CHAPTER 179

Labor and Delivery and Their Complications

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PERSPECTIVE

Emergency department (ED) births are rare. In most cases, the emergency physician will identify patients in labor and triage them to the obstetric service for urgent management, maintaining a continuum of care with their primary providers. Because some births are precipitous and obstetric resources may not be immediately available, the emergency physician must possess the basic skills for intrapartum management of both normal and abnormal deliveries. In addition, a general knowledge of postpartum care is required in case of the occasional out-of-hospital delivery.[1-3]

Limitations of the Emergency Department

The ED is a suboptimal location for the management of a complicated delivery. The obstetric suite has experienced personnel and better resources, including tocodynamometry, fetal scalp electrodes, intrauterine pressure monitors, vacuum extractors, and forceps. Also, the obstetrician usually has prenatal care information for each patient that helps to optimize maternal and fetal outcomes. Such information includes accurate gestational dates, the presence of multiple gestations, estimated fetal weights, detailed maternal pelvimetry, placental anatomy, amniocentesis results, maternal blood type and Rh factor, and prior documented obstetric complications. This information allows the obstetrician to anticipate complications of labor and delivery. It is difficult, if not impossible, to obtain these data in the ED while preparing for imminent delivery.[4] Finally, in certain situations, cesarean section is the best way to ensure successful delivery. This surgical option is not available in the ED except in dire perimortem circumstances.

Epidemiology of Emergency Delivery

In 2004, the perinatal mortality rate in the United States was 6.2 per 1000 live births and fetal deaths (>20 weeks of gestation).[5] Extensive epidemiologic data regarding the subgroup of ED deliveries are lacking. However, it has been established that delivery complications and mortalities do occur with greater frequency in the ED. In fact, the perinatal mortality rate for ED deliveries has been approximated at 8 to 10%.[6]

There are multiple causes of the "high-risk" ED delivery profile. The ED is often selected by an obstetric population with unexpected complications. Antepartum hemorrhage, premature rupture of membranes (PROM), eclampsia, premature labor, abruptio placentae, precipitous delivery, malpresentation, and umbilical cord emergencies are overrepresented in the ED population.[6]

Psychosocial factors further skew the epidemiology of ED deliveries. Women who present with precipitous deliveries often have had very little or no prenatal care.[7] Pregnant women who have drug or alcohol problems or are victims of domestic violence represent a disproportionate number of patients who deliver in the ED. Women who are unaware or in denial of their pregnancies, or immigrants without access to other medical care, also present to the ED when labor begins.[8-10] For each of these groups, all of which are compromised by psychosocial factors, inadequate prenatal care makes the subsequent delivery high risk.

Patient Transfer Considerations

Because of the high risk associated with ED delivery, patients should be transported to a facility that has obstetric and neonatal resources as appropriate. The management of a premature infant may require highly specialized intensive care that is unavailable at many community hospitals. The desire to transfer a woman with an impending high-risk delivery to such a facility must be tempered, however, by clinical and medicolegal judgment.[11,12]

Medicolegal Considerations

Transfer, with resultant en route delivery, can be disastrous for the mother and fetus. Such a transfer also violates federal law. The Consolidated Omnibus Reconciliation Budget Act (COBRA) of 1989 was based on an "inappropriate" obstetric transfer.[13] Federal law has identified labor as a condition unsuitable for transfer because of its unstable nature. Although the intent of this legislation is to protect women from medical and financial "dumping," COBRA also may force emergency physicians to perform difficult high-risk deliveries that might have better outcomes if transferred.[14]

Nursery Requirements

For many ED deliveries, labor will have progressed to a point where tocolysis is contraindicated and delivery is imminent. Generally, this is the point when the mother feels the urge to push or the head is crowning. Whenever possible, a neonatologist or pediatrician should attend high-risk preterm (<36 weeks' gestation) deliveries, and preparations for neonatal

BOX 179-1 LEVELS OF NURSERY CARE

Level 1 Nurseries

These nurseries care for infants presumed healthy. In such units, screening and surveillance are primary responsibilities.

"Rooming-in" units are encouraged, with emphasis on support of breast-feeding and assessment of parenting skills.

Level 2 Nurseries

These nurseries care for infants >30 weeks' gestation and >1200 g who require special attention short of circulatory or ventilator support and major surgical procedures. A high percentage of the patients in such nurseries have had obstetric complications (e.g., birth trauma, fetal distress, and obstetric anesthesia).

Level 3 Nurseries

These nurseries are staffed and equipped to care for all newborn infants who are critically ill, regardless of the level of support required. They are regional institutions serving as referral centers for other nurseries and for this reason are often linked with transport services.

Perinatal Centers

A perinatal center provides services to high-risk mothers and to infants requiring level 3 nursery care. Ample data show a higher neonatal survival rate for high-risk pregnancies cared for in such centers.

resuscitation and high-level nursery care should be initiated (Box 179-1).[15]

NORMAL DELIVERY

Although the epidemiology and high complication rate associated with ED births demand caution, most are normal deliveries. Knowledge of normal labor and delivery mechanics aids safe vaginal delivery and facilitates the identification of complications.

Whenever a woman in the third trimester of pregnancy seeks treatment in the ED, the possibility that she is in labor must be considered. A wide array of nonspecific symptoms may herald the onset of labor. Abdominal pain, back pain, cramping, nausea, vomiting, urinary urgency, stress incontinence, and anxiety can all be symptoms of labor. After 24 weeks' gestation, any medical assessment should include the mother and the fetus because fetal viability becomes established near that time. In addition, given the generally high-risk nature of this patient population and the abundance of bodily fluids that the health care provider and newborn are exposed to during delivery, serologic testing for infectious disease may be warranted. With the development of rapid bedside testing technology, human immunodeficiency virus (HIV) and hepatitis screening before delivery is indicated in a significant group of patients presenting with active labor.

Distinguishing False from True Labor

Braxton Hicks contractions, or false labor, must be differentiated from true labor. During the third trimester, the uterus develops into a contractile organ. After 30 weeks of gestation, the previously small and uncoordinated contractions of the uterus become more synchronous and may be perceived by the mother. Braxton Hicks contractions do not escalate in frequency or duration, in contrast to the contractions of true labor. By definition, this muscular activity is associated with minimal or no cervical dilation or effacement. Examination should also reveal intact membranes. Care not to rupture the membranes is important to avoid inducing labor prematurely. If the diagnosis remains in doubt, external electrical monitoring of uterine activity can be utilized to rule out true labor. Any discomfort associated with false labor is usually relieved with mild analgesia, ambulation, or change in activity.

Unlike false labor, true labor is characterized by cyclic uterine contractions of increasing frequency, duration, and strength, culminating in delivery of the fetus and placenta. In contrast to Braxton Hicks contractions, true labor causes cervical dilation to begin, marking the first stage of labor.

Bloody Show

Early in pregnancy, the cervix becomes increasingly vascular and develops edema, giving the cervix a boggy texture. The vascularity of the cervix also increases, giving rise to Chadwick's sign (a blue-violet coloration). At the onset of labor, the cervical mucus plug is expelled, resulting in what is called a *bloody show*. The bleeding associated with the process is slight, and usually only a few dark red spots are noticed. The dark color is due to its venous origin, and it is admixed with the mucous components of the cervical plug. The significance of a bloody show is that it is a fairly reliable indicator of the onset of true labor, specifically stage 1. Bloody show is not a contraindication to vaginal examination for determination of cervical effacement and dilation. If bleeding continues or is of a larger volume, more serious causes should be suspected, such as placenta previa and placental abruption, which are contraindications for a vaginal examination.

Stages of Labor

First Stage of Labor

The first stage of labor is the cervical stage, ending with a completely dilated, fully effaced cervix. It is divided into a latent phase, with slow cervical dilation, and an active phase, with more rapid dilation. The active phase begins once the cervix is dilated 3 cm.[16] In multiparous women, the active phase can progress rapidly into stage 2 of labor (delivery of the fetus). Most women who deliver in the ED arrive while in the active phase of stage 1 or in early stage 2 labor (Fig. 179-1).[6]

The duration of the first stage of labor averages 8 hours in nulliparous women and 5 hours in multiparous women. During this time, frequent assessment of fetal well-being is important. For low-risk pregnancies, fetal heart tones should be auscultated approximately every 15 minutes. For higher risk pregnancies, continuous external electrical monitoring may help identify fetal distress, allowing appropriate intervention.[17]

Abdominal examination using Leopold's maneuvers may confirm the lie of the fetus (Fig. 179-2). After labor has begun, particularly during the active phase of stage 1, Leopold's maneuvers are difficult to use. The firm contractions of the uterus prevent the identification of fetal "small parts." Other modalities of assessing the lie, such as ultrasonography, may be necessary if presentation remains in question.[18]

Maternal examination also provides a rough guide to gestational age. At 20 weeks' gestation, the uterine fundus reaches the umbilicus. Approximately 1 cm of fundal height is added per week of gestation until 36 weeks. At that time, the fundal height decreases as the fetus "drops" into the pelvis (Fig. 179-3). These estimates help to establish gestational age rapidly.

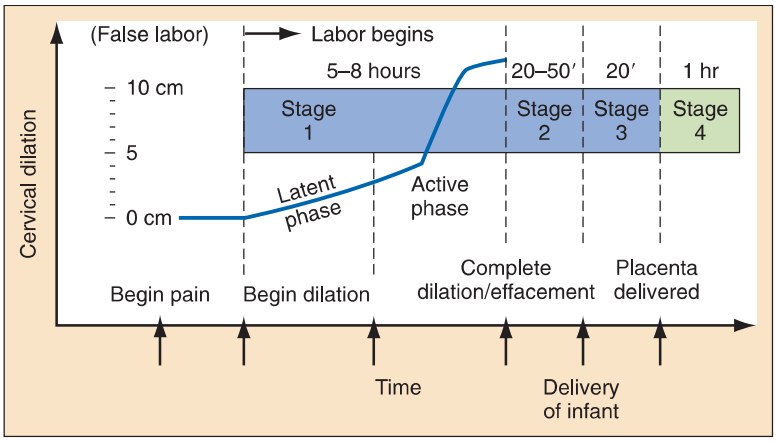

Figure 179-1. Stages of labor and delivery. Stage 1, cervical stage; stage 2, fetal expulsion; stage 3, placental expulsion (20 minutes); stage 4, uterine contraction (1 hour postpartum).

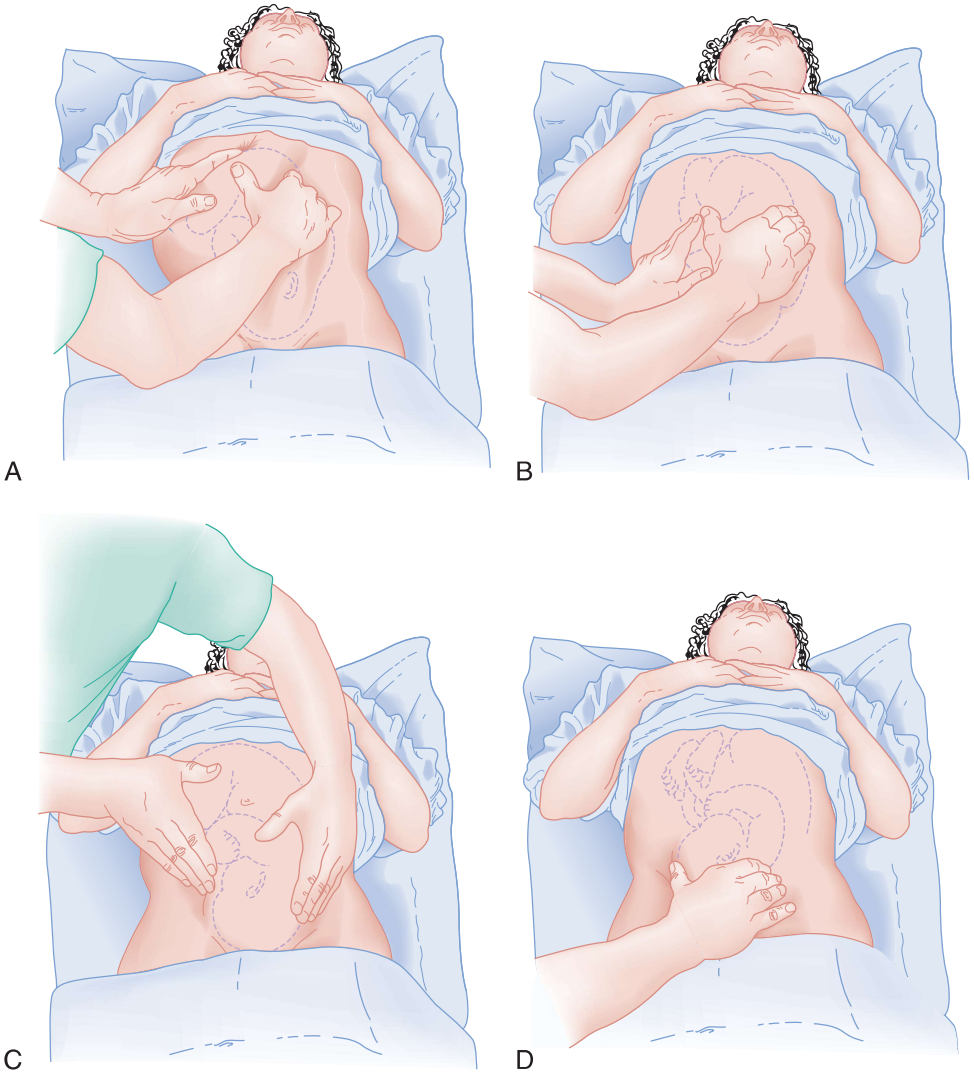

Figure 179-2. Leopold's maneuvers. **A,** The first Leopold maneuver reveals what fetal part occupies the fundus. **B,** The second Leopold maneuver reveals the position of the fetal back. **C,** The third Leopold maneuver reveals what fetal part lies over the pelvic inlet. **D,** The fourth Leopold maneuver reveals the position of the cephalic prominence. (Modified from Willson JR, et al: Obstetrics and Gynecology, 9th ed. St. Louis, Mosby, 1991.)

