Approximately 1 in 500 (0.2%) of pregnant women require surgery for nonobstetric conditions (1). Appendectomy, cholecystectomy, and adnexal procedures constitute the most common surgeries during pregnancy. Although pregnancy outcomes after surgery are often good, fetal loss rates can be as high as 2% to 20%, depending on the condition (1). This fact highlights the importance of thoughtful management in these cases. Trauma is an additional important cause for surgical intervention during pregnancy. Most series report the incidence of trauma to be approximately 8%, or 1 in 12 pregnancies (1.2). The evaluation of pregnant patients with surgical disorders and trauma is complex, owing to the fact that the woman and her fetus are both regarded as patients. The well-being of the fetus depends entirely on the stability of the physiologic processes of the pregnant woman. Knowledge of normal physiologic changes of pregnancy is essential, as increased morbidity and mortality for mother or baby can result from delays in diagnosis and treatment. This chapter will summarize the approaches to the gravid patient with surgical disease, including clinical assessment, diagnostic studies, interpretation of laboratory values, and specific considerations for various clinical conditions.
Acute Abdomen and Trauma during Pregnancy

October 24, 2008 13:9

As in nonpregnant individuals, the first task is to ensure that airway, breathing, and circulation (ABCs) are adequate. It is important to give first priority to these basic elements, because adequate maternal oxygenation and uteroplacental perfusion are the means by which the fetus is also resuscitated. Attention should always be paid to achieving hemodynamic stability in the mother first, before evaluation and treatment of pregnancy issues. Physiologic adaptations of pregnancy affect the clinician’s ability to address the ABCs, and key points that should be considered in the pregnant trauma victim are summarized in Table 100.1.

Once assured that the patient is hemodynamically stable, attention is turned to a more detailed secondary assessment. This is centered on evaluation of specific injuries or organ systems, as well as the pregnancy itself. A focused patient history is central to the evaluation of abdominal pain or trauma during pregnancy. Abdominal symptoms can be nonspecific during pregnancy, so it is especially valuable to clarify the cause of pain. The symptoms are not typical in the latter two trimesters. Pyrosis due to acid reflux is reported by many gravidas, but is often easily relieved with antacids. Constipation is a common complaint, due to the increased transit time of the gastrointestinal tract. Transient discomfort or intermittent contractions are not rare, but persistent, rhythmic, or severe abdominal pain merits evaluation. In all trimesters, right lower quadrant pain may signal appendicitis. Colicky right upper quadrant pain is suggestive of cholelithiasis, and the symptom profile for biliary tract disease in pregnant women is similar to that of their nonpregnant counterparts.

In the third trimester, it is important to evaluate and exclude the possibility of obstetric complications such as preterm labor (PTL), premature rupture of membranes, placental abruption, and intrapartum infection. A basic obstetric (OB) triage evaluation includes external fetal heart rate monitoring, assessment of contractions, palpation of the uterine fundus, speculum examination for pooling, Nitrazine and fern tests, and digital cervical examination.

A suggested approach to the initial evaluation of the pregnant patient with surgical diseases or trauma is shown in Table 100.2.

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DIAGNOSTIC STUDIES

Laboratory Values

When common laboratory tests are evaluated during pregnancy, results can be misinterpreted or confusing unless pregnancy-specific norms are considered. Physiologic changes of pregnancy, including increased blood and plasma volumes, hormone production, and altered metabolic clearance, cause changes in the plasma concentration of many analytes. Selected laboratory values of interest are displayed in Table 100.3 (3).

Amniocentesis

In selected cases, evaluation of amniotic fluid may be important to exclude intrauterine infection as a cause of abdominal pain. Abnormal findings in amniotic fluid suggestive of bacterial infection include bacteria seen on Gram stain and/or positive culture. Low glucose, typically less than 15 mg/dL, and a high white cell count are also highly suspicious. In addition, inflammatory markers such as high granulocyte colony-stimulating factor (G-CSF), tumor necrosis factor (TNF)-α, interleukin (IL)-1, and IL-6 are strongly suggestive of amnionitis. Because there is a risk of preterm contractions, premature rupture of the membranes, or fetal loss due to the procedure, amniocentesis should be done on a selective basis. However, these data can be extremely useful when the clinical picture is unclear (5).

<table>
<thead>
<tr>
<th>TABLE 100.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORMAL LABORATORY VALUES DURING PREGNANCY</td>
</tr>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>WBC increased</td>
</tr>
<tr>
<td>Hemoglobin decreased</td>
</tr>
<tr>
<td>Hematocrit decreased</td>
</tr>
<tr>
<td>Platelet decreased</td>
</tr>
<tr>
<td>Fibrinogen increased</td>
</tr>
<tr>
<td>D-Dimer positive</td>
</tr>
<tr>
<td>HCO₃— mild acidosis</td>
</tr>
<tr>
<td>BUN decreased</td>
</tr>
<tr>
<td>Creatinine decreased</td>
</tr>
<tr>
<td>Albumin decreased</td>
</tr>
<tr>
<td>ALT, AST unchanged</td>
</tr>
<tr>
<td>Bilirubin unchanged</td>
</tr>
<tr>
<td>Alkaline phosphatase increased</td>
</tr>
</tbody>
</table>

ALT, alanine aminotransferase; AST, aspartate aminotransferase; BUN, blood urea nitrogen; HCO₃, bicarbonate; WBC, white blood cell count.


