INTRODUCTION — Either regional or general anesthesia is an acceptable approach to providing anesthesia for cesarean delivery. However, the use of general anesthesia has fallen dramatically in the past few decades and now accounts for only about 5 percent of cesarean deliveries in the United States and United Kingdom [1].

CHOICE OF ANESTHETIC APPROACH — The anesthetic plan for cesarean delivery should take into account the well-being of two patients: the mother and the fetus. Regional anesthesia is the most common method of anesthesia for delivery because it allows the mother to be awake and immediately interact with her baby. It is also safer for the mother than general anesthesia. In the most recent report of anesthesia-related maternal mortality in the United States (1991-2002 period), the majority of women who died were undergoing a cesarean delivery and there were no deaths associated with vaginal delivery [2]. Maternal mortality associated with general anesthesia was 6.5 per million, while that associated with regional anesthesia was 3.8 per million, a risk ratio of 1.7. Even though overall anesthetic-related maternal mortality continues to decrease, rates for regional anesthesia are rising. Regional anesthesia is used for 95 percent of planned cesarean deliveries in the United States [3]. Spinal and combined spinal epidural (CSE) anesthesia are more commonly used than epidural anesthesia because spinal-based techniques have a more rapid onset and lower incidence of failed block than pure epidural techniques. The use of spinal anesthesia for cesarean delivery was facilitated by the popularization of pencil-point needles, which dramatically reduced the incidence of postdural puncture headache.

Regional anesthesia for cesarean delivery differs from analgesia for labor and vaginal delivery in two major ways:

- Operative anesthesia requires a more intense block because the nociceptive stimulus of surgery is more intense than the pain of labor. Relatively dilute concentrations of local anesthetics are administered for labor analgesia to avoid motor block and to minimize interference with second stage pushing efforts. However, motor block is desirable during cesarean delivery to obtain abdominal muscle relaxation. A more intense block is achieved by administering a high concentration of local anesthetic.

- The dermatomal level of anesthesia required for cesarean delivery is higher than that required for labor analgesia. A sensory block to the 10th thoracic dermatome is
sufficient to achieve analgesia for labor, but for cesarean, the anesthetic level must be extended cephalad to at least the fourth thoracic dermatome to prevent nociceptive input from the peritoneal manipulation.

A detailed description of regional anesthetic techniques, side effects, and complications can be found separately. (See "Neuraxial analgesia and anesthesia for labor and delivery: Options" and "Adverse effects of neuraxial analgesia and anesthesia for obstetrics" and "Neuraxial analgesia and anesthesia for labor and delivery: Drugs".)

General anesthesia is less desirable for cesarean delivery because the mother is unconscious, thus unable to interact with her newborn [4]. Two potential serious complications associated with general anesthesia are failed intubation and pulmonary aspiration of gastric contents. Inhibition of upper airway reflexes and alterations of gastrointestinal function increase the risk of pulmonary aspiration. (See "Aspiration pneumonia in adults"). Airway reflexes are compromised by the loss of consciousness that occurs with induction of general anesthesia. An advantage of regional anesthesia is that the parturient is awake and airway reflexes are maintained. However, aspiration may also occur during regional anesthesia if airway reflexes are compromised by injudicious sedation. Furthermore, if the regional anesthetic is inadequate, it may be necessary to induce general anesthesia. Deaths associated with regional anesthesia are more likely a result of high spinal or epidural block, respiratory failure, or a drug reaction [2].

The choice of regional or general anesthesia is influenced by a variety of other factors, such as the urgency of the procedure, maternal hemodynamic status, and physician and patient preference. A general discussion of anesthesia choices can be found separately. (See "Overview of anesthesia and anesthetic choices").

**Urgency factor** — For scheduled cesareans, the rapidity of anesthetic induction is less of a concern, so all anesthetic options are available. If the cesarean must be performed urgently (eg, nonreassuring fetal heart rate pattern), an anesthetic technique that can be performed expeditiously is preferred. If the cesarean is a true emergency, the time required to achieve anesthesia and facilitate a rapid delivery may be of critical importance to the well-being of the fetus and/or mother.