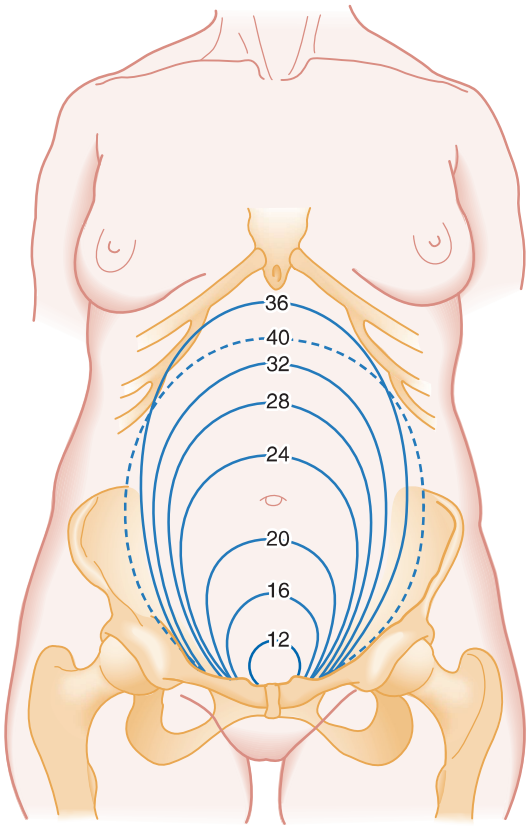

Figure 179-3. Height of fundus by weeks of normal gestation with a single fetus. *Dotted line* indicates height after lightening. (Modified from Barkaukas V, et al: Health and Physical Assessment. St. Louis, Mosby, 1994.)

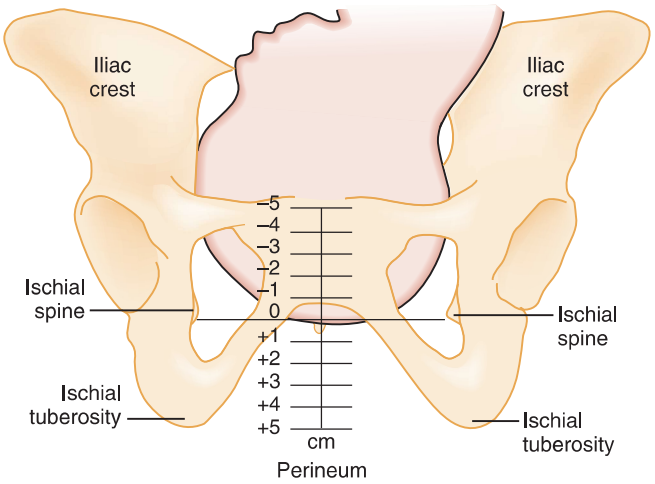

Figure 179-4. Fetal stations. The level of the ischial spines is considered "0" station. The silhouette of the infant's head is shown approaching station +1. (Courtesy of Ross Laboratories, Columbus, Ohio.)

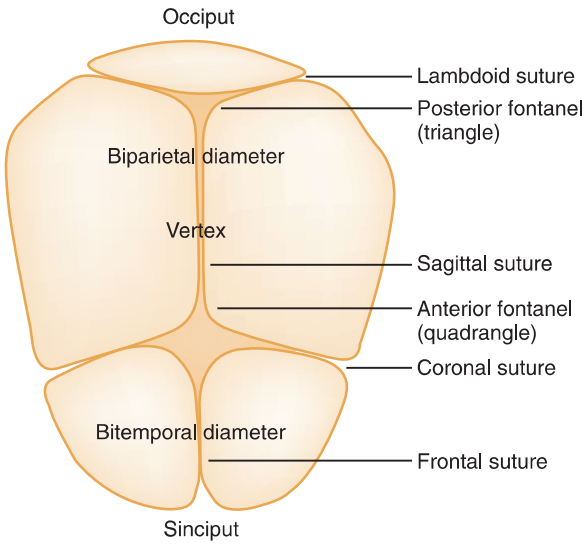

Figure 179-5. Bony landmarks of the fetal skull. (Modified from Willson JR, et al: Obstetrics and Gynecology, 9th ed. St. Louis, Mosby, 1991.)

The accurate determination of the stage of labor depends on examination of the cervix. A sterile approach using sterile gloves, a sterile speculum, and povidone-iodine (Betadine) solution is indicated to prevent ascending infection, such as chorioamnionitis. On pelvic examination, the clinician should determine the following:

1. *Effacement* refers to the thickness of the cervix. A paper-thin cervix is 100% effaced.
2. *Dilation* indicates the diameter of the cervical opening in centimeters. Complete, or maximum, dilation is 10 cm.
3. *Position* describes the relationship of the fetal presenting part to the birth canal. The most common position of the head is occiput anterior.
4. *Station* indicates the relationship of the presenting fetal part to the maternal ischial spines (Fig. 179-4).
5. *Presentation* specifies the anatomic part of the fetus leading through the birth canal.

In 95% of all labors, the presenting part is the occiput, or vertex. On digital exam, a smooth surface with 360 degrees of firm bony contours and palpable suture lines is noted. Palpation of the suture lines and the fontanels where they join allows the examiner to determine in which direction the fetus is facing. Three sutures radiate from the posterior fontanel, and four radiate from the anterior fontanel (Fig. 179-5). The lateral margins should be examined carefully for fingers or facial parts that indicate compound or brow presentations.

When the clinician suspects rupture of membranes, a sterile speculum examination should be performed. This may reveal pooling of amniotic fluid. Two tests used to confirm the presence of amniotic fluid include a fernlike pattern when the fluid is allowed to dry on a microscope slide and the use of nitrazine paper, which should turn blue, indicating an alkaline amniotic fluid (pH > 6). Although vaginal blood, cervical mucus, semen, and infection can interfere with results, sensitivities of both nitrazine paper and ferning in detecting amniotic fluid are nearly 90%.[19]

Of note, if vaginal bleeding is evident, both digital and speculum examination of the pelvis should be deferred until ultrasound can be obtained to rule out placenta previa.

Second Stage of Labor

The second stage of labor is characterized by a fully dilated cervix and accompanied by the urge to bear down and push with each uterine contraction. The fetal station is advanced to +3, with crowning of the presenting part as expulsion begins. Stage 2 uterine contractions may last 1 or 2 minutes and recur after a resting phase of less than 1 minute. The median duration of this stage is 50 minutes in nulliparous women and 20

minutes in multiparous women. More rapid progression through stage 2 should be anticipated for low-birth-weight premature infants. A prolonged second stage of labor is defined as more than 3 hours in nulliparous women if regional anesthesia is administered, more than 2 hours in nulliparous women without anesthesia or multiparous women with regional anesthesia, and more than 1 hour in multiparous women without regional anesthesia.[20] Prolonged second stage of labor is associated with an increase in maternal complications, including postpartum hemorrhage, infection, and severe vaginal lacerations.[21]

Antenatal Fetal Assessment. The assessment of any woman in the third trimester includes an assessment of fetal well-being. After 24 weeks' gestation, the fetal condition should affect clinical decision-making. During labor and delivery, the identification of fetal distress and appropriate intervention can reduce fetal morbidity and mortality.

There are currently three methods of assessing a fetus in utero. Clinical monitoring, electrical monitoring, and ultrasonography all have a role in the assessment of the fetus.[22,23] External electrical monitoring and ultrasonography merit consideration for use in the care of women laboring in the ED. The machinery for both technologies is portable and easy to use, making them attractive to the emergency physician.[24,25] These modalities can provide real-time information helpful for diagnosing fetal distress and assisting with intrapartum decision making.

Electronic Fetal Monitoring. Intrapartum fetal assessment by electronic fetal monitoring is most useful during stage 1 of labor. Electronic fetal monitoring confirms labor and may help diagnose fetal distress. Tracings of fetal heart rate and uterine activity provide information that, when combined with clinical data, can presage fetal damage and provide a window for intervention.

Uterine activity is measured transabdominally via a pressure transducer, creating a recording of the contraction frequency. Because the measurements are indirect, the strength of the contractions correlates poorly with the tracing. The tracings are position and placement sensitive. Documentation of organized cyclic uterine contractions confirms the onset of labor and rules out Braxton Hicks contractions that are too disorganized to register in this manner. Premature onset of labor can also be diagnosed. Finally, this type of external electrical monitoring may be used to determine the efficacy of administered tocolytic agents.

Fetal heart rate tracings have several components that can be assessed: baseline heart rate, variability, accelerations, decelerations, and diagnostic patterns. Baseline heart rate, by definition, is maintained for 15 minutes in the absence of a uterine contraction and is the most important aspect of fetal heart rate monitoring.

Variability can be instantaneous (beat-to-beat) or long term over intervals of 1 minute or more. Both types of variability are indicators of fetal well-being. Accelerations of heart rate are an important component of long-term variability. Accelerations occur during fetal movement and reflect an alert, mobile fetus. Brief periods of umbilical cord compression also can cause accelerations by decreasing the venous return and reflexively generating fetal tachycardia. Meanwhile, decreased variability may indicate fetal acidemia and hypoxemia or may be a side effect of a wide array of drugs. Analgesics, sedative-hypnotics, phenothiazines, and alcohol have all been reported to cause decreased variability.

Decelerations in fetal heart rate are more complicated, and their interpretation must be integrated with the clinical situation. There are three types of deceleration: variable, early, and late (Fig. 179-6). These terms refer to the timing of the deceleration relative to the uterine contraction.

Variable and early decelerations are common. Present on more than 50% of all tracings, these heart rate changes can represent physiologic reflexes associated with head compression in the birth canal or intermittent cord compression. Variable decelerations that are persistent and repetitive usually indicate repeated episodes of umbilical cord compression. The resultant hypoxia and acidosis may cause fetal distress. Attempts to shift maternal and fetal weight off the umbilical cord by changing position are indicated. If these variable decelerations continue, the situation calls for efforts to hasten the delivery or, if obstetric backup becomes available, to perform an emergency cesarean section.

Late decelerations are more serious and most often indicate uteroplacental insufficiency. The tracing contours are generally smooth, with the heart rate nadir occurring well after maximal uterine contraction. The lag, slope, and magnitude of late decelerations correlate with increasing fetal hypoxia. Late decelerations are particularly ominous in association with poor variability, nonreactivity, and baseline bradycardia. Immediate delivery to prevent further hypoxia is indicated when these findings are present. The need for newborn resuscitation should be anticipated and preparation for critical care established for these deliveries. Overall, 30% of infants with late decelerations have good outcomes. The remaining 70% have suboptimal outcomes related to either the underlying pathologic condition or hypoxia.

Finally, the clinician should be aware of the significance of sinusoidal tracings. Tracings of this type have low baseline heart rates and little beat-to-beat variability. The sinusoidal tracing is an ominous finding that is often premorbid. The differential diagnosis includes erythroblastosis fetalis, placental abruption, fetal hemorrhage (trauma), and amnionitis.

Ultrasonography. Ultrasonographic techniques have wide application in obstetric care. In the third trimester or during labor, ultrasonography can provide crucial information pertaining to impending delivery. When a technician and radiologist are available, the gestational age, biophysical profile, amniotic fluid index, as well as a survey of fetal and placental anatomy may be discerned (Table 179-1).[25-27] The parameters of

Table 179-1 Biophysical Profile: 30 Minutes of Ultrasonographic Observation

ELEMENT ASSESSED	NORMAL SCORE = 2	ABNORMAL SCORE = 0
Fetal heart rate reactivity	2 accelerations >15 beats/min for >15 sec	<2 accelerations
Amniotic fluid index	1 pocket >1 cm in orthogonal planes	No large pockets
Fetal muscle tone	1 episode of active flexion-extension with full return to flexed posture	<1 episode or slow, incomplete actions
Body movements	3 discrete moves	≤2
Breathing motions	1 episode of fetal breathing of at least 60 sec duration during 30 min of observation	No breathing activity *or* The absence of 1 episode of fetal breathing of at least 60 sec duration during 30 min of observation