Obstetric Ultrasound

Obstetric ultrasound serves to confirm fetal viability and offers the opportunity to assess fetal size, anatomy, amniotic fluid volume, and placental location (6). This information provides the basis for decision making in pregnant patients. A basic study can be completed quickly at the bedside and can be done at the time of sonographic evaluation for other indications, such as right upper quadrant ultrasound.

Sonography for Trauma

In the setting of trauma, surgeons-performed focused assessment with sonography for trauma (FAST [focused assessment with sonography for trauma]) is a useful screening tool. At one institution, FAST-US was used not only for trauma evaluation, but as a screen for pregnancy, and 18 of 144 (11%) of patients were newly diagnosed with pregnancy during this procedure. Because of this, FAST-US contributed to a significant decrease in radiation exposure when compared to other trauma patients diagnosed with pregnancy using this procedure. Because of this, FAST-US contributed to a significant decrease in radiation exposure when compared to other trauma patients diagnosed with pregnancy based on serum human chorionic gonadotropin (HCG) screening (7).

FAST-US done to detect intra-abdominal bleeding after trauma has a similar sensitivity and specificity among pregnant and nonpregnant patients. In one study of 127 pregnant trauma patients, ultrasound examination identified
intrapertoneal fluid in 5 of 6 patients and was negative in 117 of 120 patients without intra-abdominal injury. Patients with false-negative scans had serous fluid (8). In reproductive-age women with blunt abdominal trauma, free fluid in the cul de sac has been associated with a higher injury rate compared to no free fluid in both pregnant and nonpregnant women. Thus, free fluid is not necessarily a normal or physiologic finding (9).

Ultrasoundography is of limited value in the diagnosis of placental abruption after trauma. In fact, ultrasound may miss up to 50% to 58% of cases. The ecchymosis may be very similar to that of placental tissue, so identification of retroplacental bleeding is not always possible (10,11).

Appendicitis. Graded compression ultrasonography is the initial test of choice in the assessment of appendicitis during pregnancy. Imaging is focused on the self-reported area of maximal pain. The overall accuracy of this technique in diagnosing appendicitis is 86%. However, accuracy may be limited in the setting of a retrocecal appendix or perforated appendicitis, both of which are more common in the gravid patient. Color Doppler sonography can be used as an adjunct for improving the sensitivity of the test. In a series of 42 women with suspected appendicitis during pregnancy, ultrasound was found to be 100% sensitive, 96% specific, and 98% accurate in diagnosing appendicitis (12).

Biliary Tract Disease. The diagnosis of cholelithiasis during pregnancy is similar to that in the nonpregnant patient. Visualization of stones in the gallbladder is reported to be as high as 95% using sonography. Although detection of gallstones in a pregnant right upper quadrant pain is suggestive of acute cholecystitis, other features should be considered, such as gallbladder wall edema or thickening >4 to 5 mm. The Murphy sign can also be elicited, as the patient experiences pain from pressing the transducer over the gallbladder (13).

Computed Tomography

Computed tomography (CT) may be considered for evaluation of the abdomen if the initial examination or other studies are equivocal. The most common indication for CT is blunt abdominal trauma after motor vehicle crashes (13). Other common indications include appendicitis and renal colic. One study of helical CT revealed good success in detecting injuries after trauma during pregnancy. In this cohort, 17 women (35%) had normal evaluations, 11 patients (23%) had abnormal placental enhancement, and 1 uterine rupture occurred. Fifteen women (31%) had nonuterine injuries, and 27% had both uterine and other maternal injuries. The estimated radiation exposure due to helical CT was estimated to be 8.7 to 17.3 mGy, depending on technique (14). Although there are limited data regarding the accuracy of CT for the diagnosis of appendicitis during pregnancy, one series of seven patients correctly identified all cases (15). Depending on the protocol, pelvic CT can deliver a dose of radiation to the fetus as high as 2 to 5 rad. Although the threshold for teratogenesis may not be reached with this level of radiation exposure, the relative risk of childhood cancer may be increased. The odds of dying of childhood cancer increase from a baseline of 1 in 2,000 to approximately 2 in 2,000 after exposure of 5 rads (15,16). The potential risks and benefits of CT during pregnancy should be discussed with patients. CT contrast seems safe to use in pregnancy and should be administered in the usual fashion (6).

