Resuscitation in Pregnancy
Elizabeth M. Datner and Susan B. Promes

KEY POINTS

- Displace the gravid uterus off the great vessels either manually or with a left lateral tilt to avoid aortocaval compression.
- Gain intravenous access above the diaphragm.
- Preoxygenate with 100% oxygen before intubation in anticipation of a more rapid onset of hypoxemia.
- In a pregnant woman, hands for cardiopulmonary resuscitation, chest tubes, and defibrillator paddles should be placed higher on the chest wall.
- Cardioversion and defibrillation will not harm the fetus.
- When the uterus is palpable above the umbilicus and the mother is in cardiac arrest, perform cesarean section immediately.
- Continue cardiopulmonary resuscitation during and after perimortem cesarean section and consider therapeutic hypothermia in a comatose patient with return of spontaneous circulation.
- For an Rh-negative woman who has vaginal bleeding after trauma, administer Rh immunoglobulin (RhoGAM): a 50-mcg dose in the first trimester and a 300-mcg dose in the second or third trimester.
- In any pregnant woman at more than 24 weeks’ gestation who suffers trauma to the abdomen, fetal monitoring should be initiated as soon as possible and be maintained for 4 to 6 hours.

SCOPE

Resuscitation of a pregnant woman is an infrequent event. Cardiac arrest statistics are difficult to quantify, but cardiac arrest reportedly occurs in roughly 1 in 30,000 near-term pregnancies. In more recent data suggest an increase in maternal mortality from cardiac arrest, with frequency rates of 1 in 20,000. In the event of cardiac arrest in a pregnant woman, two lives must be resuscitated. Quick, decisive management is paramount for the likelihood of the mother and her unborn child. Knowing exactly what to do and acting quickly ensure the best possible outcome for the mother and her unborn child.

ANATOMY AND PHYSIOLOGY

What are generally considered abnormal vital signs in non-pregnant people may actually be within the normal range for a pregnant woman. In gravid females, the heart rate and respiratory rate are increased. In the second trimester, blood pressure is decreased by 5 to 15 mm Hg, but it returns to normal near term. Hypoxemia occurs earlier in pregnant patients because of diminished reserve and buffering capacity. Pregnant patients have a slight respiratory alkalosis—\( \text{PCO}_2 \) of 30 mm Hg and pH of 7.43—that must be taken into account when interpreting arterial blood gas values. Central venous pressure decreases in pregnancy to a third-trimester value of 4 mm Hg. A pregnant woman has less respiratory reserve and greater oxygen requirements. The gravid uterus pushes up on the diaphragm, which results in reduced functional residual capacity. Minute ventilation and tidal volume rise, as does maternal oxygen consumption. The basal metabolic rate increases during pregnancy. The greater oxygen demands of the unborn child significantly alter the mother’s respiratory physiology, and the mother hyperventilates to meet the demands of the fetus. A pregnant patient at baseline is in a state of compensatory respiratory alkalosis because of excessive secretion of bicarbonate. A pregnant woman’s ability to compensate for acidosis is impaired. Other physiologic changes that may affect resuscitation are airway edema and friability, reduced chest compliance, and higher risk for regurgitation and aspiration.

As the uterus grows, it moves from the pelvis into the abdominal cavity, which pushes the contents of the abdominal cavity upward toward the chest. In late pregnancy, the gravid uterus compresses the aorta and inferior vena cava and limits venous return to the heart. Stroke volume is decreased when a near-term pregnant woman is lying on her back and increased when the uterus is moved away from the great vessels. A woman in the second or third trimester of pregnancy should be placed in the left lateral tilt position, or the uterus should be manually displaced to the left to optimize cardiac output and venous return. During late pregnancy, cardiac output is increased. Pulmonary capillary wedge pressure remains unchanged, as does the ejection fraction.

Electrocardiographic changes, including left axis deviation secondary to the diaphragm moving cephalad and changing the position of the heart, are also present during pregnancy. Q waves are present in leads III and aVF, and flattened or inverted T waves are seen in lead III.