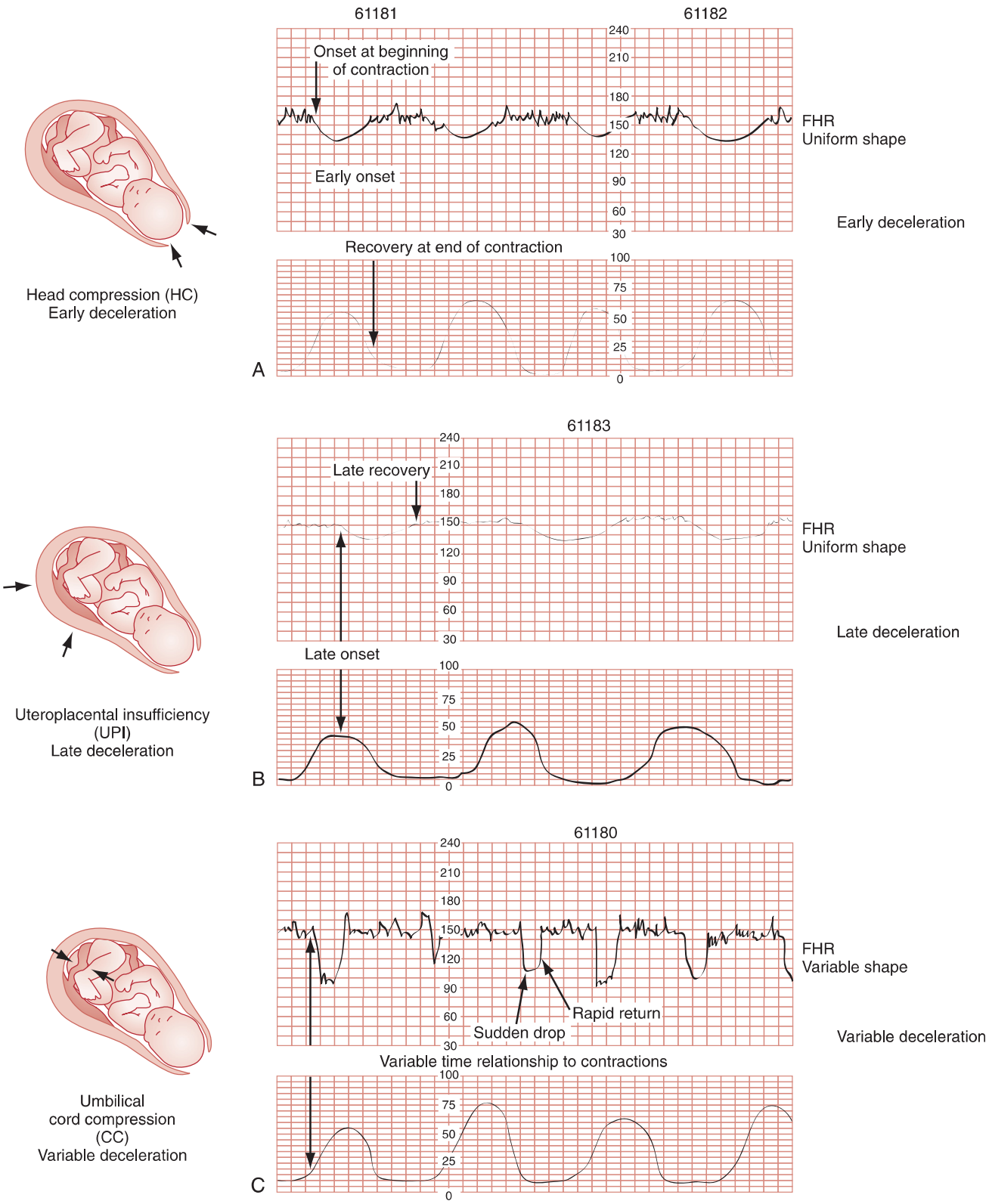

Figure 179-6. Deceleration patterns of the fetal heart rate (FHR). **A,** Early deceleration caused by head compression. **B,** Late deceleration caused by uteroplacental insufficiency. **C,** Variable deceleration caused by cord compression. (Modified from Lowdermilk DL, et al: Maternity and Women's Health Care, 6th ed. St. Louis, Mosby, 1997.)

BOX 179-2 THIRD-TRIMESTER ULTRASONOGRAPHY: POSSIBLE INDICATIONS

- Determine number of fetuses
- Establish fetal presentation
- Identify fetal heart motion
- Locate placenta
- Measure amniotic fluid
- Determine gestational age
- Survey fetal anatomy
- Diagnose cord prolapse
- Diagnose third-trimester bleeding
- Rule out abruption

immediate interest in the ED are fetal viability (specifically in utero gestation and fetal heart rate), lie, and presentation. Ultrasonography may also reveal multiple gestations, allowing for preparation and early communication with other specialists (from obstetrics, neonatology, and anesthesia).[28] In 1991, the American College of Obstetricians and Gynecologists made recommendations regarding the indications for ultrasonography in the third trimester (Box 179-2). A 2- to 5-MHz transducer is appropriate for all bedside transabdominal sonographic assessments. Transvaginal ultrasonography is relatively contraindicated in the peripartum period, particularly in the cases of premature rupture of membranes and placenta previa.[28]

Delivery. As stage 2 of labor progresses, preparation for delivery should be underway. A radiant warmer should be available and heated. Neonatal resuscitation adjuncts, such as a towel, scissors, umbilical clamps, bulb suction, airway management equipment (oxygen, bag/mask device with appropriate-sized masks, and endotracheal intubation and suctioning equipment for meconium), and equipment to achieve vascular access, should be available. Most deliveries require only basic equipment to cut and clamp the umbilical cord, suction the mouth and nose, and dry and stimulate the infant. A nurse should be at the bedside to coach and provide reassurance to the mother.

The mother should be placed in the dorsal lithotomy position and prepared for delivery. The Sims position, or left lateral position with knees drawn toward the mother's chest and back to the physician, is also an acceptable position for delivery. The vulva and perineum are cleared and gently scrubbed, directing all mucoid debris and feces away from the introitus. A repeat sterile examination to assess labor progression and confirm presentation may be performed. Some firm digital stretching of the perineum, particularly posteriorly, may prevent tears and lacerations later in delivery.

Controlled, coordinated expulsion with coaching to sustain each push aids with crowning and delivery of the head. When the fetus is crowning, care should be exercised to have the delivery occur in a slow, controlled manner. Precipitous delivery is more likely to cause maternal injuries, such as perineal, rectal, urethral, labial, vaginal, and uterine lacerations, and fetal injuries.[29,30]

The most vulnerable moment is when the fetal head begins to stretch and distend the perineum. Instructing the mother to pant and not push slows the passage of the head and the shoulders as indicated. Calm communication between the physician and the mother is the best way to maintain control of the delivery. With a controlled delivery, routine performance of an episiotomy is not recommended. Instead, use of the modified Ritgen maneuver facilitates most normal deliveries.[30]

In the modified Ritgen maneuver, a towel-draped, gloved hand is used to stretch the perineum and gently exert pressure on the chin of the fetus. The second hand puts pressure on the occiput superiorly, guiding the head into slight extension. When at the perineum, this slight extension of the head promotes delivery by positioning the head so that its smallest diameter passes through the pelvic outlet and perineum.

After the head is delivered, the physician should allow the head to rotate toward the maternal thigh and clear the fetal face and airway. Bulb suctioning of the nares and oropharynx optimally is done before proceeding with the delivery. Clearing the oropharynx at this time minimizes the likelihood of aspiration of blood, meconium, and debris collected during descent through the birth canal. Coordination with the mother is important to prevent uncontrolled fetal expulsion.

Next, the shoulders, usually anterior shoulder first, clear the perineum. The shoulders often deliver spontaneously, with little effort by the physician. First, gentle downward traction on the head promotes delivery of the anterior shoulder. A subsequent upward motion pulls the posterior shoulder through the pelvic outlet, minimizing maternal trauma. If delay occurs in delivery of the shoulders, the potential for shoulder dystocia should be considered.

As the infant clears the perineum, attention focuses on the umbilical cord. The infant should be kept low or at the level of the perineum to promote blood flow into the infant from the placenta. The cord is clamped and cut. Clamps should be placed 4 or 5 cm apart, with the proximal clamp 10 cm from the infant's abdomen. An adequate umbilical stump is important for venous access if the child requires resuscitation.

The infant is now clear of the mother and can be wrapped in towels and moved to the warmer. Gentle drying with a towel and suctioning usually provide adequate respiratory stimulation. If not, flicking the soles of the feet and rubbing the back are other modalities. Apgar scores at 1, 5, and 10 minutes after birth should be documented.

Episiotomy. Previously, the need for episiotomy in normal deliveries was an area of controversy. The original potential benefit of episiotomy included the substitution of a straight surgical incision for a ragged, uncontrolled traumatic laceration. Theoretically, the surgical approach decreased the incidence of severe rectovaginal tears. This rationale led to widespread routine episiotomy, with a medial incision used in the United States and a mediolateral incision used in the Commonwealth countries.

Recent literature has shown that both types of incisions increase maternal morbidity and are no longer recommended for uncomplicated deliveries. Women receiving episiotomies have been shown to have a higher incidence of perineal trauma and maternal blood loss during delivery and more pelvic pain, sexual dysfunction, and urinary incontinence in the postpartum period.[31]

Episiotomy should be performed only for specific indications, such as shoulder dystocia or breech delivery. When the decision is made to use an episiotomy, the procedure should be done before excessive stretching of the perineal muscles occurs but near the time of delivery to avoid excessive bleeding. Common practice is to cut the episiotomy when the head is visible during a contraction and the introitus opens to a diameter of 3 or 4 cm. Most authors currently recommend a mediolateral incision to avoid perineal tears and rectal involvement; this is particularly true for a complicated delivery in which lacerations extending the surgical incision are likely (Fig. 179-7).

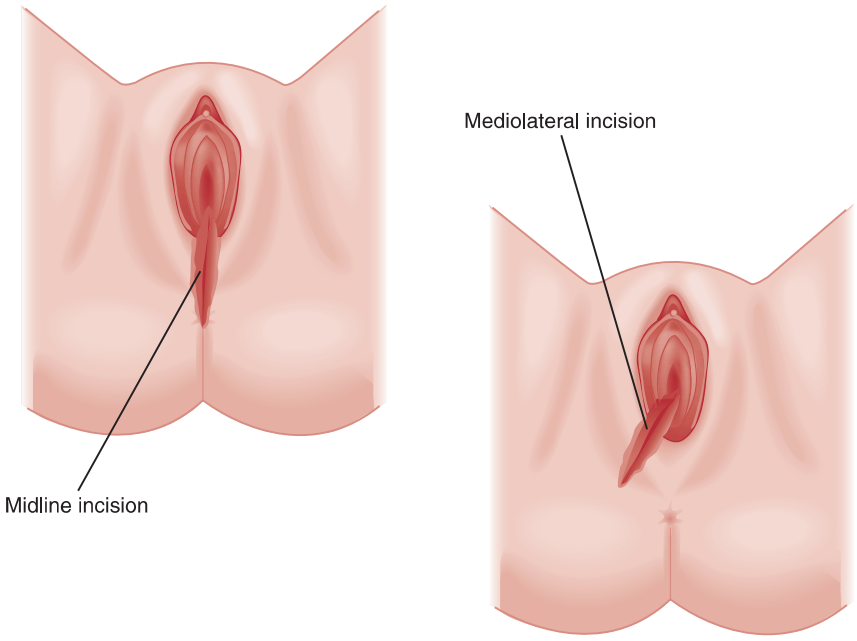

Figure 179-7. Mediolateral episiotomy incision is preferred over a strictly midline incision. (Redrawn from http://www.aurorahealthcare.org/healthgate/images/exh44028a_ma.jpg.)

Table 179-2 summarizes some of the adjuncts used in normal labor and delivery, with recommendations regarding their use in the high-risk setting of an ED delivery.

Third Stage of Labor

The third stage of labor involves the delivery of the placenta and is a time of patient observation with frequent checks of the tone and height of the uterine fundus. Signs of placental separation include the following:

1. The uterus becomes firmer and rises.
2. The umbilical cord lengthens 5 to 10 cm.
3. There is a sudden gush of blood.[32]

These signs usually occur within 5 to 10 minutes of the delivery of the infant but may extend to 30 minutes. Beyond 18 minutes, the risk of postpartum hemorrhage increases and is, in fact, up to six times more likely after 30 minutes.[33] Although the placenta may be delivered expectantly, active management reduces the length of the third stage of labor and thereby decreases the risk of postpartum hemorrhage. Active management includes the administration of uterotonics, gentle traction of the clamped umbilical cord with mild pressure applied above the symphysis pubis, and uterine massage after delivery.[34] Be aware that any attempt to deliver the placenta before it separates is contraindicated.

Examination of the placenta and umbilical cord is an essential part of the delivery process. Abnormalities of the cord should be noted at this time. Also, a segment of the umbilical cord should be kept available as a source of cord blood.

Normally a three-vessel structure, the umbilical cord is filled with a connective tissue known as *Wharton's jelly* and is approximately 50 to 60 cm long and 12 mm in diameter. Normal architecture places the two umbilical arteries on either side of the single umbilical vein. A two-vessel cord (one umbilical artery) occurs in 1 of 500 deliveries, is more common in African Americans, and is a result of aplasia or atrophy. Approximately

Table 179-2 Risk-Benefit Analysis of Routine Adjuncts to Normal Labor and Delivery

PRACTICE OR PROCEDURE	RISK	BENEFIT	UTILITY IN THE ED
NPO status and IV hydration	Fluid overload, osmolar and acid-base disturbances	Venous access, decreased risk of aspiration	Yes
Enemas	Time-consuming	Reduced pain caused by constipation	Minimal to none
Pubic shaving	Infections and irritation	None	None
Nitrous oxide analgesia	Incomplete pain control	Self-administered, minimal fetal side effects, noninvasive	Yes
Narcotic analgesia	Neonatal depression	Excellent pain control	As needed
Regional anesthesia	Technically difficult, incomplete pain control	Excellent pain control when technically successful (paracervical or pudendal block)	Variable (operator-dependent)
Electronic fetal monitoring	Increased incidence of surgical intervention	Early diagnosis of fetal distress	Variable (operator-dependent)
Ultrasonography	None	Rapid augmentation of database	Yes (operator-dependent)
Amniotomy	Augmented labor, prolapsed umbilical cord	None	No
Episiotomy	Poor maternal outcomes	None for uncomplicated delivery	No
Ritgen maneuver	None	Decreased birth trauma	Yes

IV, intravenous; NPO, nothing by mouth.

30% of two-vessel cord infants have congenital defects. An association also exists between fetal structural anomalies and placental vascular occlusion or thrombosis.[35]

The placenta should also be examined for abnormalities. Clots adherent to the uterine aspect may indicate placental abruption. Accessory lobes (succenturiate placenta if completely separate) and abnormal cord insertion are common abnormalities. The umbilical cord and placenta routinely should be held for pathologic review.[36] The discovery of an incomplete placenta or membranes should alert the emergency physician to the possibility of postpartum complications and should be documented.

Fourth Stage of Labor

The fourth stage of labor refers to the first hour after delivery of the placenta and is a critical period because postpartum hemorrhage is most likely to occur during this time. Thus, careful examination and repair of any vaginal lacerations should be performed. The cervix and vaginal fornices should be visually inspected to avoid missing deep lacerations as a result of delivery.

At this point, oxytocin is infused to promote contraction of the uterus and control hemorrhage. The uterus should be evaluated frequently for tone and massaged transabdominally if any sign of relaxation exists. Oxytocin should not be given before delivery of the placenta because this may result in the trapping of placental fragments or may hinder the delivery of an undetected twin.

