section may improve maternal venous return and cardiac output.[23,28] The implication is that the severely burned pregnant patient who appears to be terminal may respond to treatment. The out-of-hospital factors that contribute to poor maternal and fetal outcome are hypovolemia and pulmonary injury. Pregnant women tolerate smoke inhalation and chemical pneumonitis poorly.[1] In treating the pregnant burn patient, aggressive management of the airway, correction of hypoxia and hypercarbia, removal of caval compression, and vigorous fluid resuscitation may reduce maternal and fetal mortality.

ELECTRICAL AND LIGHTNING INJURIES

Maternal deaths as a result of electrical or lightning injury are rare.[1] However, fetal mortality and morbidity are high.[23] In minor maternal lightning injury, poor fetal outcome occurs in the overwhelming majority of cases, approximately 75%. The risk of spontaneous abortion and fetal demise is thought to result in part from the fact that the fluid and electrolyte content of amniotic fluid very effectively conducts current flow to the fetus.[23]

ASSESSMENT

Trauma during pregnancy presents the paramedic with two patients: the mother and the fetus. The trauma assessment of the pregnant patient with either major or minor trauma differs from assessment of the nonpregnant patient. It is appropriate to assess the fetus, and there are critical errors to be avoided. However, in the initial trauma assessment the paramedic's attention must focus on the evaluation and stabilization of the mother. The goal of evaluation and stabilization of maternal injuries is achieved by adhering to the familiar "ABCs" of assessment and treatment—the same as with the nonpregnant patient. Fetal survival depends upon stabilization of the mother's clinical condition. Of critical importance is the maternal circulatory status. Maternal shock, unrecognized and untreated, usually results in fetal demise.[2,25]

The overwhelming majority of pregnant trauma patients assessed by a paramedic are minor trauma.[2,14] The critical issue in these patients is the recognition of potential placental injury. The critical action is transfer to an appropriate facility. In these cases, initial assessment, vital signs, physical examination, and fetal assessment are usually uncomplicated and are accomplished in a matter of minutes.

By contrast, in the critically injured pregnant patient, the paramedic's only focus may be the initial assessment. The paramedic may use the entire out-of-hospital period completing the initial assessment and stabilization.

Assess the pregnant trauma patient just as any trauma patient: an initial assessment leading to a stabilization of vital signs. Next the maternal abdomen, uterine fundus, estimated fetal age, and fetal heart rate are considered, and then the physical examination is completed. The priorities of assessment and stabilization are first, initial assessment; second, fetal survey; and last, focused physical exam.

In the initial assessment, the order of priorities remains the same as always: C—cervical spine, A—airway, B—breathing, C—circulation, D—disability, and E—expose; then consideration may be given to F—fundus/fetal age estimate/fetal heart rate.

The paramedic should be aware of how anatomic and physiological changes of pregnancy may alter assessment and stabilization. Before an orderly integration of these differences into the initial and focused assessments, it may be helpful to review how those changes can contribute to difficulties in assessment. The cardiopulmonary changes of pregnancy can be summarized as high cardiac output, high oxygen demand, low blood pressure (plus or minus low peripheral vascular resistance), low or impeded venous return, and low oxygen reserve. The effects that these changes may have on maternal assessment are given in Table 25-4.

With these in mind, proceed with the familiar systemic progression of assessment and stabilization. In

Table 25-4
Anatomic and Physiological Changes of Pregnancy That Complicate Assessment

Change	Effect on Assessment	Difficulties in Assessment
High cardiac output	HR increases	Increased HR is NOT an early reliable sign of hypovolemic shock
High cardiac output	Increased blood volume	Significant blood loss may NOT be reflected by usual signs of shock
High O_2 demand, low O_2 reserve, low CO_2 normally	RR increases	RR ≤ 20 should NOT be considered adequate ventilation
Elevated abdominal contents	High diaphragm, decreased peritoneal responsiveness	Loss of landmarks for chest compressions; cannot rely on the usual signs of intra-abdominal bleeding

this chapter, the discussion of this process will emphasize how this assessment may be altered in pregnancy.

SCENE SIZE-UP

Before reaching the pregnant patient's side, the paramedic makes a preliminary 1–5-second assessment. While approaching the patient, observe for the presence or absence of labored or inadequate respirations, obvious hemorrhage or abnormal color, confusion or unresponsiveness, and an obviously gravid abdomen.

CERVICAL SPINE

The concern for possible spinal injury is no less important in the pregnant patient; the same indications for immobilization apply. In fact, hormones released during pregnancy to relax the ligaments of the pelvis also affect the ligaments of the cervical spine, predisposing the patient to cervical spine injury. Therefore, any pregnant patient with a severe mechanism of injury, neck pain, or altered level of consciousness should immediately receive in-line manual stabilization of the cervical spine. It is also important to tilt the long spine board to the left, once the patient is immobilized, to displace the uterus from the midline and off the inferior vena cava, reducing the risk for maternal supine hypotension syndrome. Alternatively, if tilting the spine board cannot be easily accomplished, manual displacement of the gravid uterus from the midline is acceptable.

AIRWAY

Aggressive airway management is particularly important in the pregnant trauma patient because of the risk of aspiration and the limited O_2 reserve. Appropriately securing a protected airway may require rapid-sequence sedation or paralysis when indicated.