During pregnancy blood volume increases, which causes a dilution anemia. The average hematocrit value is 32% to 34%. White blood cell counts are higher than normal and platelet counts are lower in pregnancy. Blood urea nitrogen and serum creatinine values are lower than normal, as are cortisol values. The erythrocyte sedimentation rate is increased. Albumin and total protein levels are decreased. Fibrinogen levels double in pregnancy, so a patient with disseminated intravascular coagulation could have a normal fibrinogen level.

Pregnancy-related changes can be seen on radiographic studies. A chest radiograph of a pregnant woman shows an...
increased anteroposterior diameter, mild cephalization of the pulmonary vasculature, cardiomegaly, and a slightly widened mediastinum. Widening of the sacroiliac joints and pubic symphysis are apparent on imaging of the pelvis. Radiography should not be avoided in a pregnant woman because of concerns about radiation exposure of the fetus, which can simply be shielded. Ultrasonography can be used at the bedside to identify fluid in the abdomen, pelvis, and pericardium and to evaluate fetal activity and heart rate. Fetal well-being is closely linked to the well-being of the mother, so all studies indicated for diagnosis and treatment of the mother should be performed.

**DIFFERENTIAL DIAGNOSIS**

Pregnant women are generally young and healthy. The rare cardiac arrest in a gravid female may be due to venous thromboembolism, severe pregnancy-induced hypertension, amniotic fluid embolism, or hemorrhage. In addition to such pregnancy-related problems, pregnant women are not exempt from common conditions that affect the general population. Trauma and sepsis may lead to cardiopulmonary failure and the need for maternal resuscitation. Box 11.1 lists key etiologic factors leading to cardiac arrest in pregnant patients.

**HEMORRHAGE**

During routine vaginal delivery, the average blood loss is 500 mL. Excessive blood loss or postpartum hemorrhage complicates 4% of vaginal deliveries. Common causes of hemorrhage around the time of delivery are uterine atony (excessive bleeding with a large relaxed uterus after delivery), vaginal or cervical tears, retained fragments of placenta, placenta previa, placenta accreta, and uterine rupture. Hereditary abnormalities in blood clotting may cause hemorrhage, so inquiries about excessive bleeding, known disorders, and family history are relevant in a patient with excessive bleeding.

**NONHEMORRHAGIC SHOCK**

Causes of nonhemorrhagic obstetric shock—pulmonary embolism, amniotic fluid embolism, acute uterine inversion, and sepsis—are uncommon but are responsible for the majority of maternal deaths in the developed world. These conditions must be diagnosed and treated expeditiously. Patients in whom pulmonary embolism is suspected should be administered heparin and then undergo diagnostic imaging. Although fibrinolytic agents are contraindicated in pregnancy, they have been used successfully in patients with life-threatening pulmonary embolism and ischemic stroke. Treatment of amniotic fluid embolism is supportive, the goals being to maintain maternal oxygenation and support blood pressure. Some case reports describe success with the use of cardiopulmonary bypass to treat women suffering from amniotic fluid embolism.

Acute uterine inversion can also cause shock. Cardiovascular collapse complicates approximately half the cases of acute uterine inversion. Classically, the extent of the shock is out of proportion to the blood loss noted. One theory to explain this observation is that a parasympathetic reflex causes neurogenic shock from stretching of the broad ligament or compression of the ovaries (or both) as they are drawn together. Uterine replacement combined with vigorous fluid resuscitation, including blood transfusion as required, should reverse the hypotension.

**TRAUMA**

Traumatic injuries occur commonly in pregnancy and are the leading cause of maternal death; they account for more than 46% of cases. Motor vehicle crashes, assaults, and falls are the most common causes of injuries. Pregnant women are at increased risk for domestic violence, and this possibility should be considered and the police notified when warranted.

Fetal outcome is affected when the mother becomes hypotensive or acidic as a result of major injury. Maternal vital signs and physical symptoms do not predict fetal distress in women with minor trauma. Only cardiotocographic monitoring for a minimum of 4 to 6 hours is useful in predicting fetal outcome. After even apparently minor falls women should undergo fetal monitoring.