Magnetic Resonance Imaging

In recent years, magnetic resonance imaging (MRI) has been used as a tool to identify the cause of abdominal pain during pregnancy. MRI studies confirm that the appendix and cecum are superiorly displaced as pregnancy advances (17). In one series, MRI was able to correctly identify the appendix in 10 of 12 cases where sonography was uninformative (18). In another study, 29 pregnant women were evaluated with MRI for abdominal or pelvic pain, and correct prospective diagnoses were made in all but one patient (19). More recently, a series of 51 patients were evaluated for abdominal pain with both sonography and MRI. Four cases with appendicitis were found, with three inconclusive results. Ultrasound revealed appendicitis in only two of the confirmed cases. MRI compared favorably with sonography— the overall sensitivity was 100%, specificity 93.5%, and accuracy 94% for detecting appendicitis (20).

According to American College of Radiology guidelines, “Pregnant patients may be approved to undergo MR studies at any stage of pregnancy, so long as the attending radiologist determines the risk–benefit ratio warrants that the study be done” (21). After conferring with the referring provider, the radiologist should document the following:

1. The information from the MR will obtain information not obtainable from nonionizing means
2. The data are needed to affect care given to the patient or fetus during the pregnancy
3. The referring physician does not feel it is prudent to wait to obtain the data until after the patient is no longer pregnant (21)

Gadolinium contrast is not recommended for use in pregnancy. Gadolinium crosses the placenta and enters the fetal circulation. It enters the amniotic fluid, where it is swallowed by the fetus and absorbed (22). It is a pregnancy category C drug, since animal studies have revealed adverse effects but no controlled studies have been performed in humans.

Decisions about contrast use should be made on a case-by-case basis after considering the risks and benefits. Written informed consent for MRI during pregnancy is suggested (21). MRI is not recommended for acute evaluation of severely ill persons, because examinations can be lengthy and there is limited access to patients.

SPECIFIC MANAGEMENT

Specific Conditions: Trauma

Trauma complicates 1 in 12 pregnancies. Two thirds of trauma cases in pregnant women are due to motor vehicle crashes, and other common causes are falls, burns, and penetrating wounds. Blunt abdominal trauma is the most frequent mechanism of injury. One percent to 20% of gravidas experience domestic abuse, and up to 60% of women affected report two or more assaults during pregnancy. At one center, nearly 3% of all trauma patients were pregnant, and 11% of these pregnancies were diagnosed during the trauma evaluation (23).

Fortunately, severe trauma requiring admission to the ICU is infrequent (3 in 1,000 pregnancies). Maternal death due to trauma is estimated to be 1.9 per 100,000 live births.
representing the leading cause of nonobstetric maternal death. It is estimated that 1,300 to 3,900 pregnancies are lost due to maternal trauma each year (24). Mild maternal injuries carry a 1% to 5% fetal loss rate, whereas life-threatening trauma is associated with loss rates up to 40% to 50%. Because mild trauma is more prevalent, most fetal loss is due to minor ma-
ternal injury (24). Population-based data indicate that motor vehicle crashes account for 82% of fetal deaths after trauma, with an overall rate of 3.7 per 100,000 live births. The highest rate of fetal death due to trauma is seen in patients between 15 and 19 years of age (25,26).

One study of 271 pregnant women observed after blunt ab-
dominal trauma showed that fetal death was associated with ejection from vehicle, motorcycle crash, pedestrian collision, maternal death, maternal tachycardia, abnormal fetal heart rate (FHR), lack of restraints, and an injury severity score (ISS) greater than 9. Preterm labor was associated with gestational age over 33 weeks, assault, and pedestrian collisions (10). As many as 20% of injured pregnant patients test positive for drugs or alcohol, and one in three do not report using seat belts (27). The worst outcomes take place among those who deliver during their hospital stay for trauma. In this group of patients, the odds ratios (OR) are strikingly high for mater-
nal death (OR 69), fetal death (OR 4.7), uterine rupture (OR 43), and abortion (OR 9.2), compared to women who deliver later or had no trauma (28). Interestingly, fetal survival was 78% among fetuses born to mothers with a high injury sever-
ity score (less than 25), whereas maternal survival was only 44%. In contrast, for women with an ISS less than 16, mater-
nal survival was 100% but the fetal survival was only 73%, giving support to the concept that even minor maternal injury places fetuses at risk (29).

Besides fetal death, complications such as abruptio pla-
centa, preterm labor, and fetomaternal hemorrhage can con-
tribute to morbidity and mortality among survivors. The di-
gnosis of abruptio is based on signs and symptoms. One of the best indicators of placental abruption is cardiotocogra-
phy. In patients with a normal study, the risk of abruption after trauma is approximately 1% to 5%. In patients with more than six contractions per hour or abnormal fetal heart rate patterns, the risk of abruption can be 20% or higher.

All women over 24 weeks’ gestation should undergo an ini-
tial evaluation with cardiotocographic monitoring for 4 to 6 hours after trauma. Four to 6 hours of observation is sufficient for patients who have experienced minor trauma, and who are hemodynamically stable, with a negative primary evaluation, FAST-US, and reassuring cardiotocography (29). An extended period of observation for 24 hours or more is indicated for women with six or more contractions per hour, nonreassur-
ing FHR patterns, vaginal bleeding, uterine pain or tenderness, premature rupture of membrane (PROM), or serious maternal injury. Consideration for prolonged monitoring is advised if laboratory data are abnormal, such as decreased fibrinogen or a positive Kleihauer-Betke (KB) test. Patients with these charac-
teristics are more likely to experience abruption or other com-
plications (30).