BREATHING

The paramedic assessing the adequacy of respiratory rate and depth should recall that the respiratory rate is normally hyperventilatory during pregnancy. A respiratory rate of less than 20 should always be considered potentially dangerous in the pregnant trauma patient. Chest auscultation may yield unequal breath sounds, suggesting pneumothorax, ruptured diaphragm, or unilateral pulmonary contusion. Pneumothoraces and hemothoraces during pregnancy become even more life threatening because of an elevation of the diaphragm and decreased O_2 reserve.

Tension pneumothorax may occur more precipitously in the pregnant patient as a result of hyperventilation combined with elevation of the diaphragm.[19] Timely management of a tension pneumothorax requires early recognition of unequal breath sounds, neck vein distension, and a declining blood pressure (tracheal deviation is a perimortem sign). Be aware that because of the 4-cm elevation of the diaphragm during latter pregnancy, a lateral needle thoracostomy risks causing an intra-abdominal injury.[38]

CIRCULATION

In a pregnant patient in the advanced stages of shock, the assessment may be straightforward: an absent radial pulse and altered level of consciousness. External hemorrhage assessment is performed in the usual fashion. However, *all* of the other usual estimates of circulatory status are subject to misinterpretation. Extensive hemorrhage may occur without the patient demonstrating the usual signs of shock. Heart rate, capillary refill, skin

color and temperature, and blood pressure are poor predictors of the amount of blood loss. A pregnant trauma patient with a full pulse, normal skin, and slight confusion may have actually lost 30% of her blood volume.[1,23] In the latter half of pregnancy, circulatory assessment includes checking the position of the uterus. Failure to assess for inferior vena caval compression (and to relieve this compression) may result in a catastrophic drop in cardiac output.[2,14,23]

DISABILITY

The neurological assessment of the pregnant trauma patient is not significantly altered by the changes of pregnancy. Altered level of consciousness has the same significance as for the nonpregnant patient. The pupils are examined for asymmetry, indicating impending brain herniation and the need for hyperventilation. As with the nonpregnant patient, the usual alert, verbal, pain, unresponsive (AVPU) evaluation assesses the pregnant trauma patient for the same potentially reversible causes of altered level of consciousness: cerebral hypoxia, cerebral hypoperfusion, and hypoglycemia.

EXPOSURE

The gross error of failing to identify an obviously gravid uterus can be avoided by simply following the usual trauma life support practice of completely removing the patient's clothing. The patient is quickly inspected for any signs of penetrating or blunt injuries not already detected.

FETUS AND FUNDUS

One of the obvious ways in which the paramedic's evaluation of the pregnant trauma patient is different is the assessment of the uterus and fetus. As soon as the pregnant patient's condition is stabilized with adequate oxygenation, control of external hemorrhage, and adequate volume restoration, the paramedic begins the out-of-hospital obstetric assessment (before the continued assessment portion of the trauma assessment). This initial obstetric assessment consists of examination of the uterine fundus, a quick check for obvious vaginal blood or fluids, and a fetal evaluation.

The critical questions are (1) is there uteroplacental injury, (2) is the fetus of viable age, and (3) is there fetal distress? The critical actions are (1) palpate the uterine fundus, (2) estimate fetal age, and (3) attempt to auscultate fetal heart tones. All of these steps are, of course, inappropriate if maternal vital signs have not been adequately stabilized.

Before the paramedic proceeds with the uterine and fetal assessment, a brief (2–3-second) observation is made for any obvious vaginal blood or fluids. Then the uterus is palpated for tenderness and rigidity; the presence of these suggests serious uteroplacental injury, such as abruptio placentae.[6] Remember that vaginal bleeding and these uterine findings are not as sensitive or specific in confirming abruptio placentae as in-hospital fetal monitoring.[2,6]

In the latter half of pregnancy, the fundus of the uterus should be a well-defined dome on palpation. A nondefinable uterine fundus may indicate uterine rupture or significant intra-abdominal bleeding.

Next, the fundal height of the uterus should be estimated. The distance in centimeters from the pubic symphysis to the dome of the fundus approximates the age of the fetus in weeks (Figure 25-2). If the uterine fundus clearly extends above the umbilicus, the fetal age is estimated as greater than or equal to 26 weeks, and this is an indication of fetal viability.[2,19] The fetus is considered viable if the chance of newborn survival is greater than or equal to 50%. For most neonatal facilities, this occurs after 25 weeks, or at a weight of approximately 750 g.[19]

Prior to reaching the emergency department, the paramedic's methods of assessing fetal distress are limited. Briefly attempt to detect fetal heart tones (FHTs) and palpate the fundus for signs of fetal movement, which indicates potential viability. During the last month of pregnancy the fetal heartbeat can usually be detected using an ordinary stethoscope (the bell of the stethoscope is firmly placed in the periumbilical area). The availability of Doppler ultrasound may easily assess fetal heart rate after 20 weeks. The normal fetal heart rate is 120–160 bpm. An early sign of fetal distress may be tachycardia above 160 bpm. A sustained bradycardia below 110 bpm is an ominous sign that may signal abruptio placentae, fetal hypoxia, or fetal brain injury.[1,2,19]

In the emergency department, mandatory continuous fetal heart rate monitoring is begun in all pregnant trauma patients over 20 weeks gestation.[2,19,23] While continuous, or even frequent, fetal monitoring may not be feasible in the prehospital setting, a brief attempt by the paramedic to assess fetal distress is appropriate. In a number of pregnant trauma patients, fetal distress (not abdominal pain, tenderness, and vaginal bleeding) is the first indication of abruptio placentae.[1,2,19] Fetal distress may be the earliest sign of occult maternal hemorrhagic shock.[38] Since fetal distress is a more reliable sign of shock than other maternal vital signs, fetal heart rate is another "vital sign" useful for assessing maternal status.[1,38]