In pregnant women suffering blunt trauma, most fetal deaths occur as a result of placental abruption. Classic symptoms are abdominal cramps, vaginal bleeding, uterine tenderness, and hypovolemia (several liters of blood can accumulate in the uterus). None of these findings are sensitive and cannot be relied on, so monitoring is required.

**DIAGNOSTIC TESTING**

**INTERVENTIONS AND PROCEDURES**

A fundamental principle in treating pregnant women is that fetal well-being depends on maternal well-being. As with all patients in the emergency department (ED), resuscitation...
starts with the ABCs (airway, breathing, and circulation). One
hundred percent oxygen should be administered to the mother
early. Hypoxia should be treated aggressively in this patient
population because when the mother is hypoxic, oxygen is
shunted away from the fetus. Additionally, preoxygenation is
important because apnea results in more rapid hypoxia in the
setting of pregnancy. Rapid-sequence induction with precau-
tions for aspiration is essential before intubation. Aggressive
volume resuscitation, administration of vasopressors if needed,
and close attention to the patient’s body position are all very
important in the treatment of hypotension in a pregnant
patient. Fetal heart monitoring and, ideally, cardiotocographic
monitoring should be initiated as soon as possible for patients
in the second or third trimester of pregnancy.8

A commercially produced wedge called a Cardiff wedge
is available to aid in the resuscitation of pregnant women.
It can be placed under the woman’s right side to support her
back while she lies in the preferred left lateral tilt position. In
the absence of a wedge, a human wedge can be used, with
the patient being tilted on the bent knees of a kneeling
rescuer. Pillows, towel rolls, and blanket rolls are readily
available in EDs and accomplish the same purpose of
angling the woman’s back 30 to 45 degrees from the floor
(Fig. 11.1). If for some reason the patient must lie on her back,
as in the case for adequate cardiopulmonary resuscitation
(CPR), a member of the health care team should manually
displace the uterus to the left so that it does not rest on the
great vessels.

The American Heart Association (AHA) basic life support
guidelines should be followed with two modifications:

- Move the uterus off the great vessels.
- Adjust the hand position for CPR cephalad to account for
displacement of the thoracic contents by the gravid uterus.

The AHA advanced cardiac life support (ACLS) guidelines
for medications, intubation, and defibrillation for patients in
cardiac arrest should be followed for gravid females with one
simple exception—a change in placement of the defibrillation
paddles and pads:

- Place one paddle below the right clavicle in the midclavicular
  line.
- Position the second paddle outside the normal cardiac apex
  so that it avoids breast tissue.7

Defibrillation energy requirements remain the same (Fig.
11.2).9 Defibrillation will not harm the fetus. ACLS medica-
tions should be used as needed. It is reasonable to remove
external or internal fetal monitoring devices during electrical
shock of the mother because of the possibility of creating
an electrical arc to the monitoring equipment, but this is
unlikely with the electrical current applied to the maternal
thorax. Box 11.2 lists the U.S. Food and Drug Administra-
tion categories for the various ACLS drug options during
pregnancy.

In pregnant patients with trauma who are in need of a tho-
racostomy, the chest tube must be placed one or two intercos-
tal spaces higher than normal to avoid diaphragmatic injury.
An open supraumbilical approach should be used for diagno-
sic peritoneal lavage in a pregnant patient, with the gravid
uterus palpable on abdominal examination.

If return of spontaneous circulation (ROSC) is achieved,
effort must be directed at further hemodynamic stabiliza-
tion. Post–cardiac arrest therapeutic hypothermia has been success-
f ul in the setting of early pregnancy and is recommended as
for nonpregnant patients.10 In a comatose post–cardiac arrest
patient with ROSC, the patient should be cooled as soon as
possible and within 4 to 6 hours to 32° C to 34.8° C for a
12-to 24-hour duration to gain the best possible neurologic
outcome. If a perimortem cesarean section has not been per-
formed because of gestational age less than 24 weeks, fetal
monitoring should be performed during hypothermia in anti-
cipation of bradycardia.11