Kleihauer-Betke testing to detect fetomaternal hemorrhage should be considered for patients beyond the first trimester, es-
pecially those with Rh-negative status. RhoG 300 μg IM should
be administered to all pregnant women with an Rh-negative blood type. Should the KB test be positive, the amount of fetal bleeding can be quantified and additional RhoG administered as necessary. A positive KB test may also be an indicator for adverse pregnancy outcome after trauma. One study reviewed 166 pregnant trauma cases. In 78 of these cases, a KB test was done. The likelihood ratio for preterm labor was 20.8-fold if the KB was positive, whereas clinical assessment did not predict preterm birth accurately (31).

Pregnant women occasionally present with other types of injuries due to trauma to the head, pelvis, or chest. Pelvic frac-
tures, especially those involving the acetabulum, are associated with high maternal and fetal mortality rates. The mechanism of injury and severity influence mortality more than the classi-
fication type or trimester of pregnancy (32). Specific manage-
ment can be complex and requires the coordination of a mul-
tidisciplinary team. Penetrating injury is less common during pregnancy than other forms of trauma. The severity of mater-
nal abdominal or vascular injuries may be less than that of nongravid women, but rate of placental injury and fetal
loss tends to be high. Management is similar to that of non-
pregnant persons, with careful and prompt evaluation of the placenta and fetus.

Specific Conditions: Appendicitis

Acute appendicitis complicates approximately 1 in 1,500 preg-
nancies, making it the most common indication for nonobstet-
ric surgery during pregnancy. Overall, appendicitis may occur
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under 24 weeks’ gestation. For patients under 24 weeks’ gestation, the uterine size and location of the appendix may reduce access for laparoscopic procedures.

**Specific Conditions: Gallstones**

Cholelithiasis is common among pregnant women, seen in 3% to 4% of OB ultrasounds. Symptomatic gallstones occur less frequently, in approximately 1 in 1,000 cases. Half or more of patients experience recurrent bouts of biliary colic, making management a challenge. Traditional management consists of intravenous hydration, nothing by mouth or a low-fat diet, analgesics, and antibiotics. Cholecystectomy is required in 1 to 6 per 10,000 pregnancies. Typical indications for surgery include acute cholecystitis (38%), gallstone pancreatitis (28%), common bile duct stone (20%), and refractory pain (18%) (41). Laparoscopy has been used successfully during pregnancy for this indication, as discussed below. Traditional management emphasized deferring surgery for symptomatic cholelithiasis until after delivery. More recent data suggest that relapse of symptoms is common, seen in 38%, and labor induction due to refractory symptoms results in preterm delivery in some cases (42).

**Specific Conditions: Adnexal Surgery**

The true incidence of adnexal masses during pregnancy is unclear, but it is estimated to be approximately 1 in 200. Simple ovarian cysts compose the vast majority of cases, and most do not require intervention. Adnexal surgery is necessary in 1 in 1,300 pregnancies, typically due to masses greater than 6–8 cm, complex masses, and ovarian torsion. Malignancy is uncommon, seen in less than 10% of cases (43). Care should be taken to avoid removal of the corpus luteum in the first trimester prior to 10 weeks’ gestation, as this can result in disruption of the ongoing pregnancy unless progesterone supplementation is provided.

Historically, about half of surgeries performed were due to ovarian torsion (1). With improvements in the diagnosis of ovarian masses, surgery during pregnancy for asymptomatic patients with adnexal pathology has become more common. In one series of 44 cases of benign ovarian masses, most surgeries were performed successfully using laparoscopy in the middle trimester, and the most common diagnosis was benign cystic teratoma (44). Outcomes after adnexal surgery during pregnancy have been shown to be excellent, so long as surgery is performed after the 7th week of gestation (45).

**FETAL ASSESSMENT**

**Risk of Fetal Loss and Recommended Fetal Assessment**

A review of 55 papers regarding surgery during pregnancy, including 12,452 patients reported in the literature, confirms that the total fetal loss rate is low, at 2.5%. Birth defects after nonobstetric surgery occurred in 3.9%, and the miscarriage rate was 5.8%, likely not increased above background rates, but not proven due to lack of controls for comparison. Premature labor after nonobstetric surgery was seen in 3.5%, and the overall rate of preterm birth was 8.2%. The highest risk for preterm birth and fetal loss was seen with appendectomy. In this setting, the preterm delivery rate was 4.6%, and losses occurred in 10.9% of cases (46).

There is no consensus on optimal fetal monitoring in the perioperative period. During the first trimester, no specific fetal evaluation is necessary. Documentation of a live intrauterine pregnancy prior to surgery is prudent in those patients who present with abdominal complaints, primarily to exclude the possibility of ectopic pregnancy or nonviable gestation. From 14 weeks to 24 weeks, assessment of fetal heart tones is advised preoperatively and postoperatively. Perioperative assessment of contractions may be considered after 20 to 24 weeks.