When the fetal assessment has been completed and maternal vital signs have been stabilized, the

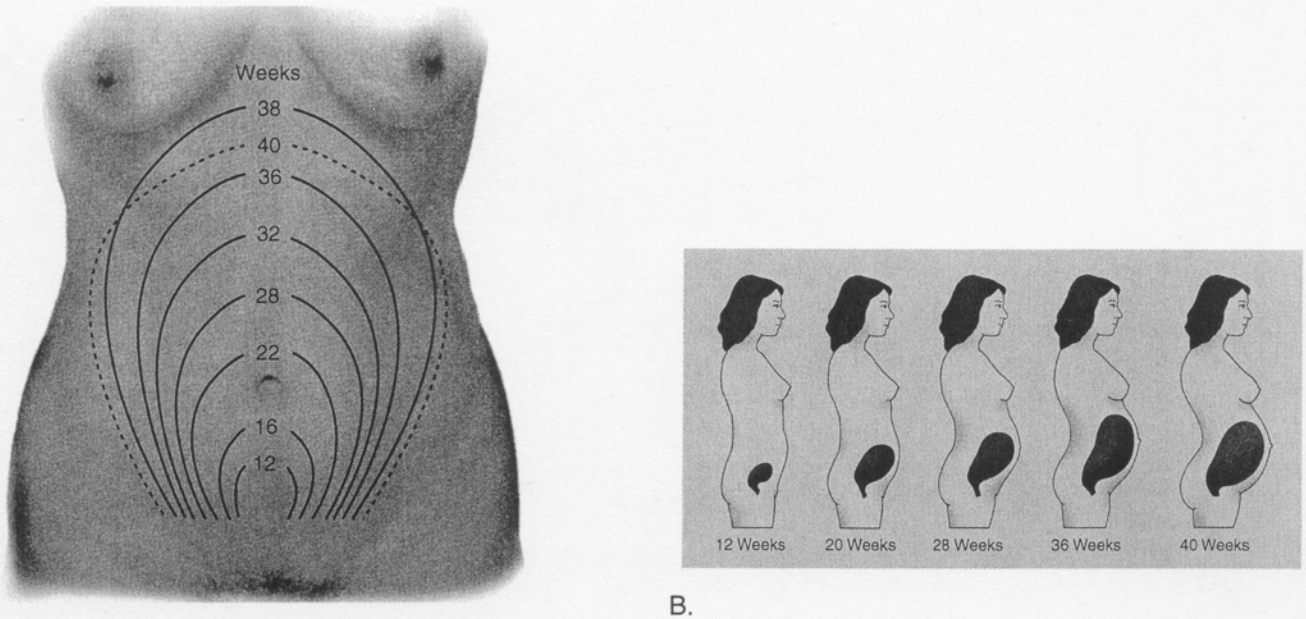


FIGURE 25-2 (A) Estimation of uterine fundal height in centimeters and fetal age in weeks gestation. *Source:* Adapted from Estes, MEZ. *Health Assessment and Physical Examination.* Albany, N.Y.: Delmar Thomson Learning; 1998. (B) Gestational age and contour changes in the abdomen during pregnancy.

remainder of the assessment for fractures and internal injuries may proceed.

ONGOING ASSESSMENT

The ongoing assessment of the pregnant trauma patient is essentially the same as for the nonpregnant patient with a few differences: the abdomen and the pelvis.

Abdomen

Occasionally, the size of the near-term uterus obscures adequate assessment of the abdomen. Keep in mind that the nonpregnant signs of peritoneal irritation and intra-abdominal bleeding are frequently absent.[1,2,19]

Pelvis

The pelvic survey includes a check of the vaginal and perineal areas for blood and amniotic fluid. The bony survey of the pelvis is of critical importance, particularly in the MVC victim. Omission of an adequate bony pelvis examination may result in a failure to detect a pelvic fracture, which is a frequent cause of hypovolemic shock and death in MVC patients.[18,27]

During the course of and then again upon completion of the continued assessment, maternal vital signs should be reassessed, and, if possible, fetal heart rate is reassessed, keeping in mind that fetal assessment should never supersede maternal assessment and treatment. A concentration on the initial assessment directs the paramedic to the pathophysiology of the life-threatening maternal and fetal conditions.

MANAGEMENT

The essential management for all trauma in pregnancy is to ensure adequate maternal and fetal oxygenation and perfusion. Treatment of the pregnant trauma victim begins with the same order of priorities discussed in assessment: ABCDEF.

The pregnant trauma patient's care involves initial and definitive field care by the paramedic, emergency department care (including maternal and fetal diagnostic procedures), and finally, definitive surgical intervention when indicated. Throughout this process, the paramedic, emergency physician, obstetrician, and trauma surgeon must all adhere to the same disciplined clinical approach. The goal of therapy is to manage the traumatic injury in a way that optimizes maternal and fetal health. Critical therapeutic actions include competent assessment, intervention, communication with other members of the medical team, and emotional support of the patient and family. In a minor accident or in a life-threatening crisis, the paramedic needs a plan with rules and strategies. The first rule of trauma

management is to treat the pregnant patient's ABCs. Vigorous attention to maternal oxygenation and circulation is the same priority for both the pregnant and nonpregnant patient.[1] The most common causes of fetal death are maternal hemorrhage, maternal death, and abruptio placentae. The most effective initial intervention is aggressive correction of hypovolemia and hypoventilation; maternal stabilization provides fetal stabilization.[2,14,19] Inadequate stabilization may result in the maternal circulation being maintained at the expense of the fetal circulation. Inadequate ventilatory stabilization results in maternal and fetal hypoxia. The critical actions in managing and stabilizing airway and breathing are to recognize and treat an absent gag reflex, a poor respiratory effort and/or rate, and a tension pneumothorax and to administer high-flow oxygen by the appropriate route[2] (Table 25-5).