Most practitioners agree that inducing general anesthesia is the most reliable means of quickly achieving operative anesthesia for cesarean. However, highly skilled clinicians are usually able to rapidly induce spinal anesthesia. In fact, spinal anesthesia is increasingly being used as a substitute for general anesthesia in all but the most emergent situations.

Spinal anesthesia is more desirable than epidural if time is of the essence because the onset of the block is faster with a spinal approach. However, if the parturient already has an epidural catheter in-situ (eg, placed previously for labor analgesia), then operative anesthesia may be achieved within a few minutes in almost all patients (≥97 percent [5]) by injecting a more concentrated local anesthetic. In this situation, anesthetic latency may be decreased by using a local anesthetic with a rapid onset, such as 2-chloroprocaine, or by increasing local anesthetic pH by adding sodium bicarbonate. In one study, the addition of bicarbonate to lidocaine decreased the time of onset of surgical anesthesia from 9.7 +/- 1.6 minutes to 5.2 +/- 1.5 minutes [6]. The addition of bicarbonate to 2-chloroprocaine results in the local anesthetic with the shortest latency and is the recommended choice in urgent cases.
**Maternal status** — Maternal medical factors also influence choice of optimum anesthetic. A discussion of anesthetic management of specific maternal disorders is beyond the scope of this review. In general, acute hemorrhage and hemodynamic compromise militate against the use of regional anesthesia since the accompanying sympathetic block will produce vasodilation, which will exacerbate maternal hypotension. The presence of a significant bleeding diathesis (eg, severe thrombocytopenia) is another contraindication to regional anesthesia because of the increased risk of causing a spinal/epidural hematoma. (See "Adverse effects of neuraxial analgesia and anesthesia for obstetrics".)

On the other hand, if evaluation of the parturient's airway anatomy suggests that intubation may be difficult, then regional anesthesia may be a more desirable choice than general anesthesia. Other reasons a regional anesthetic may be preferable include a history of malignant hyperthermia, some types of cardiac or respiratory disease, and for the prevention/treatment of autonomic hyperreflexia. There are also specific situations in which regional anesthesia may be contraindicated (eg, uncorrected coagulopathy, skin infection of the lower back).

**ANESTHESIA ISSUES IN PREGNANT WOMEN** — Pregnancy induces a variety of physiologic changes that have important clinical implications for anesthesia.

- Increased intraabdominal pressure, relaxation of the lower esophageal sphincter, and assumption of a recumbent position during labor/delivery increase the risk for pulmonary aspiration of gastric contents if upper airway reflexes are compromised. Pain, anxiety, sedatives, and opioids contribute by prolonging intestinal transit time. (See "Maternal gastrointestinal tract adaptation to pregnancy".)

Therefore, all parturients are at risk for pulmonary aspiration, regardless of the time of their last meal, and insertion of a cuffed endotracheal tube is mandatory to protect the trachea if the woman is obtunded, as occurs with general anesthesia.

- Edema of upper airway tissues, especially in preeclamptic/eclamptic parturients, may render tracheal intubation challenging.

- Pregnancy increases the basal metabolic rate and lowers pulmonary functional residual capacity. Thus, hypoxemia is likely to develop rapidly during the period of apnea that accompanies the induction of general anesthesia. (See "Changes in the respiratory tract during pregnancy".)

- In the supine position, the gravid uterus compresses the aorta and vena cava, thereby decreasing venous return, cardiac output, and blood pressure. Regional anesthesia mediated-vasodilation exacerbates this effect by promoting pooling of blood in capacitance vessels. Therefore, the uterus should be displaced off the great vessels by placing a wedge under the right hip (left uterine displacement) whenever the parturient is positioned supine. (See "Maternal cardiovascular and hemodynamic adaptations to pregnancy", section on 'Supine hypotensive syndrome'.)