At 24 weeks or beyond, cardiotocography should be performed before and after completion of surgery. In special circumstances, intraoperative monitoring may be chosen. It is important to remember that anesthetic drugs may be associated with decreased fetal heart rate variability, and misinterpretation has led to unnecessary emergency cesarean deliveries (47). In general, if the mother is normotensive and normoxemic, the fetus is well maintained. In the setting of trauma, an initial evaluation consisting of 4 to 6 hours of cardiotocography is warranted, as discussed above. Decisions about the timing, duration, and methods of fetal monitoring are dependent on the clinical scenario and procedure planned. Such decisions should be made in consultation with an obstetrician and input from an anesthesiologist.

**PRETERM LABOR AND TOCOLYSIS**

Preterm labor is a frequent event, due to either the underlying condition or the surgical intervention. In one series of 77 patients undergoing nonobstetric surgery, preterm labor was seen in 26% of patients in the second trimester and in 82% of those in the third trimester. Preterm labor was commonest after appendectomy and adnexal surgery. Actual preterm birth was seen in 16%. Only in 5%, however, was a clear link to the surgical procedure established (1). Another study of 62 pregnant subjects with nonobstetric abdominal surgery during pregnancy revealed 18% delivered preterm, similar to that institution’s preterm delivery rate but higher than the national average (48,49).

Most women with preterm labor will not deliver prematurely. Tocolytic medications are given to reduce uterine contractions in many cases, because it is difficult to predict accurately which women will go on to deliver prematurely. There is not a single drug of choice to manage preterm labor. The most commonly used tocolytic agents include inhaled nitroglycerin, magnesium sulfate, and indomethacin. The selection of a tocolytic drug should be based on gestational age, maternal health conditions, and possible side effects. Because tocolytic drugs prolong pregnancy for only 2 to 7 days, their chief utility is to allow for administration of steroids to improve fetal lung maturity (50).

In the postoperative patient, discomfort most often represents typical postoperative pain, but care should be taken to evaluate for preterm labor or signs of intrauterine infection. Clinical assessment includes physical examination with palpation of the fundus, cervical examination, and cardiotocography. Adjunctive tests to aid in predicting preterm birth include cervical length measurement, fetal fibronectin testing, and
possibly amniocentesis. Tocolysis should be undertaken with caution in the surgical patient, and obstetric consultation is recommended in the event of preterm contractions after surgery.

**Corticosteroids for Fetal Lung Maturity Enhancement**

All pregnant women between 24 and 34 weeks of gestation who are at risk of preterm delivery within 7 days should be given a single course of corticosteroids for fetal lung maturity enhancement (51). Recommended regimens for this indication include the following:

- Betamethasone, 12 mg intramuscularly every 24 hours for two doses
- Dexamethasone, 6 mg intramuscularly every 12 hours for four doses

These corticosteroids have been shown to cross the placenta and still retain their biologic effects. They have minimal maternal corticoid activity and cause little immune suppression. Overall, antenatal corticosteroid use has proved to be one of the most beneficial interventions in the treatment of preterm labor. Corticosteroids for fetal lung maturity enhancement reduce the incidence and severity of respiratory distress syndrome in preterm infants, and betamethasone has been shown to decrease neonatal mortality (52). In addition, intraventricular hemorrhage and necrotizing enterocolitis are decreased with steroid use (52,53). Consideration should be given as to whether a patient may benefit from corticosteroid administration, and decisions individualized. Consultation with an obstetrician regarding this issue is recommended.

**Venous Thromboembolism Prevention**

Pregnancy is a prothrombotic state, and the risk of venous thromboembolism (VTE) is increased among women who undergo cesarean delivery as compared with vaginal birth (53). However, there are few data regarding the risk for VTE after nonobstetric surgery. There are no clear guidelines or recommendations to address prevention of thromboembolism in the setting of trauma or abdominal surgery during pregnancy. Nonpregnant trauma patients with at least one risk factor for VTE (including estrogen exposure) are recommended to receive thromboprophylaxis (54,55). In the gravid patient, mechanical prophylaxis, such as pneumatic compression, is reasonable, and low-molecular-weight heparin (LMWH) prophylaxis can be considered on a case-by-case basis. For patients with additional risk factors for thromboembolism beyond pregnancy itself, pharmacologic methods should be combined with use of mechanical approaches.

**Consultation**

**Obstetrics**

Obstetric consultation should be considered for any patient requiring surgery during pregnancy. Because there are few data to guide clinical management, the American College of Obstetricians and Gynecologists states that “it is important for non-obstetric physicians to obtain obstetric consultation before performing non-obstetric surgery. The decision to use fetal monitoring should be individualized, and each case warrants a team approach to ensure optimal safety for the woman and her baby” (48).