In the pregnant trauma patient, airway and breathing interventions are indicated for a rate less than 18 and a tidal volume less than 800 mL. If the patient requires intubation, the controlled ventilatory rate of 25–30 produces the desired maternal $PaCO_2$ of 30 mm Hg.[19] The airway and cervical spine are managed simultaneously.

Upon recognition of a tension pneumothorax, a needle thoracentesis should be performed. A lateral

Table 25-5
Trauma Assessment and Treatment in Pregnancy: ABCDEF

Priority	Critical Decision	Altered in Pregnancy	Critical Action
1. C-spine	Does possibility of C-spine injury exist?	Yes, hormones relax C-spine ligaments	Immediately ensure in-line manual stabilization while securing the airway
2. **A**irway	How best to rapidly secure airway, endotracheal intubation and rapid induction	Yes; aspiration risk obstruction; check gag reflex;	Check for foreign body airway vomitus present; intubate as indicated
3. **B**reathing	O_2 flow rate Assess breathing; Assess for tension pneumothorax	Yes (O_2 debt) Yes (RR >18/min) Yes (elevated diaphragm)	High O_2 flow rate Check rate and depth: assist if <18/min Check for neck vein distention; needle decompression at second intercostal space (ICS)/mid-clavicular line (MCL)
4. **C**irculation	Assess for shock Identify and treat blood loss IV therapy Vena caval release	Yes (decreased pulse is a late sign) Yes Yes Yes	Check pulses: carotid and radial Apply direct pressure to external hemorrhaging sites Start two large-bore IVs of crystalloid; give 2 liters and reassess Place patient in left lateral recumbent position
5. **D**isability	Is there an altered level of consciousness? Is there any risk of herniation?	No Yes ($PaCO_2$ <25 mm Hg)	Check pupillary response and level of consciousness, patient response to pain stimuli Place on hyperventilatory rate; no less than 20/min; choose rate of 25–30/min
6. **E**xpose	Is the patient pregnant? Stabilize vital signs	Yes No	Completely remove patient's clothing Stabilize before proceeding
7. **F**etus	Is there uteroplacental injury, fetal viability, fetal distress, or indication for 4-hr electronic monitoring?	Yes	Check blood and amniotic fluids; palpate uterine fundus; estimate fundal height and fetal age; attempt to detect fetal heart tones; transfer to appropriate facility

fourth or fifth intercostal site insertion may enter the abdominal cavity and is therefore discouraged.[19] An anterior second intercostal/midclavicular site avoids this complication.

While these interventions are proceeding, the other team members may be initiating circulatory stabilizing procedures: controlling major bleeding, starting two IVs, and positioning the patient on her left side. Keep in mind that failure to deflect the uterus away from the inferior vena cava markedly reduces cardiac output.[1,2] The patient should remain on her left side at all times unless this is absolutely impossible. A 6-inch rolled towel beneath the backboard will provide sufficient elevation to deflect the uterus from the vena cava.[14]

Circulation is stabilized in the usual manner: by placing two large-bore IVs with trauma tubing and rapidly infusing 2 liters of crystalloid solution while reassessing vital signs. While starting the IV lines, blood is drawn for rapid glucose testing and for other laboratory studies.

A potential pitfall in the management of circulation in the pregnant patient is the underestimation of internal bleeding (e.g., in a pelvic fracture). A life-threatening hemorrhage with 30%–35% blood volume loss (class III shock) may develop before obviously abnormal vital signs are detectable. In the second half of pregnancy, the volume of crystalloid used to resuscitate hypovolemia may need to be 50% greater. Aggressive volume resuscitation is not likely to result in volume overload (though this must be monitored).[2,14]

After or during the initiation of the IVs it is appropriate to consider using the pneumatic antishock garment (PASG) in the nonpregnant patient. In the pregnant patient, routine use of the PASG is not recommended. There are no studies demonstrating the effectiveness of the PASG for trauma in pregnancy.[2] Furthermore, the application of the abdominal compartment should be considered contraindicated after the 20th week of pregnancy when uterine compression of the inferior vena cava may decrease venous return and preload.[2,6,19,23]

The PASG may be used as a lower extremity air splint and may facilitate IV access. Inflating the PASG leg compartments increases peripheral vascular resistance (and afterload) in the pregnant trauma patient. Theoretically, this might benefit a pregnant patient with low peripheral vascular resistance, but this has not been studied in pregnant trauma patients.[19]

To complete the circulatory assessment, vital signs are obtained and recorded.

A quick neurological assessment of the pupils and AVPU directs the paramedic toward abnormal structural or metabolic conditions. If findings indicate any risk of uncal herniation, the patient should be hyperventilated. A hyperventilation rate over and above the usual tachypnea of pregnancy requires a ventilatory rate of 30 per minute, until arterial blood gases are available (goal: $PaCO_2$ between 25 and 30). If findings indicate hypoglycemia, 50 mL 50% dextrose in water ($D_{50}W$) is given.