BOX 179-3 FACTORS LINKED TO PRETERM LABOR

Demographic and Psychosocial
Extremes of age (>40 yr, teenagers)
Lower socioeconomic status
Tobacco use
Cocaine abuse
Prolonged standing (occupation)
Psychosocial stressors

Reproductive and Gynecologic
Prior preterm delivery
Diethylstilbestrol exposure
Multiple gestations
Anatomic endometrial cavity anomalies
Cervical incompetence
Low pregnancy weight gain
First-trimester vaginal bleeding
Placental abruption or previa

Surgical
Prior reproductive organ surgery
Prior paraendometrial surgery other than genitourinary (appendectomy)

Infectious
Urinary tract infections
Nonuterine infections
Genital tract infections (bacterial vaginosis)

SPECIFIC DISORDERS

Third-Trimester Complications Associated with Delivery

Obstetric problems in the third trimester often result in the initiation of labor. Premature labor, premature rupture of membranes, and third-trimester bleeding are relatively common complications. The fundamental question to be addressed in these settings is whether the fetus would fare better in utero or delivered.

Premature Labor

Premature, or preterm, labor and fetal immaturity are the leading causes of neonatal mortality. *Preterm labor* is defined as uterine contractions with cervical changes before 37 weeks of gestation. Women with premature labor are a heterogeneous group. Many underlying conditions result in preterm labor, which accounts for 11% of all pregnancies but 70% of all perinatal mortality.[37] Factors linked to this problem include substance abuse, reproductive history, uterine anomalies, iatrogenic complications, infections, and lifestyle or psychosocial stressors (Box 179-3).[38] The unexpected nature of premature labor often results in an ED visit. When delivery is not imminent, the patient can be moved to the obstetrics unit for further care.

Clinical Features. The diagnosis of preterm labor requires the identification of uterine activity and cervical changes before 37 weeks of gestation. Early maternal signs and symptoms include an increase or change in vaginal discharge, pain resulting from uterine contractions (sometimes perceived as low back pain), pelvic pressure, vaginal bleeding (usually bloody show), and fluid leak.

Diagnostic Strategies. If uterine contractions and cervical changes are present and the estimated fetal weight on ultrasonography is less than 2500 g, the diagnosis of premature labor is likely. The differentiation of false labor (Braxton Hicks contractions) from true labor is best done by electrical monitoring. Ultrasonography may also aid in the diagnosis because fetal breathing movements make the diagnosis of false labor unlikely. The initial evaluation of a woman with possible preterm labor should include urinalysis, complete blood count, and pelvic ultrasonography. If delivery is not imminent, these studies can be performed in the ED or obstetrics area, whichever would provide the best monitoring. When possible, these patients should be transferred to a perinatal center with an associated intensive care unit.

Management. A viable fetus and healthy mother are indications for medical management directed toward the prolongation of gestation. Preterm labor should not be postponed with medical management in the cases of intrauterine demise, major congenital anomalies, eclampsia, or, most important, PROM.[38] When patients with PROM, fetal disorders, and maternal contraindications are excluded, only one fourth of all women in premature labor are candidates for medical management.[39]

The treatment of preterm labor involves multiple modalities. Tocolytics to palliate labor and fetal maturation therapy combined with bedrest and hydration are used in hopes of prolonging pregnancy (Box 179-4). These patients optimally should be transferred to an appropriate center before delivery whenever possible because medical management fails in more than 25% of preterm patients in whom it is attempted.[40]

Tocolysis. The two classically used tocolytics were magnesium sulfate and beta-mimetic drugs. Other medications that have been shown to be as or more effective include prostaglandin synthetase inhibitors (nonsteroidal anti-inflammatory drugs [NSAIDs]) and calcium channel blockers.[41,42] When indicated and in coordination with an obstetric consultant, tocolytics initiated in the ED may arrest premature labor, preventing imminent delivery in 75 to 80% of patients for 48 to 72 hours.[37]

BOX 179-4 COMMONLY USED TOCOLYTIC AGENTS

Magnesium sulfate
- 4–6 g IV bolus over 30 min
- 2–4 g/hr IV infusion

Terbutaline
- 5–10 mg PO q4–6 h
- 0.25–0.5 mg SC q 30 min–6 h
- 10–80 µg/min IV

Ritodrine*
- 10 mg PO q2–4 h
- 5–10 mg IM q2–4 h
- 50–350 µg/min IV

Isoxsuprine
- 20 mg PO q4–6 h
- 0.05–0.5 mg/min IV

IV, intravenously; SC, subcutaneously; PO, orally.
*Ritodrine is currently discontinued in the United States.

BOX 179-5 CONTRAINDICATIONS TO TOCOLYSIS

Absolute
- Acute vaginal bleeding
- Fetal distress (not tachycardia alone)
- Lethal fetal anomaly
- Chorioamnionitis
- Preeclampsia or eclampsia
- Sepsis
- Disseminated intravascular coagulopathy

Relative
- Chronic hypertension
- Cardiopulmonary disease
- Stable placenta previa
- Cervical dilation >5 cm
- Placental abruption

Table 179-3 Drug and Labor Interactions

DRUG	EFFECT ON LABOR
Barbiturates	In anesthetic doses can stop labor
Alcohol	Decreases oxytocin release, smooth muscle relaxant
Cocaine	Increased prematurity, placental infarction
Caffeine or aminophylline	Increased duration of labor
Narcotics	Increased latent phase, slow dilation (minimal effect once in active labor)
Atropine, scopolamine	Lower uterine segment relaxation, decreased frequency of contractions
Halothane	Strong inhibition of labor
IV nitroglycerin	Profound uterine relaxation

IV, intravenous.

Magnesium Sulfate. Magnesium sulfate competitively inhibits calcium uptake into smooth muscle and allows relaxation. Women treated with magnesium require monitoring. Magnesium produces respiratory and neurologic depression at elevated levels, exacerbated by renal insufficiency. Pulmonary edema and cardiac dysrhythmias have also been reported.[37] These effects can be reversed rapidly by the administration of calcium-containing solutions (i.e., 1 g of 10% calcium gluconate solution). Because women with premature labor are at risk for ascending infections, early treatment with antibiotics is often indicated during magnesium therapy (Table 179-3).[43]

Beta-Mimetics. Beta-mimetics (ritodrine and terbutaline) cause smooth muscle relaxation by activating enzymes that bind calcium to the sarcoplasmic reticulum. This effect is mediated by $beta_2$-receptors that increase cyclic adenosine monophosphate concentrations in the myometrium. The beta-mimetic is titrated to effect since the dosage needed to eliminate uterine activity is unpredictable and varies. Only side effects limit beta-mimetic administration. They freely cross the placenta and cause fetal tachycardia. In one meta-analysis, beta-mimetics and magnesium sulfate had similar efficacy in eliminating contractions.[42]

Pulmonary edema is the main adverse effect of high-dose beta-mimetics. This complication is more likely to occur in mothers with preexisting cardiac disease, multiple gestations, and maternal infection. This form of pulmonary edema is high-output failure and tends to occur when there is sustained maternal tachycardia greater than 120 beats/min. Beta-mimetics should be gradually titrated according to uterine activity and maternal heart rate. Eventually, tachyphylaxis and receptor down-regulation decrease the effectiveness of these drugs over 24 to 48 hours.[40]

$Beta_1$-related side effects can be problematic in diabetic mothers. $Beta_1$ stimulation can lead to diabetic ketoacidosis and the usual cascade of metabolic and electrolyte abnormalities.[44] Surveillance of the urine for glucose and ketones is recommended. Fetal heart stimulation can result in increased cerebral perfusion pressures. A premature infant's central nervous system vasculature is delicate and may not tolerate these changes. Beta-mimetics are associated with an increased incidence of fetal intraventricular hemorrhage.[45]

NSAIDs. The prostaglandin synthetase inhibitors, specifically indomethacin and sulindac, have been shown to be as or more effective than magnesium and the beta-mimetics in multiple trials. However, in the fetus, pulmonary hypertension, patent ductus arteriosus constriction, renal insufficiency, necrotizing enterocolitis, and intraventricular hemorrhage have been reported with NSAID use. Potential maternal side effects include a prolonged bleeding time and renal insufficiency.[42,46]

Calcium Channel Blockers. Calcium channel blockers have also been used as tocolytics with success. Nifedipine or nicardipine may be given. Onset is more rapid than that of magnesium, and the maternal and fetal side effect profiles are good.[41,42]

Aggressive titratable tocolytics are best for the initial 24 to 48 hours of preterm labor. After uterine contractions have been stopped, the patient can usually be maintained on oral agents, although the benefits of maintenance tocolysis, studied to date primarily with beta-mimetics and magnesium, have yet to be shown.[42] The contraindications to tocolytics are important to review before initiating these therapies (Box 179-5). Any patient receiving tocolytics should be externally monitored (electrically) for signs of fetal distress.

Premature Rupture of Membranes

Clinical Features. PROM, also known as *amniorrhexis*, is defined as rupture of the amniotic and chorionic membranes before the onset of labor. PROM affects 3% of all gestations.[47] During pregnancy, the chorionic and amniotic membranes protect the fetus from infection and provide an environment that allows fetal growth and movement. The amniotic fluid is constantly exchanged by fetal swallowing and urination and umbilical cord transfer. The fetal airway also contains a secreted fluid that allows for fetal breathing movements, promoting fetal

respiratory development. This fluid is produced at 5 mL/kg/hr at term gestation and is resorbed rapidly by the pulmonary lymphatics, blood vessels, and upper airway at birth.

The word *premature* in PROM refers to rupture before labor, not to fetal prematurity. In 10 to 15% of PROM cases, the fetus is at or near term, and PROM may result in normal labor. When PROM is associated with fetal prematurity, there is significant fetal morbidity and mortality. PROM is the inciting event in one third of all preterm deliveries.

After the membranes rupture, the period from latency to the onset of labor varies. Longer latent periods are common earlier in pregnancy, and the latency shortens as gestational age increases. At term, labor is a desirable result of PROM, but with fetal immaturity labor is problematic because delivery would result in fetal complications, such as hyaline membrane disease.

Diagnostic Strategies. The diagnosis of PROM usually can be established by history and physical examination. The patient usually describes a spontaneous gush of watery fluid followed by a mild persistent seepage. In most cases, the patient suggests the diagnosis and usually is correct. Urinary incontinence or excess vaginal or cervical secretions are occasionally confused with PROM.

Examination of women with potential PROM should be performed under sterile conditions to prevent ascending infection. Direct digital examination of the cervix should be avoided. The incidence of infection has been shown to be proportional to the number of examinations. The identification of amniotic fluid was previously discussed. Table 179-4 summarizes the bedside testing modalities available to confirm the diagnosis of PROM. Visualization of the cervix for prolapsed cord or abnormal fetal presentation (prolapse of a small part) should be done during the uterine evaluation for effacement and dilation. Cultures for group B streptococci, *Chlamydia*, and gonorrhea should be obtained.

Management. When the diagnosis of PROM is established, management depends on several factors: gestational age and maturity of fetus, the presence of active labor, the presence or absence of infection, the presence of placental abruption, and the degree of fetal well-being or distress.[48] Obstetric consultation and admission are indicated.

Gestational age may be well known by menstrual history and previous ultrasonographic scans. In the absence of such data, immediate ultrasonography provides an estimated gestational age quickly. Fetal maturity is a more complex determination. Beyond 36 weeks of gestation, fetal pulmonary maturity is likely. If the gestational age is less than 36 weeks, testing the amniotic fluid for the lecithin-to-sphingomyelin ratio or for phosphatidylglycerol can establish maturity. Fluid pooling in the posterior vaginal vault can be used for this purpose.

In the immature fetus (24–31 weeks of gestation), administration of corticosteroids can accelerate pulmonary maturation. The benefit of this strategy has been shown with preterm labor; however, this therapy is less well documented for PROM. In PROM, treatment with steroids seems to decrease the incidence and severity of hyaline membrane disease, but it may increase the risk of maternal infectious complications. Rupture of the membranes also stimulates fetal lung maturation, making it more difficult to establish a treatment benefit in PROM compared with preterm labor. When gestational age is less than 26 weeks, the latent interval to delivery is often 1 week. Tocolytics are an obvious choice, but their use is controversial. When tocolytics are used, the goal is to temporize, allowing time for therapy to take effect. These treatment decisions should be coordinated with the receiving obstetrician.