**Anesthesia**

Prior to delivering anesthesia care, the anesthesiologist is responsible for reviewing the medical record, interviewing and performing a focused examination on the patient, ordering and reviewing appropriate medical tests, ordering appropriate medications, ensuring consent for anesthesia is obtained, and documenting the above in the patient medical record. Preoperative anesthesia consultation should be considered in most cases of nonobstetric surgery during pregnancy, as obstetric complications that may lead to operative delivery are possible (56,57).

**Neonatology**

In the scenario of surgical diseases affecting third trimester pregnancy, decisions must be made about obstetric and neonatal management. This is especially critical for cases at the threshold of viability. Parents should participate along with physicians in decisions regarding management, including the selection of facility for perinatal care, the type of fetal surveillance planned, and whether or not to perform cesarean birth for fetal indications.

Although the overall prognosis for premature infants has steadily improved, the morbidity and mortality for extremely low-birth-weight infants remains high. The mean survival rates for infants born between 23 and 25 weeks increase from 30%, to 52%, to 76% with each additional week of development. Likewise, the survival for infants weighing 401–800 g ranges from 11% in those under 500 g to 74% in those over 701 g. Severe disability is common among survivors in this group of vulnerable infants.

Neonatal consultation is extremely important for those patients at risk for preterm birth, particularly in the “periviable” period. Parents should be informed about the prospects for infant survival, the likelihood of various outcomes related to prematurity, and the potential risks and benefits of treatments for preterm infants. Decisions regarding the planned level of intervention for the neonate should be documented in the medical record. Noninitiation of resuscitation for newborns less than 23 weeks or 400 g birth weight is appropriate (58).

**PERIOPERATIVE MANAGEMENT**

**Anesthesia**

The goals of anesthesia for nonobstetric surgery are different than those of the labor patient. Instead of attempting to preserve uterine tone and minimize fetal sedation, the objective is to provide effective surgical anesthesia while avoiding stimulating uterine contractions. There is little concern for the effects of fetal respiratory depression, but instead a focus on uteroplacental exchange.

In general, regional or local anesthetics are thought to be safer than general anesthesia. Regional anesthesia for
abdominal surgery has the advantage of minimal fetal local anesthetic drug exposure and is less likely to be associated with airway complications. Local anesthetics are not known to be teratogenic when used in this clinical setting.

Due to the risk of aspiration from gastroesophageal (GE) reflux and delayed gastric emptying, it is customary to administer a nonparticulate antacid or H2 blocker as well as medication to improve GE sphincter tone preoperatively. If general anesthesia is planned, preoxygenation and rapid-sequence intubation are typically performed. Care should be taken to avoid hyperventilation, as uterine blood flow is impaired. Inhalational agents, such as isoflurane and others, decrease uterine tone and effectively inhibit labor during surgery.

In general, agents used for general anesthesia during pregnancy might include: use of an open technique to gain access to the abdominal cavity, direct visualization for trocar placement, and lower insufflation pressures. Laparoscopy is of particular utility in late pregnancy, when the size of the uterus obscures views and reduces access to abdominal structures.

Rates of fetal loss in the first trimester have been reported to be about 10% to 15%, similar to persons with no surgery (63). The effects of CO2 on the fetus are unclear. Insufflation with carbon dioxide has been reported to cause metabolic acidosis in animal studies but is not known to cause harmful sequelae in human cases (60,61).

The largest experience with laparoscopy has been reported by the Swedish Health Registry (2,233 laparoscopies and 2,491 open laparotomies). In both groups, there was an increase in low birthweight (<2,500 g) due to fetal growth restriction and also associated with delivery before 37 weeks. There were no significant differences between the groups with respect to any other obstetric outcomes (62). It would seem reasonable to assume fetal growth periodically among patients who have undergone nonobstetric surgery appear not to be influenced by the choice of anesthetic in one study of 5,403 operations in pregnant women (59).

### Laparoscopy during Pregnancy

Various conditions are suitable for treatment via laparoscopic surgery. In general, laparoscopy has had a good record of safety during pregnancy. Special considerations for laparoscopy during pregnancy might include use of an open technique to gain access to the abdominal cavity, direct visualization for trocar placement, and lower insufflation pressures. Laparoscopy is of particular utility in late pregnancy, when the size of the uterus obscures views and reduces access to abdominal structures.

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### Delivery Considerations

Optimal maternal and infant outcome depends on planning for contingencies. Action items that might impact care when managing pregnant trauma or surgery patients are listed below:

1. Admit the mother to a facility able to provide appropriate specialty care, including neonatology and neonatal intensive care unit (NICU) care.
2. Provide level I trauma center care for any gravid trauma patient whenever possible.
3. Ensure immediate availability of equipment for emergency delivery, in the emergency room (ER), main operating room (OR), intensive care unit (ICU), or surgical unit, where appropriate. This includes all items for infant resuscitation, such as warmer bed, oxygen, endotracheal tubes, suction, other supplies, and emergency medications.
4. Plan for adequate staff to address obstetric issues, including fetal monitoring and/or emergency delivery.
5. Plan for adequate nursing care for perioperative needs on labor and delivery ward.
6. Ensure that clear instructions designate which providers or specialty services are responsible for various aspects of patient care.
7. Display contact information for the various providers prominently in patient medical record, in case emergency evaluation and treatment is necessary.
8. Encourage impeccable communication between specialists, including general surgery, trauma surgery, obstetrics, anesthesiology, neonatology, or others.
9. Obtain consultations early, and document recommendations or treatment plans.
10. Clearly indicate what the plans are for fetal assessment and whether or not intervention is planned for indications, such as emergent cesarean in the event of nonreassuring fetal heart rate patterns.
11. Delivery timing and route may be individualized. In general, delivery at full term (>37 weeks) is the goal. Cesarean is reserved for usual clinical indications, with the notable exception of the perimortem patient (Table 100.5).
12. A typical trauma care team for a gravid patient includes the following:
   a. ER physician
   b. ER nurse
   c. Trauma surgeon
   d. Obstetrician
   e. OB nurse
   f. Anesthesiologist

### Table 100.4

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<tr>
<th>Chapter 100: Acute Abdomen and Trauma during Pregnancy</th>
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<tr>
<td><strong>SOCIETY FOR AMERICAN GASTROINTESTINAL ENDOSCOPIC SURGEONS GUIDELINES FOR LAPAROSCOPIC SURGERY DURING PREGNANCY</strong> (2000)</td>
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<td><strong>TABLE 100.4</strong></td>
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<tr>
<td>1. Preoperative obstetric consultation</td>
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<td>2. If possible, defer operation until second trimester, when fetal risk is lowest</td>
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<td>3. Use pneumatic compression devices whenever possible, as pneumoperitoneum enhances lower extremity venous stasis and pregnancy induced a hypercoagulable state.</td>
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<td>4. Monitor fetal and uterine status, and use maternal end-tidal CO2 and/or arterial blood gas (ABG).</td>
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<td>5. Protect uterus with a lead shield if intraoperative cholangiography is possible. Use fluoroscopy selectively.</td>
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<td>6. Attain abdominal access using an open technique, as the gravid uterus is enlarged.</td>
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<td>7. Shift the uterus off the inferior vena cava by using dependent positioning/lateral tilt.</td>
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<td>8. Minimize pneumoperitoneum pressures (8–12 mm Hg) and do not exceed 15 mm Hg.</td>
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Emergent cesarean may be warranted in the following circumstances:

1. Fetal heart tones are present (there is a living fetus)
2. The fetus is at a viable gestational age (≥23 to 24 weeks)
3. Adequate equipment and personnel are available to perform cesarean
4. Adequate equipment and personnel are available for neonatal resuscitation
5. Lack of response to maternal cardiopulmonary resuscitation (CPR) within 4 minutes (discussed in text)
6. Persistent nonassuring fetal heart rate (FHR) pattern is present—examples include fetal bradycardia, prolonged decelerations, or repetitive late decelerations
7. Deteriorating maternal condition—cardiovascular instability
8. Direct uterine or fetal injury
9. Gynecologic or obstetric emergencies
10. Perinatal emergencies

Maternal CPR or Death

Rarely, a pregnant woman is sufficiently unstable to require cardiopulmonary resuscitation (CPR) or advanced cardiac life support (ACLS) procedures. To be most effective with CPR, it is important to recall the physical changes of pregnancy that affect the efficiency of compressions. Aortocaval compression by the gravid uterus decreases cardiac output by 25%, and hypotension in supine position is not uncommon.

The American Heart Association suggests key components for the resuscitation of the pregnant woman in cardiac arrest, itemized below (64):

1. Left lateral position
2. 100% oxygen
3. IV access and fluid bolus
4. Identification of the cause of cardiac arrest, and consideration of other medical conditions that could complicate efforts to revive the patient
5. Chest compressions should be done higher on the sternum, slightly above the center, because of the elevated diaphragm and abdominal contents. Vasopressors should be used when necessary, but be aware that ephedrine, vasopressin, and dopamine can decrease uterine blood flow. Maintaining maternal circulation is still the most important means of supporting the fetus, even in the event of maternal CPR. Medication doses and defibrillation protocols do not change. If fetal or uterine monitors are in place, these should be removed before delivering shocks. No other changes from the ACLS protocol are advised. Pregnancy-specific complications that providers should consider during their resuscitation efforts include magnesium toxicity, eclampsia, and amniotic fluid embolism (64).

Perimortem Cesarean

Intact survival of a fetus is most likely when cesarean delivery is accomplished within 5 minutes of cardiac arrest in a pregnant patient (65). A recent report of outcomes after 38 cases of perimortem cesarean indicated that there were 34 surviving infants. Of those infants, time of delivery was available for 25 cases. Twelve of 25 (48%) were delivered within 5 minutes, and 9 of these 12 infants had no neurologic deficits on follow-up. Of the remaining cases, four were delivered between 6 and 10 minutes, two between 11 and 15 minutes, and seven delivered more than 15 minutes from cardiac arrest. Neurologic sequelae were present in at least one of the survivors in each of these groups. Interestingly, of 20 perimortem cesareans with resuscitable causes, 13 mothers were revived and discharged from the hospital in good condition (65). Clearly there is a role for this life-saving procedure for both mother and baby.