Next, adequately expose the patient and attach monitors (cardiac, BP, pulse oximetry). Reassess vital signs and the patient's response to initial therapy. If the patient has had no response to 2 liters of crystalloid, the patient requires the administration of O-negative blood upon arrival in the emergency department (ED).

After the airway, oxygenation, and fluid resuscitation are secured and completed, a brief obstetric evaluation may be performed, ideally prior to communication with the ED. The paramedic examines for "the four Fs": fluids, fundus, fetal age, and fetal distress, if possible, with the latter being more effectively accomplished in-hospital.

Communication with the ED should occur as soon as possible after the primary stabilization, the reassessment after therapy, and the brief obstetric observation. The paramedic's report to the ED should include (1) the patient's present condition, including interventions necessary; (2) the response to initial therapy; (3) the gestational age by history (if this is known) and/or the estimated fundal height (fetal age) by examination; and, of course, (4) the estimated time of arrival at the ED. This information facilitates ED preparation and mobilization of a multidisciplinary team, if indicated.

Once communication has occurred, reassess vital signs and complete the continued assessment portion of the trauma assessment. Paramedics providing critical care transport may perform gastric decompression with a nasogastric (NG) tube and urinary catheterization. Urinary catheterization provides valuable information regarding (1) renal output (reflective of adequate perfusion) and (2) the presence of blood in the urine. In the setting of traumatic maternal shock, gross hematuria suggests the diagnosis of pelvic fracture and/or a retroperitoneal hemorrhage.

All pregnant patients with *minor* trauma should (1) have high-flow O_2 administered; (2) be transported on their left side; and (3) have a large-bore IV of crystalloid started.

INTERNET ACTIVITIES

Visit the e-medicine Web site at http://www.emedicine.com. Click on the Emergency Medicine on-line book and select Obstetrics and Gynecology. Then click on Pregnancy, Trauma. Review the chapter on the management of the pregnant trauma patient.

TRAUMATIC MATERNAL ARREST

By the time the paramedic completes the initial assessment and stabilization of the pregnant patient, it should be evident if maternal vital signs are not returning (or if maternal injuries are not compatible with life). After vigorous attempts to resuscitate the pregnant patient appear to have failed (or in a patient who would otherwise meet the criteria for field pronouncement of death), the paramedic should immediately assess the fetus. By this time in the assessment, the only pertinent question is: Is the fetal age 25 weeks or more? The paramedic may choose to document and communicate the fetal age qualitatively in terms of the fundal height, such as "below the umbilicus," "just above the umbilicus," or "well above the umbilicus." Unless specifically countermanded by protocol or by on-line medical direction, maternal resuscitation efforts should be continued until arrival at the ED. When chest compressions are indicated, performance of these may be facilitated by using the 6-inch backboard elevation method of maternal positioning. The hyperventilatory rate should be greater than 30 bpm to optimize PaO_2 and $PaCO_2$ levels.

Early communication with the ED is critical, allowing for mobilization of resources such as neonatology. Radio communication should be brief and blunt, such as: "We are transporting a pregnant traumatic arrest to your facility; fundal height is well above the umbilicus; CPR is in progress; ETA is 4 minutes."

Immediately upon arrival in the ED, a C-section should be performed if fundal height exceeds the umbilicus and clinical signs of fetal life are present (e.g., confirmation of fetal heartbeat). Maternal resuscitation efforts may continue after a perimortem delivery.

MINOR TRAUMA

Rarely is a paramedic confronted with major trauma in pregnancy and imponderables such as traumatic maternal arrest. However, paramedics are likely to encounter minor injuries. It is critical that the paramedic have a consistent and thorough approach to minor trauma in pregnancy. Potential pitfalls in caring for minor maternal trauma patients include (1) failure to do a paramedic obstetric examination; (2) failure to transport to a facility capable of conducting electronic obstetric monitoring; (3) failure to adequately give and document informed consent to a patient who refuses transport; (4) giving false reassurance that the pregnancy outcome will be good; and (5) administering inappropriate drugs to pregnant patients with minor trauma.

In the pregnant patient with minor injury, the maternal initial assessment and vital signs are easily and quickly obtained. Then, as indicated, the paramedic obstetric examination (fluids/fundus/fetal age/fetal heart rate) is performed. Every minor trauma pregnant patient with a fundal height above the umbilicus (25 weeks gestation or more) requires appropriate obstetric electronic monitoring (i.e., a minimum of 4 hours of uterine and fetal monitoring). This approach should include pregnant patients with no apparent signs of pelvic, low back, or abdominal injury. There may be significant fetal or uteroplacental injury without obvious injury.[6,19]

Informed consent for the patient who refuses transport is always problematic. By understanding the epidemiology of minor trauma in pregnancy, the paramedic is better equipped to inform the patient who wishes to refuse transport. The pregnant patient should be informed that even though her injury is minor, it may result in serious complications of pregnancy, such as fetal death, in 5%, or 1 in 20. Documentation should show that the risks and inadvisability of refusal were understood by the patient.