All patients with PROM should be assessed for intra-amniotic infection. Infectious complications should be diagnosed and treated before the mother develops overt clinical signs of infection. Preterm PROM is usually treated with intravenous penicillin and erythromycin. Treatment of term PROM is indicated when the patient is group B streptococcus positive or has not been tested. The signs and symptoms of chorioamnionitis are late manifestations of advanced infection and are discussed next.[48]

Table 179-4 Bedside Testing for Premature Rupture of Membranes

METHOD	RESULT
Nitrazine	Amniotic fluid pH 7.1–7.3 turns nitrazine paper yellow; >7.3 is blue
Ferning	Amniotic fluid crystallizes
Smear combustion	Amniotic fluid, when flamed, turns white and crystallizes
	Vaginal secretions caramelize and turn brown

Chorioamnionitis

Chorioamnionitis occurs when vaginal or cervical bacteria ascend into the uterus, instigating an inflammation of the chorion and amnion layers of the amniotic sac.[49] It occurs in 1 to 10% of all pregnancies, and risk factors include prolonged labor, premature rupture of membranes, excessive vaginal examinations, and recent amniocentesis. Box 179-6 summa-

BOX 179-6 Chorioamnionitis Evaluation

Fluid in Vaginal Vault
Phosphatidylglycerol

Cervical Cultures
Escherichia coli and other gram-negative bacteria
Neisseria gonorrhoeae

Vaginal Cultures
Chlamydia spp.
Mycoplasma hominis
Group B streptococci
Ureaplasma urealyticum

Amniocentesis Studies
Gram's stain (group B streptococci)
Culture
Glucose
Lecithin-to-sphingomyelin ratio

Maternal Signs and Symptoms
Premature rupture of membranes
Uterine tenderness
Fever
Tachycardia
Malodorous vaginal discharge
Leukocytosis

Fetal Signs and Symptoms
Decreased activity
Abnormal biophysical profile (ultrasonographic examination)
Fetal tachycardia
Decreased variability of fetal heart rate

rizes the findings and evaluation of chorioamnionitis. Chorioamnionitis may result in prolonged first- and second-stage labor and decreased responsiveness to oxytocin. Early, aggressive treatment, even before evidence of infection occurs, decreases neonatal morbidity and delays delivery, allowing fetal maturation.[50,51]

Vertical Transmission of Human Immunodeficiency Virus

Emergency deliveries may involve women who are known to be HIV positive in addition to women who are infected but have never been tested. The latter group generally includes pregnant women with little or no prenatal care who are at risk for precipitous delivery. Transmission may occur in the antepartum, intrapartum, or postpartum period (breast-feeding). Because intrapartum transmission accounts for up to 75% of vertically transmitted HIV infections, antiretroviral therapy upon presentation, even while labor progresses, can decrease vertical HIV transmission.[52] Potential mechanisms of transmission include microtransfusion during contractions, absorption of virus through the mucous membranes, and even invasion through the epithelium. Risk factors for transmission include high viral loads, prolonged rupture of membranes, maternal drug use, vaginal delivery, and breast-feeding (Table 179-4).[53,54]

In November 2002, the Food and Drug Administration approved the OraQuick Rapid HIV-1 Antibody Test (OraSure Technologies, Bethlehem, Pa).[55] Point-of-care testing for HIV with a median turnaround time of 45 minutes realistically allows the clinician to initiate intrapartum and neonatal antiretroviral therapy when the test is positive. As usual, serologic confirmation is recommended, but emergent interventions can proceed based on the bedside result.[56] Since 1994, it has been known that immediate treatment during labor can significantly decrease vertical transmission to the newborn.[57,58]

A positive HIV test in some cases may allow for a change in the method of delivery. Cesarean section decreases the rate of HIV transmission compared with vaginal delivery methods. In a 1999 meta-analysis from the United States and Europe, vertical HIV transmission was decreased by cesarean section with an odds ratio of 0.43 (95% confidence interval, 0.33–0.56). The protective effect of surgical delivery over other delivery methods persisted even when the data were stratified for receipt of antiretroviral therapy.[59] This finding was tempered by a reported increase in maternal morbidity and mortality in HIV-positive women undergoing cesarean section, namely an increased incidence of endometritis, maternal sepsis, pneumonia, and transfusion. Therefore, cesarean section may be reserved for only high viral load patients.[60]

Ideally, decisions regarding the mode of delivery and the need for antiretroviral therapy can be made before the rupture of membranes. The risk of transmission increases after that time and continues to increase as the fetus traverses the birth canal.[61] When antiretroviral therapy and elective cesarean section are employed, the likelihood of vertical transmission is reduced by 87% compared with that for women receiving neither intervention.[59]

This relatively new diagnostic and therapeutic burden on the emergency physician faced with an imminent delivery is challenging. Data indicate that antiretroviral treatment and the mode of delivery make labor a true emergency for an HIV-positive patient. In addition, pregnant women with advanced HIV disease have a higher incidence of premature births, postpartum endometriosis, and perinatal mortality.[54]

Currently, the main obstacle to this type of care is the availability of point-of-care HIV testing. Since the late 1990s, the results supporting this approach have become increasingly robust and seem to justify the efforts.[62,63]

Complicated Delivery

Perspective

Complicated deliveries, involving dystocia, malpresentation, and multiple gestations, are potentially life-threatening emergencies. The emergency physician cannot "solve" these obstetric problems with cesarean section and will therefore face the prospect of an extremely high-risk vaginal delivery. As expected, these abnormal deliveries increase the risk of fetal and maternal complications. Aggressive attempts to obtain obstetric, neonatal, and anesthesia support are warranted. If the delivery proceeds in the ED, preparations for maternal and neonatal resuscitation should be made rapidly.

Principles of Disease

Knowledge of abnormal labor and its anatomy and physiology is important for the clinician facing a complicated delivery. Intrapartum management skills will enable the emergency physician to proceed with delivery in an efficient, capable manner.

Dystocia and Malpresentation. Dystocia, or abnormal labor progression, accounts for one third of all cesarean sections and half of primary cesarean sections. Because rapid surgical resolution is unavailable to the emergency physician, intrapartum management skills are important.

Dystocia can be divided into three etiologic categories. Labor fails to progress when there are problems related to the pelvic architecture (the passage), when there are fetal size or presentation problems (the passenger), and when uterine expulsive forces are inadequate. Although it is useful to consider these causes independently, dystocia is usually caused by a combination of factors. Presentation problems are particularly important because they become apparent during stage 2 of labor and require immediate action.

In order of increasing incidence, brow, face, shoulder, and breech presentations are the most common malpresentations (Table 179-5). True fetopelvic disproportion is much less common. Cesarean section is indicated when labor arrest or cord prolapse coexists with these presentations.[64]

Breech Delivery

Perspective. Breech is the most common malpresentation, occurring in approximately 4% of all deliveries. Three types of breech presentation exist: frank, incomplete, and complete (Fig. 179-8; Box 179-7). The main mechanical problem with breech presentations is that the buttocks and legs do not provide a sufficient wedge, hindering cervical accommodation of the relatively larger head. In addition, because the presenting part does not completely occlude the cervical opening, umbilical cord prolapse may occur.

The terminology for breech deliveries is complicated. By convention, the presentation (frank, incomplete, and complete) is followed by the relationship of the fetus to the birth canal, using the fetal sacrum as a reference point. The mode of delivery used also has specific terminology. *Spontaneous breech delivery* refers to vaginal delivery without manual aid,

Table 179-5 Relative Incidence of Malpresentations

MALPRESENTATION	INCIDENCE
Breech presentation	1/25 live births
Shoulder dystocia	1/300 live births
Face presentation	1/550 live births
Brow presentation	1/1400 live births

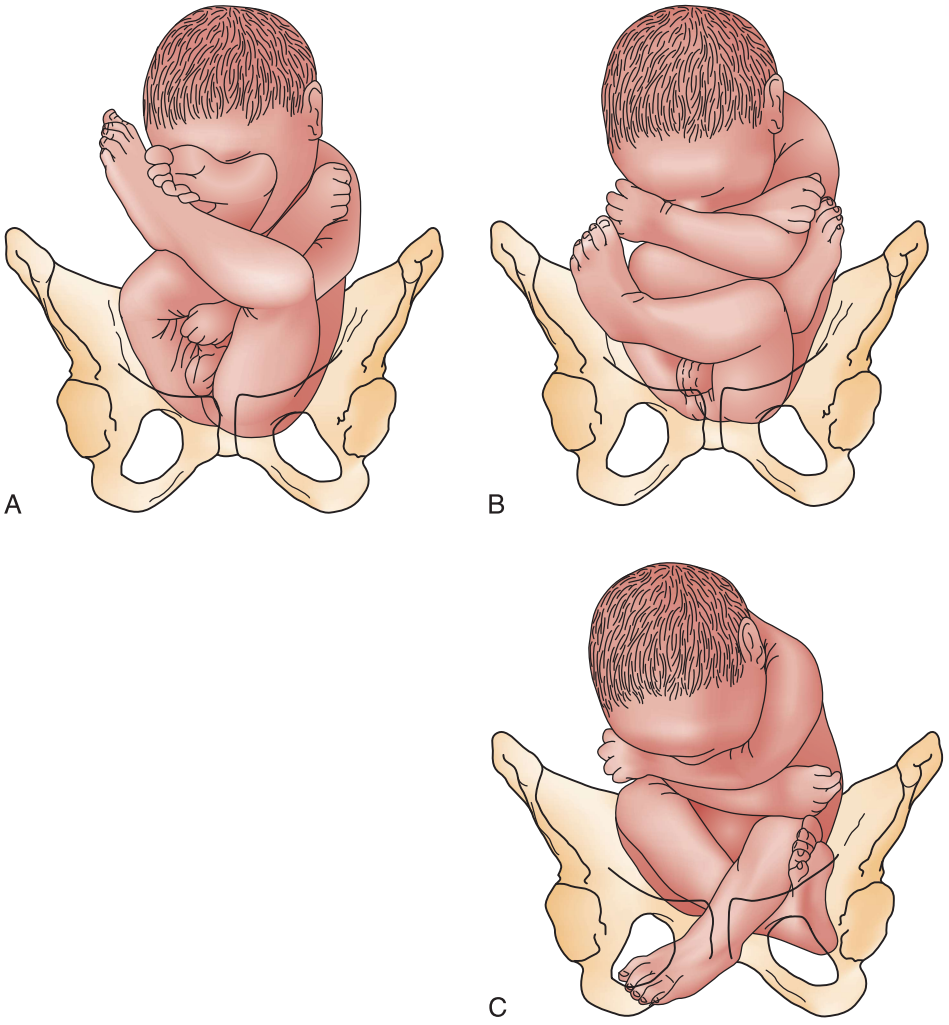

Figure 179-8. Breech presentations. **A,** Frank breech presentation. **B,** Complete breech presentation. **C,** Incomplete breech presentation. (Modified from Cunningham FG, et al: Williams Obstetrics, 19th ed. Norwalk, Conn, Appleton & Lange, 1993.)

BOX 179-7 BREECH PRESENTATIONS

Frank Breech
60–65% of all breech presentations
Hips flexed, knees extended
Buttocks act as good dilating wedge
Incidence of cord prolapse approximately 0.5%

Complete Breech
Least common, occurs in approximately 5% of all breech presentations
Hips and knees flexed
Buttocks act as good dilating wedge
Incidence of cord prolapse is 5–6%

Incomplete Breech
25–35% of all breech presentations
Incomplete hip flexion, single or double footling
Poor wedge
Increased incidence of prolapsed cord (15–18%)

almost always of a small premature infant. *Assisted breech delivery* and *partial breech extraction* are terms that apply when delivery is manually assisted after the umbilicus clears the perineum. The head may be delivered by intrapartum maneuvers or forceps. *Complete breech extraction* consists of the application of traction to the lower extremities or groin before delivery of the buttocks. This approach is never indicated for a singleton breech because it increases the chances of head entrapment. Confusion arises because the word *complete*, as used here, describes the mode of delivery, not the presentation.

Slightly less than 4% of deliveries are breech. Correlated with this abnormal presentation are several factors: prematurity, multiparity, fetal abnormalities, prior breech presentation, polyhydramnios, and uterine abnormalities.[65]

Overall, one third of breech fetal deaths are believed to be preventable. Asphyxia is often due to umbilical cord prolapse or entrapment of the head. Fetal head and neck trauma can occur if inappropriate delivery techniques are used. Scheduled cesarean section for these patients reduces the potential for emergency room presentation. Since the 1990s, however, obstetricians have been attempting to decrease cesarean rates. As part of this process, some centers have proposed a trial of labor and vaginal delivery for selected full-term infants with frank breech presentations.[66] Therefore, the potential for the emergency physician to encounter a breech presentation may be increasing.

Diagnostic Strategies. Before labor, Leopold's maneuvers facilitate the diagnosis of breech presentation. In the case of breech presentation, Leopold's first maneuver identifies a firm, round mass (the head) in the fundus of the uterus. The third maneuver reveals the softer breech at the pelvic inlet. For the emergency physician, active labor restricts the use of Leopold's maneuvers; thus, vaginal examination is required.

The differentiation of a vertex presentation from a breech by tactile vaginal examination is not always simple. Any time

a fontanelle is not identified on examination, a breech presentation should be suspected. During the vaginal examination, it is helpful to remember that the face and the skull have a complete circle of bone, whereas the anus is flanked by bone on only two sides.

If time allows, immediate ultrasonographic studies or plain radiographs are indicated to obtain information on the position of the fetal arms and neck. If the fetus has a hyperextended neck, vaginal delivery is associated with a 70% incidence of spinal cord injuries. If possible, labor should be delayed to allow cesarean section.[67] Likewise, if the arms are over the head, they increase the dystocia when the head enters the birth canal. If ultrasound reveals anencephaly or massive hydrocephaly, vaginal breech delivery should be allowed to continue because cesarean section is undesirable.

Management. Premature infants in the breech position often deliver spontaneously without difficulty. As the infant comes to term, dystocia becomes increasingly common. When committed to a vaginal delivery, knowledge of breech dystocia mechanics may allow atraumatic delivery. The key goals are to maximize the size of the passage and to minimize the dystocia of the aftercoming head. Box 179-8 summarizes the actions associated with successful vaginal breech delivery.

The Mauriceau maneuver is the use of the fetal oral aperture to flex the fetal neck and draw in the chin. Because fetal neck extension is associated with cord injuries and worsening dystocia, this maneuver is crucial to successful vaginal delivery. While the Mauriceau maneuver is used, the fetal pelvis should be supported to avoid abdominal injuries. Generous episiotomy may even be necessary to facilitate the Mauriceau maneuver in a full-term infant. If the aftercoming head cannot be delivered quickly, the chances of good fetal outcome are poor. For term infants, labor arrest, asphyxia, and/or brachial plexus injuries are potential complications of vaginal breech deliveries.