**PREOPERATIVE ISSUES**

**Patient evaluation** — Ideally, pregnant women should meet with an anesthesiologist
antepartum or in the early intrapartum period, whether or not a cesarean is planned. This meeting allows the patient to ask specific questions regarding anesthesia, and it also permits the anesthesiologist to identify medical problems that may have important implications for the anesthetic plan. This consultation is particularly important for women with known disorders that affect administration of anesthesia, such as coagulopathy, severe obesity, restriction or abnormality of the spine, and cardiovascular or respiratory disease. As an example, preoperative evaluation may find that the woman has an airway that will render intubation difficult (eg, short neck, limited jaw movement) [7]; thus, rapid-sequence induction would be relatively contraindicated because of the risk of losing control of the airway. In this situation, other techniques, including awake intubation, are preferable.

**Diet** — The American Society of Anesthesiologists recommends that patients abstain from solid food for at least six hours prior to elective cesarean delivery (8 hours for fried or fatty foods) [8,9]. Clear liquids, which have a more rapid gastric transit time, may be ingested until two hours prior to surgery. The unpredictability of unplanned cesarean births requires that certain standards for oral intake be followed at all times during labor. To be prepared for the emergent use of anesthesia, laboring women should avoid solid food, and restrict their oral intake to clear liquids.

**Reduction of gastric acidity/volume** — Acidic aspirate is especially injurious to the lungs. Prophylactic administration of a nonparticulate antacid (eg, sodium citrate 30 mL p.o.), histamine 2-receptor antagonist (eg, ranitidine, 50 mg i.v.), proton pump inhibitor (eg, omeprazole, 20 mg p.o.), or prokinetic drug (eg, metoclopramide 10 mg i.v.), alone or in combination, prior to induction of general anesthesia is a standard procedure to mitigate the effects of aspiration [10]. There is some evidence that use of both an antacid and a histamine 2-receptor antagonist is superior to use of antacids alone [11].

The goal is to raise intragastric pH and, for some agents, lower intragastric volume and increase lower esophageal sphincter tone. Although these drugs have been shown to increase pH and some decrease gastric volume, they have not been proven to reduce the frequency of aspiration pneumonitis due to the low incidence of this event. Parturients at increased risk for aspiration (obese, anticipated difficult intubation) are candidates for these drugs.

Even though some anesthesiologists administer these agents prior to regional anesthesia using the rationale that the cost and side effects are low and one cannot predict if induction of general anesthesia will be required, aspiration is very unlikely in this setting. The incidence of failed epidural has been estimated at 2 to 6 percent, and the incidence of failed spinal is even lower. Even if general anesthesia is required to perform a cesarean, the incidence of aspiration is approximately 15 per 10,000 [12]. Thus, the likelihood of aspiration occurring during a cesarean in which regional anesthesia is planned is very low.

**Choice of medication** — Although sodium citrate has an unpleasant taste that may itself precipitate vomiting, it is used routinely in many practices because it decreases the acidity of gastric contents. Other pharmacologic measures designed to lower the risk of aspiration or decrease its severity are metoclopramide (10 mg intravenously, slowly) to increase lower esophageal sphincter tone and promote gastric emptying, an H2 antagonist such as ranitidine (150 mg orally or 50 mg intravenously) to alkalinize gastric contents, or a proton pump inhibitor (eg, omeprazole 40 mg intravenously) to decrease gastric acid secretion. A very small amount of these drugs administered parenterally cross the placenta.
Prevention and management of hypotension — Fetal oxygenation depends upon placental perfusion; thus, a decrease in maternal blood pressure can compromise fetal oxygenation, which can be manifested by deterioration of the fetal heart rate. (See "Antepartum fetal heart rate assessment", section on 'Cardiovascular response to hypoxia'.

Induction of anesthesia tends to reduce maternal blood pressure. This is particularly true for regional anesthesia, which results in pooling of blood in capacitance vessels due to sympathetic block mediated vasodilation. The onset of block is more rapid with spinal than epidural anesthesia; for this reason, hypotension occurs more commonly after spinal anesthesia than after epidural anesthesia.

Prophylactic strategies to prevent regional anesthesia-induced hypotension include volume expansion using intravenous fluids, administration of vasopressors, and mechanical interventions.