MEDICATIONS TO AVOID IN TRAUMA IN PREGNANCY

The paramedic will, on occasion, administer medications; these may include medications for pain, nausea, or asthma. The use of morphine for severe pain (e.g., ankle fracture) is acceptable. Ketorolac's (Toradol) safety in pregnancy has not been established and therefore should be avoided. Promethazine (Phenergan) has been used extensively in pregnancy; however, its safety, particularly in the first 3 months of pregnancy, has not been established. In the rare instance when a pregnant patient with minor trauma also has asthma, albuterol (Proventil) is probably safe. While albuterol has not been studied in trauma in pregnancy, its use in nontraumatic pregnancy has been. Fetal and placental blood flow alterations and fetal distress have not occurred with albuterol.[39] Two other medications sometimes used in asthma are terbutaline (Brethine) and epinephrine; both of these should be considered contraindicated for routine administration after blunt trauma in pregnancy.[19,23] Neither terbutaline nor epinephrine is the drug of choice for asthma; the former interferes with normal uterine contractions and monitoring, and the latter's vasoconstrictive effects may significantly decrease uterine blood flow and fetal oxygenation.[19,23]

Premature contractions are a common complication of trauma in pregnancy and may occur after minor trauma. Paramedic protocols that include the use of terbutaline or magnesium to arrest premature contractions should be amended to apply only to *nontraumatic*

premature labor. The reason is that 90% of these premature contractions will spontaneously disappear and are usually benign.[6] Furthermore, those contractions that do not stop are often associated with uteroplacental injury such as abruptio placentae. In this setting, stopping the uterine contractions might limit the ability to diagnose serious complications.

EMOTIONAL CARE OF THE MATERNAL TRAUMA PATIENT

For the critically injured pregnant patient, the timely and appropriate initial stabilization does not allow for any more than basic emotional support. The paramedic employs the same focused, orderly, professional attention to critical life support decisions and actions.

For the pregnant patient with minor trauma the paramedic has the opportunity to provide more advanced emotional support. This attention to the patient's psychological needs is particularly important in cases of assault and domestic violence. But every pregnant patient has emotional needs. A potential problem for paramedics is the trauma patient who requests reassurance from them that "everything will be OK with my baby." While being emotionally supportive, the paramedic should avoid prognosticating. The paramedic may choose to respond with a comment such as: "The best thing you can do now for your pregnancy is to take care of yourself. While you are being evaluated and treated you'll be helping your baby," or "What the baby needs now is for us to help deliver more blood and oxygen. You can help by lying on your side." The anxious patient may easily interpret "most" as "always " and "not likely" as "never."

The pregnant patient's earliest response may involve denial, anger, guilt, and blaming. One of the healthiest coping responses of the pregnant patient is her involvement and participation in the care of her baby and of herself.

EMERGENCY DEPARTMENT CARE OF THE PREGNANT TRAUMA PATIENT

Once the paramedic presents the pregnant trauma patient to the ED, the process of stabilization and evaluation continues. Before a multidisciplinary team of neonatology, general surgery, and obstetrics can be utilized, the emergency physician proceeds in much the same way the paramedic does: initial, fetal, and continued assessment and treatment. One difference in the emergency physician's approach is that as the prioritized stabilization proceeds, definitive diagnostic evaluations and indicated emergent referrals are made. The other principal difference from the prehospital approach is electronic monitoring of uterine contractions and fetal heart rate, which should be initiated as soon as the maternal condition is stabilized.

Once the primary stabilization and fetal evaluation have been accomplished, the definitive ED evaluation involve blood studies, x-rays, diagnostic peritoneal lavage, ultrasonography, and placement of NG tube and urinary bladder catheterization (if not already performed by the paramedic). Peritoneal lavage is no longer considered contraindicated in pregnancy.[19] Radiology studies (x-ray, computed tomography, magnetic resonance imaging) without fetal shielding (e.g., pelvis) are considered indicated if these are needed to rule out potentially life-threatening injuries.[19] Initial blood studies are complete blood cell count, including platelets, a DIC screen, type and cross match, routine chemistries and electrolytes, and possibly a Kleihauer Betke (KB) test. (This is a test for the presence of fetal blood in maternal circulation. This test determines the dosage of RhoGAM).

Electronic Obstetric Monitoring

All pregnant patients with direct or indirect abdominal trauma and with an estimated fetal age of greater than 20 weeks must have 4 hours of fetal and uterine electronic monitoring after the trauma event.[1,2,19,23] It is critical that monitoring be begun as soon as possible after maternal vital signs are stabilized in order to detect abruptio placentae, which occurs early after trauma.[1,23]

Monitoring for fetal heart rate abnormalities helps detect not only abruptio placentae but also maternal shock and fetal compromise. For ruling out adverse pregnancy outcomes, uterine monitoring appears to be even more important than fetal monitoring. Monitoring for uterine contractions (tocography) is extremely accurate in predicting abruptio placentae. If after 4 hours of uterine monitoring no abnormal uterine contraction activity is observed, the patient's chances of a normal pregnancy outcome are similar to that of an uninjured pregnant woman. Greater than four contractions in 1 hour is considered an abnormal contraction pattern.[14]

Fetomaternal Hemorrhage

As mentioned earlier in the chapter, a rare complication of trauma in pregnancy is the transfusion of fetal blood into the maternal circulation. The routine screening blood work done on pregnant trauma patients sometimes includes a KB test (for presence of fetal blood) and always should include type and Rh

determination. In most cases, the KB test is useless because (1) it may fail to detect small but harmful amounts of fetal blood and (2) all Rh-negative mothers may safely receive an anti-Rh prophylactic injection. (This injection of anti-Rh immunoglobulin rids the maternal blood of Rh-positive fetal blood, thereby preventing maternal sensitization against and rejection of fetal blood.)[40] All Rh-negative pregnant women presenting after direct or indirect abdominal trauma should receive the standard anti-Rh injection.[19] It is not critical that this injection be given within 24 hours. However, to avoid mistakes in follow-up, it is most practical to administer the anti-Rh immunoglobulin injection prior to the patient's leaving the ED.