BOX 179-8 VAGINAL BREECH DELIVERY

Actions to Do as Able

Monitoring fetal heart rate
Focused history
Diagnosis of breech lie
Cervical dilation and station determination
Ultrasonography or plain radiography
Evaluation for prolapsed cord if spontaneous rupture of membranes
Episiotomy
Knee flexion and sweep out legs
Pulling out a 10- to 15-cm loop of cord (room to work) after umbilicus clears perineum
Use of bony pelvis as means of holding infant
Keeping face and abdomen away from symphysis, and using rotation to deliver the more accessible arm
Mauriceau maneuver

Actions to Avoid

Inappropriate transfer with delivery en route
Misdiagnosis of cervical dilation
Iatrogenic rupture of membranes (cord prolapse)
Moving patients or leaving unmonitored
Traction on the fetus during delivery
Grasping fetus by the waist, causing abdominal organ injury
Arm entrapment over head
Neck hyperextension

Shoulder Dystocia

Perspective. Shoulder dystocia is the second most common malpresentation, occurring in 1 in 300 deliveries. In contrast to a breech presentation, which may be diagnosed antepartum, shoulder dystocia develops intrapartum. Maternal and fetal factors are associated with shoulder dystocia. Maternal factors include diabetes, obesity, and prolonged second stage of labor; fetal factors include macrosomia, postmaturity, and erythroblastosis fetalis. The combination of prenatal data, estimated fetal weight, and fetal biometry cannot reliably identify most deliveries complicated by shoulder dystocia. The fact that shoulder dystocia responds well to a variety of intrapartum maneuvers means that delivery skill is an important determinant of fetal outcome.

The consequences of shoulder dystocia can be devastating. As with breech presentation, infant complications are more common and severe than maternal complications. Asphyxia, traumatic brachial plexus injuries, and humeral and clavicular fractures contribute to a complication rate of 20%.[68] Maternal complications are related to traumatic delivery and include vaginal, perineal, and anal sphincter tears as well as urinary incontinence.[69]

Diagnostic Strategies. Shoulder dystocia is diagnosed clinically by the inability to deliver either shoulder. The fetal head may appear to retract toward the maternal perineum. This finding is known as the "turtle sign." Traction on the head extends and abducts the shoulders, increasing the bisacromial diameter and worsening the dystocia. Figure 179-9 shows the normal and abnormal relationship of the shoulders to the birth canal and illustrates why the bisacromial diameter is an important element of fetal biometry.

Normally, the shoulders negotiate the maternal pelvis in sequential fashion, anterior shoulder first. With shoulder dystocia, both shoulders attempt to clear the maternal pelvis simultaneously. In addition to the turtle sign, examination often reveals that the fetal shoulders are on a vertical axis (rather than oblique). These findings in combination with an arrested delivery confirm the diagnosis of shoulder dystocia.[70]

Management. When shoulder dystocia becomes evident, knowledge of intrapartum delivery maneuvers can be lifesaving. Successful vaginal delivery is most likely when a directed sequential approach to each maneuver is used. Rapid resolution of shoulder dystocia is important to avoid fetal asphyxia and resultant central nervous system injury. A head-to-body time interval over 6 to 8 minutes is considered critical in the development of these sequelae.[68] Obstetric and neonatology assistance may improve the outcome, and aggressive attempts to obtain help in these areas are warranted.

Initial attempts to resolve shoulder dystocia involve increasing the anteroposterior diameter of the passage. An episiotomy may be used for fetal maneuvering by allowing access to the posterior shoulder. Anteriorly, draining the bladder with a Foley catheter can generate room.

The most important first step is to use the McRoberts' maneuver (Fig. 179-10). Maternal leg flexion to a knee-chest position may disengage the anterior shoulder, allowing rapid vaginal delivery to follow. This maneuver "walks" the pubic symphysis over the anterior shoulder and flattens the sacrum, helping the fetus to pass through the birth canal one shoulder at a time. This method, although requiring very little effort, is successful in 40% of shoulder dystocia cases when used alone.[71]

If the McRoberts' maneuver does not free the anterior shoulder, suprapubic pressure may accomplish the goal. Pressure may slip the anterior shoulder beneath the pubis or cause the posterior shoulder to retreat into the hollow of the sacrum. Digital pressure on the posterior shoulder (via the episiotomy) may help facilitate posterior shoulder retreat.

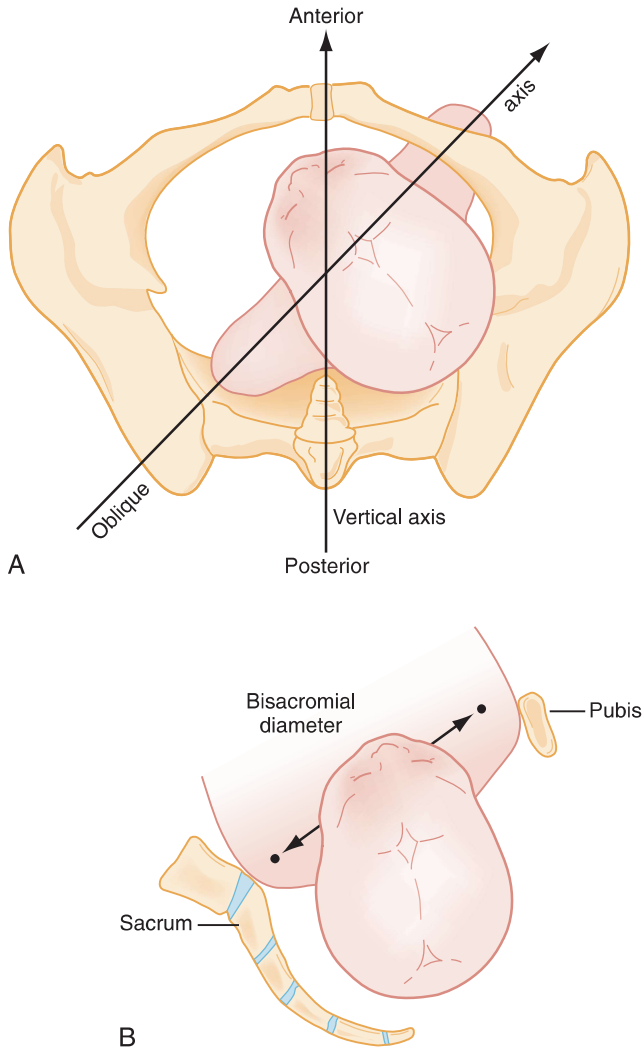

Figure 179-9. **A,** Normal delivery. As the fetal head rotates, the shoulders assume an oblique position and enter the pelvis one at a time. **B,** Shoulder dystocia. Both shoulders attempt to clear the pelvis simultaneously, forcing the bisacromial diameter into the opening.

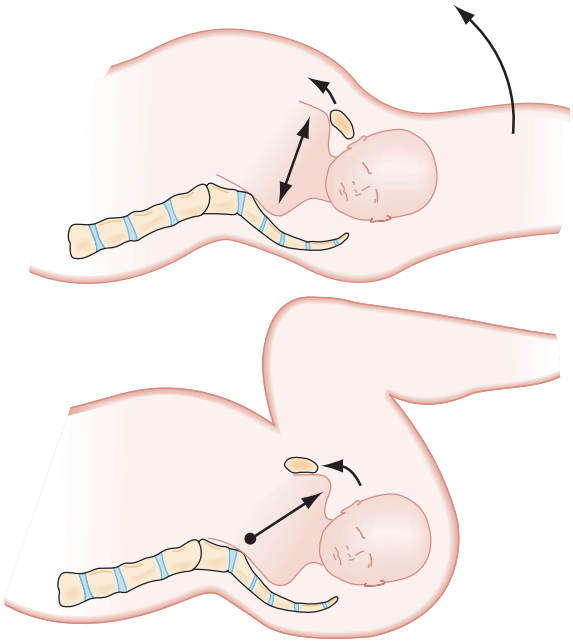

Figure 179-10. McRoberts' maneuver. **Top,** Bisacromial diameter pinned behind pubic symphysis. **Bottom,** Removing the maternal legs from the stirrups and putting the knees up to the chest fulcrum the pubic symphysis over the impacted anterior shoulder.

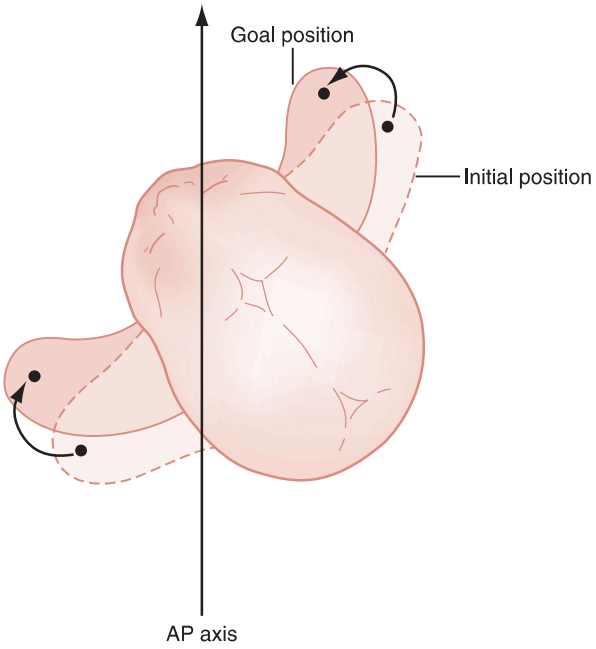

Figure 179-11. Rubin's maneuver decreases the bisacromial diameter. AP, anteroposterior.

Use of these intrapartum maneuvers resolves most cases of shoulder dystocia. However, if delivery is still impossible, more drastic interventions are warranted. Decreasing the bisacromial diameter may be possible by pushing the most accessible shoulder toward the fetal chest (Rubin's maneuver; Fig. 179-11). Often, both shoulders assume the same attitude, decreasing the bisacromial diameter and allowing delivery. Attempts to manipulate the shoulders for Rubin's maneuver may be transabdominal, via the introitus (anterior shoulder), or via the episiotomy (posterior shoulder).

If the shoulders remain undeliverable, the next step is to use Wood's corkscrew maneuver. In this process, the impacted shoulders are released through rotation of the fetus 180 degrees. Fetal rotation is achieved by pushing the most accessible shoulder in toward the chest.[72] The fetal axilla can be snared with a digit, or a hand can be slid in along the fetal spine to sweep the hips and generate rotation. Wood's corkscrew maneuver is difficult to perform but should be attempted before reaching for an arm. A slightly oblique anteroposterior position for the shoulders provides the largest passage through the pelvic outlet.

At this juncture, if the fetus remains trapped and several attempts have failed to yield delivery, consideration of delivery of an arm is appropriate. A hand is introduced along the posterior aspect of the posterior shoulder. This would be a tight fit, requiring tactile identification of fetal anatomy. The posterior arm is swept across the chest, bringing the fetal hand up to the chin. Attempts to splint the humerus may prevent fractures and brachial plexus injuries. The fetal hand is grasped and pulled out of the birth canal across the face, delivering the posterior shoulder. The mnemonic *HELPER* (Box 179-9) has been proposed to help keep these steps organized and to

BOX 179-9 HELPER MNEMONIC FOR SHOULDER DYSTOCIA

Help
Obstetrics, neonatology, anesthesia
Episiotomy
Generous, possibly even episioproctotomy
Legs flexed
McRoberts' maneuver
Pressure
Suprapubic pressure, shoulder pressure
Enter vagina
Rubin's maneuver or Wood's maneuver
Remove posterior arm
Splint, sweep, grasp, and pull to extension

facilitate a sequential approach. These steps successfully deliver almost all cases of shoulder dystocia.

Face, Brow, and Compound Presentations. Face and brow presentations yield a larger engaging aspect of the fetal head and predispose to labor arrest. Although these abnormal presentations can be diagnosed with ultrasonography or Leopold's maneuvers, most are discovered during labor via vaginal examination. Approximately half are discovered during the second stage of labor.

The engaging diameter of the head in vertex position is approximately 0.8 cm less than a face presentation and 1.5 cm less than a brow presentation. Face presentations are described using the chin as a reference point (e.g., mentum anterior). Face presentation is managed expectantly. The obstetric adage "if a face presentation is progressing, leave it alone" arises from the fact that mentum anterior presentations usually deliver vaginally and mentum transverse presentations frequently rotate to become mentum anterior. Brow presentations, occurring when the fetal head is partially flexed, also spontaneously convert to vertex or face presentations in more than 50% of cases.[65]

A persistent mentum posterior face and brow presentation cannot be delivered vaginally if the fetus is full term. The resultant labor arrest requires symphysiotomy or cesarean section. Prolongation of the second stage is the most common outcome of both of these malpresentations at term. For the emergency physician, this prolonged second stage may provide a window during which obstetric help may arrive.

Compound presentations are those in which an extremity enters the birth canal with the head or breech. Small and premature fetuses generally proceed to vaginal delivery without incident.

Labor arrest and umbilical cord prolapse are accepted indications for cesarean section in the setting of face, brow, and compound presentations. Manipulation of a compound presentation, including attempts to reduce the hand or arm, increases the rate of cord prolapse. Therefore, manipulation attempts are contraindicated. Cord prolapse rates are 10 to 20% even without manipulation. Close monitoring and careful examination are indicated.

Multiple Gestations

Perspective. Although twin gestations accounted for less than 1% of all deliveries historically, there has been a recent increase in the frequency of twin and triplet or higher births (65 and 500%, respectively) due to the increasing use of infertility treatments.[73] In 2003, twin deliveries accounted for 31.5 per 1000 live births. Because multiple gestation deliveries have a higher incidence of preterm labor and low birth weights, both maternal and fetal complication rates are correspondingly increased.[74]

Diagnostic Strategies. Most women with multiple gestations have the situation identified well before the third trimester. In patients who have had little or no prenatal care, bedside ultrasonography allows rapid diagnosis and early preparation. The stages of labor for twins and other multiple gestations are similar to the stages for a singleton. Nulliparous women experience longer labors than multiparous women, with an overall labor duration that is similar to that of singleton pregnancies. Of importance to the emergency physician is a relatively short latent phase of labor, with rapid progression to the active phase. The active phase is usually longer, however. The prolongation of the active phase is due to overdistention of the uterus plus malpresentation and may allow time for obstetric assistance to arrive.