Intravenous fluids — Intravenous fluid loading has been a standard prerequisite to regional anesthesia [13]. Crystalloid preload prior to spinal anesthesia does not reliably prevent maternal hypotension [14], probably due to rapid redistribution of crystalloid from the intravascular space.

A systematic review found that colloid prehydration (hydroxyethylstarch) was superior to crystalloid prehydration (lactated Ringer's, Hartman's solution) in reducing, but not eliminating, the incidence of spinal-induced hypotension in parturients (RR hypotension requiring intervention 0.68, 95% CI 0.52-0.89) [15]. Crystalloid prehydration appeared to be superior to no prehydration (RR of hypotension requiring intervention 0.78, 95% CI 0.60-1.00).

Most anesthesiologists administer crystalloid solutions for cesarean delivery because they are less expensive and more readily available than colloid. Furthermore, the limited available data do not indicate a large absolute benefit of colloids over crystalloids. If crystalloid is chosen, glucose-free solutions should be used to prevent hyperinsulinemia in the fetus. Excessive placental glucose transfer can result in compensatory release of fetal insulin (fetal hyperinsulinemia) and neonatal hypoglycemia [16,17].

Vasopressor treatment — Prophylactic administration of vasopressors prior to, or coincident with, induction of regional anesthesia will minimize the incidence and severity of hypotension. Ephedrine (25 to 50 mg intramuscularly) prior to induction of regional anesthesia is one option, although prophylactic use may produce "overshoot" hypertension.

Hypotension in parturients was formerly treated with mixed alpha- and beta-adrenergic agonists (eg, ephedrine) due to concern that pure alpha agonists would produce uterine artery constriction. However, since the first human report of pure alpha agonists to treat maternal hypotension [18], their use has become more accepted.

A quantitative systematic review comparing ephedrine and phenylephrine in healthy parturients undergoing elective cesarean delivery found that the neonates of women who received ephedrine had a lower pH than the neonates of the women who received phenylephrine [19]. A subsequent trial in non-elective cesarean deliveries also demonstrated similar fetal acid base status for these two vasopressors [20].
This same group of investigators has also shown that infusion of phenylephrine (100 mcg/mL) or ephedrine (8 mg/mL) to maintain maternal blood pressure near baseline resulted in more favorable acid-base status in the neonates in the phenylephrine group [21]. They found that ephedrine crossed the placenta to a greater degree than did phenylephrine, supporting the hypothesis that lower fetal pH with ephedrine results from stimulation of fetal beta-adrenergic receptors.

Anesthesiologists continue to use both ephedrine (5 to 10 mg) and phenylephrine (50 to 100 mcg) to treat maternal hypotension. The choice of therapy is often guided by the maternal heart rate: phenylephrine is preferred when the maternal heart rate is relatively fast (greater than 100 bpm) since it tends to slow the heart rate to a greater degree than ephedrine. Relatively few practitioners use vasopressor infusions to maintain or treat maternal blood pressure.

**Cohydration and vasopressor infusion** — Cohydration or coload refers to the rapid administration of crystalloid at the same time that the spinal anesthetic is injected, in contrast to preloading, in which the fluid is administered prior to anesthetic administration. Cohydration is intended to reduce the incidence of spinal anesthesia-induced maternal hypotension; the rationale is that crystalloid will be present in the intravascular space at the precise moment that it is needed: when spinal-induced vasodilation occurs. It is not necessary to delay surgery in order to deliver a fluid preload, as the incidence of hypotension is similar whether fluid is given in advance or coincident with the spinal anesthetic [22].

A more promising approach is the combination of cohydration with prophylactic vasopressor administration. In a randomized trial involving 112 nonlaboring women scheduled for cesarean delivery, rapid cohydration combined with phenylephrine infusion (100 mcg/min) at the initiation of spinal anesthesia resulted in a significant reduction in the incidence of hypotension compared with no cohydration (1.9 versus 28.3 percent) [23].