IMAGING

Ultrasonography is an important method for assessment of
both the mother and fetus, but additional radiographic studies
are often required. Shielding can ensure that exposure even
with maternal head and chest computed tomography (CT) can
be kept below the 1-rad (1000-millirad) limit. Intrauterine
exposure to 10 rad (10,000 millirad) produces a small increase
in childhood cancer; exposure to 15 rad creates a risk for
mental retardation, childhood cancer, and a small head. A
head or chest radiograph delivers less than 1 millirad to the
shielded gravid uterus. A lumbar spine, hip, or kidneys-
ureters-bladder radiograph delivers more than 200 millirad.
A CT scan of the head delivers less than 50 millirad to the
shielded uterus, and a chest CT scan provides an exposure of
less than 1000 millirad. In sum, important radiographic studies
of the head, neck, and chest can safely proceed if the uterus
is shielded.

FETOMATERNAL TRANSFUSION

After the 12th week of pregnancy, when the uterus rises
above the pelvic rim and becomes susceptible to trauma, fetal
blood can theoretically cross into the maternal circulation
after significant trauma. A 50-mcg dose of Rh immuno-
oglobulin (RhoGAM) is used when the mother is Rh negative.
During the second and third trimesters a 300-mcg dose is
administered, which protects against 30 mL of fetomaternal
hemorrhage. A 16-week fetus has about a 30-mL volume
of blood, so the entire blood volume is covered by the 300-
mcg dose.

Pregnant patients in the second or third trimester who suffer
major traumatic injury could theoretically have fetomaternal
transfusion that exceeds the coverage provided by the 300-mcg dose. This situation is rare and occurs in less than 1% of pregnant patients after trauma. In patients with major trauma and advanced pregnancy, the Kleihauer-Betke test should be considered, especially when significant vaginal bleeding is present. Rh immunoglobulin is effective when administered within 72 hours, so the test does not have to be performed in the ED.

**PERIMORTEM CESAREAN SECTION**

The two goals of perimortem cesarean section are to improve the unstable hemodynamics of the mother and minimize morbidity and mortality in the child. If resuscitative efforts, including ACLS algorithms and alleviation of aortocaval compression, fail to improve maternal hemodynamics, perimortem cesarean section must be considered. The likelihood that perimortem cesarean section will result in a living and neurologically normal infant is related to the interval between onset of maternal cardiac arrest and delivery of the infant. The gestational age of the neonate is also critical. If cesarean section is performed in the ED, it should be done rapidly. Time is of the essence. Fetal viability outside the uterus is best beyond 24 weeks’ gestation, but it is not always possible to know the exact gestational age in the ED. On the basis of case reports, it is recommended that cesarean section be performed in the ED if the gestational age is believed to be more than

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**Fig. 11.2 Algorithm for resuscitation of a pregnant patient.** CPR, Cardiopulmonary resuscitation.
At this stage of pregnancy, the fundus is likely to be palpable at or above the level of the umbilicus. The child should be delivered within 5 minutes of maternal cardiac arrest, so the procedure should be initiated within 4 minutes of failed CPR of the mother. The procedure is summarized in Box 11.3. Maternal CPR should be maintained throughout the procedure to optimize blood flow to the uterus and the mother and should be continued after cesarean section. Once delivery is accomplished, ED personnel should be prepared to resuscitate the neonate. It is important to note that published and anecdotal reports describe return of maternal blood pressure and maternal survival after perimortem cesarean section. Successful resuscitation of a pregnant woman and her unborn child requires a coordinated team approach.

**CONCLUSION**

In the setting of resuscitation, a pregnant woman poses challenges given the physiologic and anatomic changes associated with pregnancy. Remembering these normal adjustments that occur in gravid women is critical. Aortocaval compression must be avoided during resuscitation of a pregnant woman. Appropriately diagnosing the cause of the patient’s medical problem while being mindful of the ABCs of resuscitation is a must. Thankfully, cardiac arrest is an uncommon event in pregnant women. When it occurs later in pregnancy, perimortem cesarean section may improve the outcome of the infant and mother if performed in a timely manner. As with all resuscitations, a team effort is mandatory, but possibly even more so in this setting because the emergency practitioner is caring for two patients whose lives are very tenuous and time is of the essence.

**REFERENCES**

References can be found on Expert Consult @ www.expertconsult.com.
REFERENCES