Emotional Support and Protective Services

The emergency physician continues the same attention to the pregnant patient begun by the field paramedic. In addition to anticipating the normal concerns and anxieties, the ED staff should be prepared to provide the initial emotional support for the patients with grief reactions or patients who have been victims of domestic violence or sexual assault. The ED is in a position to provide the patient with appropriate consultants and resources. This may involve consultation with mental health professionals, protective services, law enforcement, and crisis intervention counselors for victims of rape or domestic violence. The ED must comply with the state's requirements for reporting assault.

Admission Criteria

In some EDs that are staffed with ED paramedics, the paramedic will care for minor trauma patients. The appropriate role of the ED paramedic in managing minor trauma in pregnancy is to involve the ED physician early in the evaluation and in the disposition. For some EDs there is a policy to transfer all stable pregnant trauma patients to the labor and delivery department for further evaluation. If, however, the departmental policy is that some pregnant trauma patients are seen by the emergency physician and the ED paramedic, then there are admission criteria to be carefully observed. The pregnant trauma patient should *not* be discharged from the emergency department if any of these admission criteria are present. All pregnant trauma patients who are over 24 weeks pregnant should be admitted for 24 hours or more for the following: (1) vaginal bleeding; (2) rupture of membranes/amniotic fluid leak; (3) any evidence of maternal hypovolemia, even if the maternal vital signs are stable; (4) any serious maternal injury, even if the maternal vital signs are stable; (5) uterine or abdominal pain and/or tenderness; (6) abnormalities (e.g., hematoma) found on uterine ultrasound; (7) abnormal uterine contraction pattern: over four contractions in an hour; and (8) abnormal fetal heart rate: (a) sustained tachycardia (greater than 160 bpm per minute), (b) sustained bradycardia (less than 120 bpm), (c) transient bradycardia occurring late after maternal contraction, and (d) loss of rate variability. The majority of these criteria can be detected by the field paramedic's 4F obstetric assessment.

The treatment of the pregnant trauma patient can be summarized with a priority setting: ABCDEF. A careful but rapid flow through the ABC process identifies critical actions needed to reverse unstable or lethal conditions. The chief differences from the treatment of nonpregnant patients are the fetal assessment and the circulatory critical actions: placing the patient in the left lateral decubitus position and more aggressive than usual fluid resuscitation (2 liters rapid infusion). In minor trauma, the treatment is to provide high-flow O_2, establish an IV, place in left lateral decubitus position, and transfer to an appropriate facility for 4-hour uterine and fetal monitoring.

In more serious trauma, the paramedic and ED protocols should thoroughly and efficiently advance the field and ED professionals through a system of mostly familiar priorities and critical actions (see Table 25-5).

INTERNET ACTIVITIES

Visit the British Trauma Society Web site at http://www.trauma.org/resus/pregnancytrauma.html and review the material on trauma in pregnancy.

SUMMARY

Trauma during pregnancy is common. A systematic approach for managing minor and major trauma in pregnancy is based upon familiar, core ABC management principals. The ABCDEF approach includes attention to clinically relevant pregnancy-related changes in anatomy and physiology; this system effectively addresses the maternal, fetal, and placental complications of trauma. The paramedic's role in trauma management of pregnant women is critical. The paramedic caring for the pregnant trauma patient may encounter anxiety-provoking and tragic circumstances. Early recognition of and intervention for life-threatening maternal, placental, and fetal conditions ensures the best chance for maternal and fetal well-being.

REVIEW QUESTIONS

1. In the United States, the most common reported injuries in the pregnant trauma patient are:
- **a.** Physical assaults
- **b.** Motor vehicle crashes
- **c.** Industrial accidents
- **d.** Falls

2. In urban locales in the United States, such as Cook County, Illinois, the most common cause of death in pregnant patients is:
- **a.** Complications of pregnancy, labor, and delivery
- **b.** Motor vehicle crashes
- **c.** Gunshot wounds
- **d.** Stab wounds

3. Most trauma in pregnancy is a result of:
1. Domestic violence
2. Motor vehicle crashes
3. Gunshot wounds
4. Minor trauma
   - **a.** 1, 2, 3
   - **b.** 1, 3
   - **c.** 2, 4
   - **d.** 4 only
   - **e.** All of the above

4. Adverse pregnancy outcomes in severely injured pregnant patients with maternal shock are:
- **a.** 100%
- **b.** 80%
- **c.** 50%
- **d.** 25%

5. In minor abdominal trauma, such as a simple fall:
1. Abruptio placentae may occur.
2. If there are no pelvic signs or symptoms, abruptio placentae may occur.
3. Fetal demise may result.
4. Direct fetal trauma is unlikely.
   - **a.** 1, 2, 3
   - **b.** 1, 3
   - **c.** 2, 4
   - **d.** 4 only
   - **e.** All of the above

6. In the 1990s, a pregnant woman's highest mortality was associated with:
- **a.** Toxemia
- **b.** Postpartum hemorrhage
- **c.** Postpartum infection
- **d.** Trauma

7. Today, a pregnant woman's highest mortality is associated with:
- **a.** Obstetric-related diseases (such as toxemia) treated in an urban setting
- **b.** Urban trauma
- **c.** Obstetric-related diseases treated in a rural setting
- **d.** Rural trauma

8. Fetal mortality correlates most with:
- **a.** Presence of pelvic trauma
- **b.** Maternal mortality
- **c.** Presence of maternal shock
- **d.** Presence of head trauma

9. Anatomic differences between the nonpregnant and the obstetric patient include all the following except:
- **a.** Obstetric patient has a risk of decreased venous return causing a decrease in cardiac output.
- **b.** Obstetric patient has a cephalad displacement of her diaphragm.
- **c.** Obstetric patient has a decreased perfusion to the extrauterine pelvis.
- **d.** Obstetric patient has a greater size of pelvic vessels than the nonpregnant patient.