Maternal Brain Death

On rare occasions maternal brain death is identified in a pregnant woman while somatic support has been maintained and the fetus remains alive. Under these circumstances, a determination must be made as to whether to deliver the fetus immediately, to initiate supportive care to allow further fetal maturation, or to allow the fetus to die as the mother is removed from mechanical ventilation. Immediate delivery when gestational age is consistent with neonatal survival is always preferred. However, if the mother’s condition permits, it is possible to support the mother and permissible fetus until fetal maturation allows for neonatal survival. This somatic support can be provided for extended periods with no apparent neonatal or pediatric sequelae with 2-year follow-up reported (66,67).

Ethical Decision Making

There is a potential for conflicts in decision making between the clinician and the pregnant woman. Patients may be asked to consent to procedures that carry some risk to the fetus. Alternatively, interventions proposed for fetal benefit may present a risk to maternal health. Principle-based ethics, based on the concepts of autonomy, beneficence, and justice, have been used to aid choices. Providers also need to take into account the social and cultural context within which the patient is making her choices. According to the ACOG Ethical Guidelines, “Every reasonable effort should be made to protect the fetus, but the pregnant woman’s autonomy should be respected . . . intervention against the wishes of a pregnant woman is rarely if ever acceptable” (68).

In the case of a patient who is incapacitated, state laws vary with respect to who may serve as a surrogate decision maker. The designee should base their decisions on the values and wishes of the patient, which may or may not have previously been stated in writing. Clinicians should try to anticipate such scenarios and attempt to adhere to the woman’s wishes regarding treatment for herself and/or her fetus. If there is not consensus about who should be designated, the advice of an ethics committee should be considered.

INJURY PREVENTION/REDUCTION

Lack of seat belt use has been shown to contribute to the severity of maternal and fetal injuries. Knowledge of proper
seats use is low among some patients, especially teens and those with low education levels. In one survey of 450 pregnant women, only 72.5% reported using the seat belt in the proper location. Women who always wore restraints were more likely to report correct placement. 60% of respondents thought restraints would protect their baby, whereas 11.6% thought restraints caused injury to the baby, and 37% were unsure. The most common reasons for lack of use were lack of comfort (52.8%) and forgetting (42.5%). However, only 36.9% of women reported receiving information about seat belt use during that pregnancy (69). Another survey of 807 pregnant women revealed that although 79% of women used safety restraints, only 52% of them did so correctly, and only 21% were educated on proper use during pregnancy (70). Educational interventions during prenatal care can improve the proper use of seat belts significantly. At one institution, the proportion of women reporting correct seat belt placement improved from 70.8% to 83% after instruction during prenatal care (71).

There are case reports of complications due to seat belts and air bags, including uterine rupture (72). However, the evidence to date suggests that correct use of seat belts reduces the likelihood of fetal loss. One statewide study reviewed the experience of 9,928 women (2.6% of the overall pregnant population) with a history of motor vehicle crashes during pregnancy. Unbelted women were 2.8 times more likely to experience a fetal death after the incident (73). Prenatal care visits and emergency room encounters provide an opportunity for providers to give health messages to their patients regarding the importance of proper seat belt use.

Domestic Violence Awareness

Studies indicate that women who experience physical violence are at higher risk for pregnancy loss and low-birth-weight infants (74). A recent prospective study of pregnant women indicated that among 495 surveyed, low birth weight was increased in those reporting verbal abuse (7.6% vs. 5.1%). Also, neonatal deaths were more common among those with physical abuse (1.5% vs. 0.2%). Unexpectedly, 94 women who declined interview had higher rates of low-birth-weight infants (12.8%), preterm birth (5.3% vs. 1.2%), abortion (7.4% vs. 2.2%), and NICU admission (7.4% vs. 2.2%) than those reporting no abuse (75).

Women generally feel that a provider asking them about domestic violence in a confidential, private setting is helpful. Universal screening for domestic violence is recommended by several professional organizations, such as American Medical Association (AMA), American College of Obstetricians and Gynecologists (ACOG), and American Academy of Family Physicians (AAFP). Behavioral cues that domestic violence may be an issue include late entry to prenatal care or sporadic attendance at prenatal visits, changes in appointment patterns, over-protective or threatening partner, or multiple visits for somatic complaints. Battered women are commonly reported to seek medical services at eight times the rate of other women, but they are rarely identified or referred for services. Indeed, battered women account for up to a quarter of all women seeking emergency medical services and/or prenatal care. Emergency visits for abdominal complaints or trauma may serve to prompt the clinician to consider domestic violence as an underlying cause of symptoms. Should a patient indicate that domestic violence is a concern, assistance is available from the National Domestic Violence Hotline, 1-800-799-SAFE. This 24-hour, toll-free hotline provides information and referrals from anywhere in the United States.

References