Vertex twin A and vertex twin B occur in approximately 40% of deliveries. In the remaining 60%, one or both of the twins has a malpresentation, usually twin B.[75] Delivery problems with twin B cause most of the preventable perinatal mortality of twin gestation.[76]

Management. The presentation of the twins is an important determinant for the safety of vaginal delivery. Twins who are vertex-vertex, the most common presentation, can be delivered vaginally. If twin B is nonvertex, some obstetricians recommend cesarean section to prevent delivery-related complications for twin B. External cephalic version may also be attempted to convert twin B to a vertex lie and then proceed to vaginal delivery. Breech extraction is a third, more difficult, option. The general consensus is that if twin A is nonvertex, cesarean section is the preferred route. In such cases, efforts should be made to delay delivery until an operative approach can be used.[77,78] Proceeding vaginally can result in the "stuck twin" syndrome and lead to poor outcome.

The interval between the delivery of twin A and twin B is variable. Although in most cases twin B delivers in minutes, prolonged interdelivery times with good fetal outcomes have been reported. When twin B does not follow rapidly, in utero assessment is important to document fetal well-being. If fetal heart tracings are reassuring, the delivery of twin B (especially nonvertex) should not be hastened. Repeat ultrasonographic evaluation may be utilized to confirm twin B's presentation and well-being during the interdelivery period.

After every emergency department delivery, particularly deliveries that are precipitous or that occur in the out-of-hospital setting, the mother should be examined for the possibility of twins. Ongoing labor may be confused with postpartum cramping, only to have twin B and all of the potential complications surprise the clinician. This situation is particularly relevant for women with inadequate prenatal care and low-birth-weight infants.

Umbilical Cord–Related Emergencies

Perspective

Umbilical cord–related complications can occur in normal and abnormal deliveries. Immediate intervention is required to prevent fetal morbidity and mortality. The spectrum of cord-related emergencies includes prolapsed cord, nuchal loops of the umbilical cord, body coils, cord knots, and entangled cords in monoamniotic twins. Cord length is believed to be proportional to fetal activity in utero during the first and second trimesters. Excess cord length increases the potential for umbilical cord complications of all types. Because the umbilical cord supplies the fetus with all of its oxygen, interruption of cord circulation before establishment of fetal respiration is a life-threatening emergency. Fetal asphyxia caused by cord

Table 179-6 Conditions Associated with Umbilical Cord Prolapse

PRESENTATION	INCIDENCE (%)
Vertex	0.14
Breech	2.5–3.0
Frank breech	0.4
Complete breech	5
Incomplete breech	10
Shoulder	5–10
Compound	10–20
Face or brow	Rare

circulation compromise is potentially preventable with appropriate delivery interventions.

Umbilical Cord Prolapse

Clinical Features. Umbilical cord prolapse occurs when (1) the umbilical cord precedes the fetal presenting part or (2) the presenting part does not fill the birth canal completely. Most instances of cord prolapse are unexpected and develop during the second stage of labor.

Cord prolapse has a variable rate of association with different fetal presentations. Compound, shoulder, and breech presentations all yield gaps and a relatively poor dilating wedge. Table 179-6 summarizes the rates of umbilical cord prolapse with various fetal presentations. Overall, malpresentations account for 50% of cord prolapse cases; therefore, prolapse may be the first indication of a malpresentation.[79] The incidence of cord prolapse is reported to range from 0.3 to 0.6% of all deliveries and associated perinatal mortality ranges from 8.6 to 49%.[80,81]

Diagnostic Strategies. Umbilical cord prolapse may be overt or occult, requiring a pelvic examination to reveal the umbilical cord lying beside the presenting part. The diagnosis also may be made with Doppler ultrasonography. In most cases, the diagnosis is obvious, and the cord is encountered at the perineum or introitus.

Management. Whenever a prolapsed cord occurs with a viable infant, cesarean section is the delivery method of choice. If surgical delivery is available, maneuvers to preserve umbilical circulation should be instituted immediately. The mother should be placed in the knee-chest position with the bed in Trendelenburg as the presenting part is digitally elevated off the umbilical cord.[82] It is crucial that the mother be instructed *not* to push, to avoid further compression of the cord. Placement of a Foley catheter and instillation of 500 to 750 mL of saline into the bladder may help lift the fetus off the cord, particularly in the first stage of labor.

Preparation for an emergency ("crash") cesarean section should be underway. The time from prolapse to surgical intervention is an important factor in fetal outcome. Perinatal mortality rates of approximately 15% are reported for prolapsed cord deliveries; however, if cesarean section can be done within 10 minutes, the mortality rate decreases to 5%.[83] These numbers have implications for the availability of obstetric and surgical backup for the ED.

If surgical delivery cannot be done in a timely fashion, funic reduction (manual replacement of the cord into the uterus) and rapid vaginal delivery may be the only options available. The same maneuvers to decrease cord compression are used, and the umbilical cord is pushed gently, in a retrograde fashion, above the presenting part. Manipulation and cord trauma should be kept to a minimum because the resultant vasospasm can cause fetal hypoxia. After funic reduction, the development of umbilical cord body coils or nuchal loops is common and should be anticipated.[84]

Subsequent to delivery, the physician should be prepared for resuscitation of a distressed newborn. If one is available, a neonatologist should attend the delivery.

Cord Entanglement

The umbilical cord can also become entangled with itself, spontaneously knotting. Umbilical cord knots are related to intrauterine movements early in pregnancy. Approximately 4 or 5% of stillbirths are found to have knots that are believed to have caused fetal demise. Despite this association, cord knots can persist without problems as long as perfusion is maintained.

Loose umbilical cord knots pulled tight at delivery may cause fetal distress. As with cord prolapse, this situation must be resolved quickly to prevent fetal asphyxia. Rapid delivery with avoidance of further cord traction optimizes fetal outcome. No specific interventions exist to deal with this problem.

Long umbilical cords are associated with true knots as well as entanglements and prolapse. Because the fetal limbs are short and flexed in most presentations, they are rarely involved. Loops around the neck and body do occur, however. Umbilical cord loops can be single or multiple, and there are reports of six nuchal loops. Risk factors for excessive cord length include increasing parity and fetal weight. Although generally benign, they may result in fetal complications, such as nonreassuring fetal status and respiratory distress.[85]

During delivery, loose nuchal cords should be reduced at the perineum. Loose body coils usually disentangle spontaneously. The reduction process may be aided by slipping them over the extremities or forward over the head. Occasionally, loops are tight enough to impede delivery and cannot be reduced. The solution is to cut the clamped cord and deliver the infant rapidly. The high frequency of nuchal loops (one in five births) means that the emergency physician should expect to encounter this problem.

Maternal Complications of Labor and Delivery

Perspective

Maternal complications of labor and delivery include postpartum hemorrhage, uterine inversion and rupture, amniotic fluid embolism, infections, and more. Many of these problems can be managed nonsurgically. When severe, however, these complications threaten the reproductive future and the life of the mother, and they may require emergent surgical intervention.

Postpartum Hemorrhage

Clinical Features. Postpartum hemorrhage is the most common complication of labor and delivery. Defined as hemorrhage greater than 500 mL, it affects 5 to 10% of all deliveries and accounts for up to 25% of obstetric deaths.[86,87] Postpartum hemorrhage is divided into primary and secondary categories. The primary category includes blood loss that occurs within the first 24 hours, and the secondary category is hemorrhage 24 hours to 6 weeks after delivery. The clinical picture is as expected with any type of hemorrhage, although due to maternal adaptations during pregnancy, the patient may not show signs of shock until more than 1500 mL of volume is lost.[88]

Differential Considerations. The differential diagnosis of primary postpartum hemorrhage includes uterine atony, genital tract trauma, retained placental tissue, and coagulopathies, or the "four Ts": tone, trauma, tissue, and thrombin.

Uterine Atony. The most common cause of serious immediate postpartum hemorrhage is laxity of the uterus after delivery. It accounts for 75 to 90% of postpartum hemorrhage cases.[89] Postpartum bleeding from the placental implantation site normally is limited by contraction of the myometrium, constricting the spiral arteries. If the uterus cannot or does not contract, ongoing hemorrhage will occur. Predisposing factors include overdistention of the uterus (multiple gestations and polyhydramnios), prolonged labor, chorioamnionitis, use of tocolytics, and general anesthesia with halogenated compounds. Despite the myriad causes, uterine atony is a diagnosis of exclusion. Physical examination to rule out obstetric trauma and retained products of conception must be done before reaching the diagnosis. On examination, the uterus is palpable as a soft, boggy mass.

After other causes have been excluded, therapy to augment myometrial contraction should be instituted to prevent further hemorrhage. Two-handed uterine massage may stimulate uterine contraction. One hand exerts pressure transabdominally while the other supports the uterus via the introitus. Uterotonics in conjunction with massage usually provide enough stimuli to control bleeding. Blood should be typed, crossmatched, and available for resuscitation should these measures fail.

Maternal Birth Trauma. Maternal birth trauma is the second most common cause of postpartum hemorrhage, accounting for 20% of the cases. Uncontrolled delivery, macrosomia, and malpresentation all may result in maternal birth-related trauma. Although genitourinary structures are most commonly involved, any part of the birth canal–associated anatomy may be injured, with resultant postpartum hemorrhage. Tears and lacerations may involve the perineum, rectum, cervix, vagina, vulva, and urethra. Blood vessels beneath the vulvar or vaginal epithelium can also be injured without frank hemorrhage, resulting in the formation of large, contained hematomas. These hematomas may go unrecognized for hours, gradually enlarging and eventually resulting in hemorrhagic shock. This type of hemorrhage should be suspected whenever there is evidence of ongoing blood loss and no identifiable obstetric site of bleeding (a firm uterus and negative examination for lacerations). Delayed postpartum hemorrhage at these sites can also occur and is often a diagnostic challenge.

Tears. Vaginal tears, especially posteriorly over the ischial spines, should be diagnosed early by postpartum exploration rather than hours later when the mother is hemorrhaging. The vulva, including periurethral structures, should be examined. Although minor tears may be left, any laceration involving subcutaneous tissue should be repaired with absorbable suture.

The most common sites of tears are the vaginal, perineal, and rectal structures. Tears are classified as first, second, third, and fourth degree. First-degree tears involve the perineal skin and vaginal mucous membranes without involvement of the underlying fascia and muscle. Second-degree lacerations extend through the skin into the fascia and muscles of the perineal body but not into the rectal sphincter. Third-degree tears involve the skin, mucous membranes, perineal body, and anal sphincter. Fourth-degree tear involvement extends through all layers, including the rectal mucosa. These lacerations are also associated with tears in the region of the urethra.

The repair of these tears and the repair of episiotomies are virtually identical. Commonly, repair of the episiotomy is delayed until the placenta is delivered, which allows an uninterrupted approach to potentially complicated repairs. The goal of these repairs is to restore anatomy and provide hemostasis with a minimum of suturing. Third-degree and fourth-degree tears should be repaired by the obstetrician in an operating room.

Retained Products of Conception. Approximately 10% of postpartum hemorrhage cases are due to retained placental tissue. Normally, the plane of cleavage between the zona basalis and the zona spongiosa results in clean separation of the placenta from the uterus. When this occurs, the placental tissue delivers as a single unit, without evidence of fragmentation. Occasionally, accessory placental tissue exists as succenturiate placenta, but this also should cleave normally and deliver spontaneously.

Any placental defect or evidence of accessory placental tissue may signify a retained cotyledon. Retained fragments prevent myometrial constriction and result in hemorrhage. Inappropriate traction on the placenta during stage 3 of labor can result in tears with retained products of conception, which may cause immediate and delayed postpartum hemorrhage. Ultrasonography may be utilized in the diagnosis of retained placenta, with an empty or fluid-filled uterus providing a high negative predictive value and an expanded endometrium or solid echogenic masses within the uterus providing evidence of retention.[28,90]

Treatment requires removal of the remnant placental tissue. Digital uterine exploration with blunt dissection of the fragments from the myometrium allows myometrial contraction. Normal placental tissue cleaves away easily, allowing removal. Abnormally adherent tissue is not freed by this mechanism.

Placenta Accreta, Increta, and Percreta. Placenta accreta, increta, and percreta describe various degrees of abnormal placental attachment to the uterus. Placental villi may invade the myometrium at the site of implantation, firmly rooting the placenta and obliterating the normal cleavage plane. Thus, abnormal attachment results in retained products of conception and postpartum hemorrhage. When the placenta adheres to the myometrium without the intervening decidua basalis, it is termed *placenta accreta*. In *placenta increta*, the villi extend into the myometrium. In *placenta percreta*, the placenta penetrates the full thickness of the myometrium.[91]

The incidence of these placental disorders is 1 in 2000 to 7000 deliveries. Placenta accreta occurs in 80% of these cases. Associated risk factors include multigravidity, prior cesarean sections, placenta previa, previous curettage, and uterine infections.

Management

Uterine Exploration and Placental Removal. In the face of ongoing hemorrhage and retained products of conception, attempts to remove the placenta manually are indicated. The procedure entails risk of infection, perforation, and increased hemorrhage but may be the most expeditious way to control bleeding.[92] Before beginning, the patient should be on a monitor, good vascular access should be established, and blood products should be available.

The umbilical cord is traced through the cervical os to the placenta, allowing the identification of a placental margin. The placental membranes are digitally perforated, and the placenta is gradually divided from the myometrium. The palmar surface of the hand should be directed toward the placenta, taking care to avoid uterine perforation. After placental removal, the uterus should be explored for retained cotyledons. Removal of any further fragments still present requires curettage of the uterine cavity by an obstetrician. Placenta accreta, percreta, and increta may be diagnosed in this way because these are not digitally dissectible.

Once emptied, the uterus can be stimulated to contract. Uterine massage, oxytocin, and prostaglandins all may be used.

Uterine Packing. Uterine packing to decrease postpartum hemorrhage was widely used previously but now is uncommon. For the emergency physician, this technique may be used to create tamponade, preventing further blood loss. The procedure has limited morbidity and is straightforward. The physician introduces 15 to 20 yards of 4-inch gauze with a ring forceps and packs it into the uterus using a layering technique. A special "uterine packer" is available to help direct gauze high into the uterus but is not necessary.