10. Physiological differences between the nonpregnant and the obstetric patient include all of the following except:
- **a.** In the pregnant patient, the resting heart rate is normally 10–15 bpm slower.
- **b.** In the pregnant patient, the resting respiratory rate is more rapid, thereby lowering the $PaCO_2$.
- **c.** In the pregnant patient, the blood pressure may be 10%–15% lower.
- **d.** In the pregnant patient, the gastric emptying rate is slower.

11. In penetrating midabdominal trauma during the latter months of pregnancy, visceral injuries to the mother:
- **a.** Occur in only 20% of pregnant patients as compared to over 70% of nonpregnant patients
- **b.** Occur in over 70% of pregnant patients as compared to only 20% of nonpregnant patients
- **c.** Occur in equal frequency in pregnant and nonpregnant patients
- **d.** Death is more likely due to nonobstetric injury and not uterine injury.

12. Unlike abruptio placentae, uterine rupture:
- **a.** Is more common
- **b.** May result from minor trauma
- **c.** May present without abdominal pain, tenderness, and hypovolemia signs
- **d.** Is more likely to be associated with maternal death due to the concurrent nonobstetric injuries

13. A multiple-trauma patient has an HR of 110, an RR of 26, anxiety and a confused mental status. The patient is 7 months pregnant. The class shock and estimated blood loss would be:

a. No shock; simple anxiety
b. Class I; 10% blood loss
c. Class II; 20% blood loss
d. Class III; 30% blood loss
e. Class IV; 40% blood loss

14. The most sensitive method of detecting possible abruptio placentae in the pregnant trauma patient is:
a. Vaginal bleeding; if none, abruptio is unlikely
b. Palpation of fundus by the paramedic; if nontender, abruptio is unlikely
c. Fetal monitoring by the paramedic; if fetal heart tones (FHT) are greater than 120, abruptio is unlikely
d. Electronic monitoring of uterine contractions

15. In trauma during pregnancy, fetomaternal hemorrhage, or fetal blood entering the maternal circulation:
a. Is not of clinical significance after minor trauma
b. Often results in maternal exsanguination
c. Is more likely, depending upon the severity of injury
d. Should always be treated with Rh immunoglobulin if the pregnant patient is Rh negative

16. In a 7-month pregnant multiple-trauma patient with an HR of 110, an RR of 26, anxiety and a confused mental status, the initial out-of-hospital treatment would be:
a. D_5W, keep vein open (KVO) rate
b. Crystalloid, KVO rate
c. Crystalloid, 250 mL/hr
d. Crystalloid, 1–2 liters infused rapidly
e. None of the above

CRITICAL THINKING

- Upon arrival at the scene of an MVC, you are led to a patient sitting on the curb. The patient is a 28-year-old female who was the driver of a vehicle that was struck head-on by a second vehicle. The impact was low speed and there is approximately 24 inches of crush to the front of the vehicle. The patient is obviously pregnant but has had no prenatal care and does not know her due date. She denies injury. Shoulder and lap restraints were worn. The car was not equipped with an airbag. Upon physical exam, the patient is conscious, alert, and oriented ×3. Skin is warm, dry, and normal in color. Capillary refill time is 2 seconds. Blood pressure is 136/P (palpation), HR 110, RR 36, and SpO_2 (oxygen saturation) 97%. Breath sounds are clear and equal bilaterally. The abdomen is soft and nontender, but there is a lap belt abrasion that extends across the abdomen at the level of the umbilicus. The fundus extends approximately 36 cm above the pubis. The patient refuses transport, stating she is uninjured. Based upon the physical examination, what is the gestational age of the fetus? Despite the lack of physical signs of injury, what injuries may exist? How reliable are the vital signs at predicting injury? Should this patient be encouraged to consent to transport? Explain the physiological changes of pregnancy that are relevant to this patient.
- You are dispatched to the scene of a gunshot wound. Your patient is a 32-year-old female who appears to be 36–38 weeks pregnant. She has sustained a gunshot wound to the left temple. The wound appears to be from a small-caliber handgun. There is minimal external hemorrhage. The patient is pulseless and apneic and cardiopulmonary resuscitation (CPR) is being performed by the first responders. The pupils are fixed and dilated. Witnesses to the shooting indicate that 10 minutes has elapsed since the shooting. Transport time to the hospital will be 12 minutes. Should CPR be discontinued on the scene? Why or why not? What treatment, if any, should be initiated on this patient?
- Recently the media reported the case of a perimortem C-section that was performed by two field paramedics on the order of their medical control. The mother was never resuscitated and expired at the scene and the infant survived only a few days. The paramedics then faced reprimands from their employer for performing a procedure outside their scope of practice. Evaluate the merits of performing a C-section in the field. If faced with the same situation, how would you respond?

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