Opponents of packing point out that an atonic uterus may accommodate a large volume of packing and blood without effective tamponade. Packing may also increase the risk of postpartum infection even when prophylactic antibiotics are given. As with all uterine manipulation and instrumentation, some risk of perforation also exists. Because dilation and curettage and hysterectomy sometimes are not available to the emergency physician, the importance of uterine packing as an option is increased. This approach is a temporizing measure.[93]

Pelvic Vessel Embolization. Pelvic bleeding postpartum can be difficult to control. Hysterectomy as a solution results in infertility and brings with it all the complications of general anesthesia and major surgery. Radiographic embolization of the bleeding vessels by an interventional radiologist is another option. The procedure does not require an anesthesiologist, operating room, or obstetrician and may, in fact, be more available on an emergent basis. The success rate of embolization is estimated to be 90%.[94]

A catheter is placed in the aorta and fluoroscopically guided to the bleeding sites that are imaged by radiopaque dye. The vessels are embolized with absorbable gelatin sponges placed via the catheter. Common sites of bleeding include the uterine artery, pudendal artery, and hypogastric artery. Because only the smallest involved branches are embolized and recanalization usually occurs, future reproductive capability is generally preserved.[95]

Uterotonic Agents. The use of uterotonic agents, although commonly applied upon delivery of the placenta, also has special application in the case of postpartum hemorrhage. Uterotonics, such as oxytocin, ergot alkaloids, and prostaglandins, control bleeding by inducing myometrial contraction. Oxytocin is considered to be first-line treatment, given either intramuscularly or intravenously. Ergot alkaloids, such as methergine and ergotamine, may induce hypertension and are therefore contraindicated in patients with preeclampsia or other comorbid conditions. Finally, prostaglandins may also be used, although the F class is contraindicated in asthma.[84]

Hysterectomy. Most postpartum hemorrhages are controllable with uterotonics and massage or uterine exploration for products of conception. Rarely, hemorrhage continues despite the interventions outlined. Life-threatening obstetric bleeding may require emergency hysterectomy. The desire to preserve the patient's reproductive capabilities must not be given priority if her life is in jeopardy.[96]

A speedy search for the refractory cause of hemorrhage is warranted because coagulopathies may complicate obstetric hemorrhage. Disseminated intravascular coagulation (DIC) can occur as a consequence of placental abruption, eclampsia, amniotic fluid embolism, postpartum infections, and dilution of clotting factors caused by aggressive volume resuscitation. Also, retained products of conception and dead fetal tissue contain excess thromboplastin, which can initiate DIC. All women with severe postpartum hemorrhage should be evaluated for DIC. As with DIC from nonobstetric causes, clinical signs of bleeding are associated with hypofibrinogenemia, thrombocytopenia, and elevated levels of fibrin split products and D-dimer.[97]

Appropriate management entails hemodynamic support as well as correction of coagulopathies. In fact, recent investigations have reported the successful use of recombinant factor VIIA for severe cases of postpartum hemorrhage.[98]

Uterine Inversion

Uterine inversion is an uncommon but serious complication of delivery that occurs during stage 4 of labor. The resultant postpartum hemorrhage can be severe and life-threatening, accounting for a maternal mortality rate of up to 15%. Uterine inversion is relatively rare, complicating 1 in 2000 deliveries.[99] It is classified by duration as well as degree of inversion. Risk factors include forceful traction on the umbilical cord (especially in conjunction with a fundal placenta), placenta accreta, maternal congenital abnormalities of the uterus, fundal pressure during delivery, use of magnesium sulfate in the antepartum period, and primiparity.[99,100]

Clinical Features. Clinically, the patient notes the sudden onset of severe abdominal pain. Abdominal examination reveals tenderness and an absence of the uterine corpus, which is potentially visualized at the cervical os or bulging from the introitus. Profuse bleeding leading to hemodynamic instability can also occur. Ultrasound may assist in making the diagnosis. Once uterine inversion is identified, the appropriate mobilization of resources should begin simultaneously with efforts to reestablish the correct anatomic position of the uterus.

Management. The highest likelihood for successful repositioning of the inverted uterus is immediately after inversion occurs. If the placenta is still adherent, it should not be removed until after repositioning. Removing the placenta while the uterus is inverted is associated with excessive blood loss. The initial attempt to reposition the uterus should be to push the fundus upward via the introitus. Digital pressure should be directed toward the mother's umbilicus along the long axis of the uterus. Contraction of the cervical uterine segments can create a muscular ring, preventing repositioning. Therefore, all uterotonic agents should be withheld immediately upon diagnosis of uterine inversion.

If initial attempts fail and a cervical ring develops, pharmacologic attempts to relax the uterus are indicated. Sedation and tocolytics can be used to facilitate uterine replacement. Terbutaline and magnesium sulfate have been used successfully to relax cervical rings. When the uterus has been repositioned, the muscle relaxants should be halted, and oxytocin and prostaglandin therapy should be initiated. Firm manual pressure via the introitus should be maintained until uterine contraction begins, the cervical ring contracts, and the uterus can no longer invert.

If all these measures fail and obstetric/anesthesia backup becomes available, halogenated anesthetics may be used to induce relaxation of the cervical rings with or without an attempt at surgical repair.[99]

Uterine Rupture

Criticism of the high rate of cesarean delivery in the United States has led to an advocacy of vaginal birth after cesarean (VBAC). Prior cesarean section is no longer an automatic indication for repeat cesarean delivery. The high success rate and relative safety of VBAC are countered partly by the risk of uterine rupture. Dehiscence of a surgical scar occurs in 0.6% of VBAC deliveries.[101] As more women have VBACs, emergency physicians can expect to encounter uterine rupture.

Clinical Features. Uterine rupture is an unpredictable event occurring late in pregnancy or as stage 1 of labor transitions to the active phase. It is defined as a full-thickness uterine wall perforation. The severity of rupture ranges from simple scar dehiscence to complete fetal extrusion. It may be spontaneous, but it is most often liked with previous uterine surgery.[102]

This diagnosis should be entertained when appropriate because significant fetal mortality is associated with the event. As the degree of fetal expulsion through the rupture increases, the fetal mortality rate increases as well. Minimal fetal extrusion results in a perinatal mortality rate of less than 1%, whereas complete extrusion results in a 10 to 20% mortality rate. Maternal death is rare, but significant hemorrhage is common, complicating one third of cases. Maternal genitourinary injury may also occur in association with uterine rupture.

Diagnostic Strategies and Difficulties. The diagnosis of uterine rupture is sometimes difficult because pain is not always present. Risk for uterine rupture with VBAC generally cannot be predicted based on maternal characteristics except that women with a prior classic, or T-shaped, incision and women who have had more than three cesarean sections are at increased risk. Intrapartum vaginal bleeding may signal the problem, but its absence by no means precludes rupture. Prolonged fetal heart rate deceleration, indicating fetal distress, is the most reliable sign of fetal extrusion.[28] Emergency ultrasonography may reveal a protruding amniotic sac, hemoperitoneum, and/or the site of myometrial rupture; however, good sensitivity data are lacking.[102]

Management. If uterine rupture is suspected, delivery should be hastened to limit fetal hypoxia. Emergency cesarean section is the best method to speed delivery and repair the injury. The American College of Obstetricians and Gynecologists guidelines for uterine rupture identify a 30-minute window of opportunity that maximizes fetal outcome.[103] At surgery, the maternal condition dictates whether uterine repair or hysterectomy is indicated. In the absence of opportunity for emergency laparotomy, appropriate interventions remain speculative. Uterotonic agents (especially ergonovine) may enlarge the rupture and are contraindicated.

Amniotic Fluid Embolism

Amniotic fluid embolism is a rare and catastrophic complication of labor and delivery. The incidence rate is 6.0 and 14.8 per 100,000 in primigravid and multiparous deliveries, respectively.[104] Although the mechanism is not well understood, it is thought to involve the spread of amniotic fluid through the maternal vasculature, activating either a procoagulant or anaphylactic cascade. Uterine trauma at or around the time of delivery, amniocentesis, and miscarriage also may result in amniotic fluid embolism. The diagnosis is usually clinically evident with the sudden onset of dyspnea, hypoxia, altered mental status, seizure, or hemodynamic collapse. DIC frequently follows and maternal mortality is high. In more than half of amniotic fluid embolism patients, postpartum bleeding due to coagulopathy occurs. Central hemodynamic monitoring, vasopressors/inotropes, and DIC management may be needed.[105-107]

Postpartum Endometritis

Perspective. Puerperal infections affect 5% of all vaginal deliveries and 10% of all cesarean sections. Operative delivery, prolonged rupture of membranes, lack of prenatal care, prolonged stage 2 labor, use of intrauterine monitoring, and frequent vaginal examinations have all been linked to these ascending gynecologic infections.[108] Of all puerperal deaths, 8% have infection and sepsis as a direct or contributing factor.[109] Causative organisms for these infections include gram-positive cocci and gram-negative coliforms. Less commonly, *Chlamydia* and *Mycoplasma* species have been implicated.

Clinical Features. Endometritis is the most common puerperal infection, usually developing on the second or third day postpartum. Typically, the lochia has a foul odor and the white blood cell count is elevated. Fever and abdominal pain indicate greater severity of infection, often warranting inpatient care and intravenous antibiotics. Often, a coexistent surgical wound infection is present. A search for retained products of conception is indicated, particularly if bleeding is ongoing.

Management. Treatment is empirical and directed at the most likely organisms. Clindamycin in conjunction with an aminoglycoside is usually used, although second- and third-generation cephalosporins are acceptable alternatives.[110] Most patients with postpartum endometritis require admission.

Postpartum Cardiomyopathy

Perspective. For unclear reasons, the postpartum period is associated with the relatively sudden onset of cardiomyopathy in healthy women without evidence of prior cardiac disease. Estimates indicate that postpartum cardiomyopathy (PPCM) occurs in 1 of 4000 pregnancies and is more common in African American and multiparous women. Proposed etiologies include viral, immunologic, toxic, and genetic factors, but in most cases no specific cause is found.[111] Mortality rates for PPCM range from 18 to 56%.

Clinical Features. Symptom onset varies, as does the severity of the cardiomyopathy. Onset is usually days to weeks after delivery, and symptoms range from mild fatigue to acute pulmonary edema. PPCM is often unrecognized in its milder form, leading to the consensus that the condition may be more prevalent than reported. Dyspnea on exertion, orthopnea, and fatigue may be easily misinterpreted as normal in a mildly anemic woman who is breast-feeding a new infant at home. The clinician should not dismiss these symptoms because congestive heart failure and dysrhythmias may ensue.

Management. Treatment with diuretics, vasodilators, and oxygen relieves the symptoms in many cases. Angiotensin-converting enzyme inhibitors are contraindicated if PPCM occurs during the last month of pregnancy (owing to teratogenicity) but should be considered a mainstay of treatment postpartum. Amlodipine (a dihydropyridine calcium channel blocker) may also have a role in the treatment of PPCM.[112,113]

Cardiac function returns to normal in half of patients with PPCM during the following 6 months. Others have residual left ventricular dysfunction and a cardiac mortality of 85% during the next 5 years. The presence of cardiomyopathy after one pregnancy does not predict recurrence during subsequent pregnancies.[114] Most obstetricians recommend against future pregnancies, however, believing that there is some residual cardiac function impairment. If such a pregnancy cannot be avoided, it should be considered high risk and followed closely.

Postpartum Depression

Perspective. Although likely underdiagnosed, it is estimated that postpartum depression affects 10 to 15% of mothers. Although in many cases it is self-limited, the condition has been recognized as having important consequences for the mother, infant, and family. Risk factors for postpartum depression include previously diagnosed depression and neuroticism, inadequate

spousal support, adverse socioeconomic factors, recent life stressors, and emergency delivery.[115]

Clinical Features. Postpartum depression patients present with symptoms not unlike those of other major depressive disorders. These symptoms include depressed mood, anhedonia, loss of appetite, insomnia, fatigue, decreased concentration, feelings of guilt and worthlessness, and suicidal ideation.[116] Most women with postpartum depression do not have vegetative signs or symptoms. Symptoms peak at 10 to 12 weeks postpartum, although some cases are diagnosed up to 1 year postpartum.[117]

When unrecognized, these women are at high risk for suicide and may come to the ED with overdoses or other manifestations of a suicidal attempt.[118]

Management. Early identification and referral are the key components of therapy. Dismissal of postpartum fatigue as normal, without considering the diagnosis of postpartum depression, can be disastrous. Not only does this condition contribute to marital discord, maternal risk for suicide, and even infanticide, but also studies have shown that children of depressed mothers have an increased incidence of delayed cognitive, psychological, neurologic, and motor development.[119] Therefore, sensitivity to the possibility of postpartum depression is crucial to successful treatment. The disposition of inpatient psychiatric care with suicide precautions may be required, as deemed appropriate.

KEY CONCEPTS

- ED deliveries should be considered high risk. Antepartum hemorrhage, PROM, eclampsia, premature labor, precipitous delivery, malpresentation, and umbilical cord emergencies are all overrepresented in emergency deliveries.
- Women in labor who present to the ED are generally best cared for in the obstetric suite. Women with the urge to push or with the head of the infant crowning are at imminent risk of delivery, which should take place in the ED. The transfer of a woman with an impending high-risk delivery to a perinatal center must be tempered by clinical and medicolegal judgment.
- Most ED deliveries require only basic equipment to cut and clamp the umbilical cord and to dry and suction the infant. However, the ED should have the equipment and staff available to care for a newborn requiring further resuscitation.
- Maternal complications of labor and delivery include obstetric trauma, postpartum hemorrhage, uterine inversion and rupture, amniotic fluid embolism, coagulation disorders, and infections. Many of these problems can initially be managed nonsurgically in the ED.
- Deliveries complicated by dystocia, malpresentation, or multiple gestations are life-threatening emergencies. The clinician must develop strategies to treat each of these potential complications of delivery.

The references for this chapter can be found online by accessing the accompanying Expert Consult website.