**Mechanical compression** — Mechanical interventions, such as use of leg wrapping or compression boots, have also been used to decrease the incidence and severity of regional anesthesia-induced hypotension [24]. Moreover, sequential compression boots may help prevent thrombus formation in patients undergoing surgery. (See "Prevention of venous thromboembolic disease in surgical patients" and "Deep vein thrombosis and pulmonary embolism in pregnancy: Epidemiology, pathogenesis, and diagnosis" and "Deep vein thrombosis and pulmonary embolism in pregnancy: Prevention".)

**GENERAL ANESTHESIA**

**Induction** — If examination of the upper airway suggests that intubation will not be problematic, the following sequence is used for providing general anesthesia to the gravida:

- A nonparticulate antacid is generally given preoperatively to alkalinize gastric contents. Some practitioners also administer metoclopramide or an H2 blocker as prophylactic measures to minimize the risk and severity of aspiration (see 'Reduction of gastric acidity/volume' above).
- Just prior to induction, 100 percent oxygen should be administered by face mask to denitrogenate the maternal lungs. Preoxygenation for three to five minutes
establishes an oxygen reserve prior to the expected apneic interval that accompanies anesthetic induction and tracheal intubation. If there is insufficient time to accomplish this, an alternative is to administer 100 percent oxygen for four vital capacity breaths. This is important because of the reduced functional residual capacity of pregnant women.

- At this time, the obstetrician should prepare and drape the abdomen for incision.

- Following preoxygenation, a rapid-sequence induction is performed to minimize the likelihood of pulmonary aspiration. Anesthetic agents are administered intravenously, rapidly followed by tracheal intubation without intervening mask ventilation. Typically, an assistant applies continuous pressure to the cricoid cartilage to compress the esophagus and help prevent reflux of gastric contents into the pharynx from the moment the anesthetic agents are injected until proper endotracheal tube placement is confirmed, although the efficacy of this maneuver has been questioned [25,26].

The preferred muscle relaxant is succinylcholine (1 to 1.5 mg/kg) because of its rapid onset of action. Various anesthetic induction agents may be used, including propofol (2 to 3 mg/kg), etomidate (0.2 to 0.3 mg/kg), or ketamine (1 to 2 mg/kg). A once-popular induction agent, thiopental, is no longer available in the United States. Since ketamine tends to increase arterial pressure, it is a reasonable choice for anesthetic induction in acutely hypovolemic patients. Etomidate is used in patients in whom avoidance of hypotension is important, as etomidate typically causes less hemodynamic perturbation than the other induction agents.

- Tracheal intubation is performed as the induction agent and succinylcholine exert their effects (approximately 45 seconds). The cuff of the tube is inflated immediately upon placement to protect the lungs from aspiration. Equipment for emergency airway management, including laryngeal mask airways, a video assisted laryngoscopy device such as a Glide Scope®, a set-up to perform transtracheal jet ventilation, and cricothyrotomy, should be readily available at sites where cesarean delivery is performed.

Once proper placement of the endotracheal tube is confirmed, the obstetrician is informed that surgery may commence.

**Difficult airway** — The rates of difficult and failed intubation in pregnant women are as high as 3.3 and 0.4 percent of cases, respectively [27]. These rates are eight-fold higher than in nonpregnant patients [28]. If the airway examination suggests that intubation may be difficult, a different approach to induction should be taken (eg, preparation for awake intubation). This is beyond the scope of this review. (See "The difficult airway in adults" and "The failed airway in adults".)

**Maintenance** — Many anesthesiologists administer 100 percent oxygen prior to delivery of the fetus, especially in cases of nonreassuring fetal heart rate tracing. Anesthesia is maintained using low concentrations of nitrous oxide (25 to 50 percent) and inhalation anesthetics (eg, isoflurane, sevoflurane 0.25 to 0.5 MAC [minimum alveolar concentration]) until delivery of the baby (if nitrous oxide is not used, then higher concentrations of inhalation agents are necessary). After the birth, higher concentrations of nitrous oxide may
be used, while keeping in mind that inhalation anesthetics produce dose-dependent uterine atony. Opioids such as fentanyl and remifentanil may also be administered. The abdominal muscle relaxation provided by inhalation agents may obviate the need for a second dose of neuromuscular blocker.

Intraoperative recall is a possibility during cesarean surgery because low doses of anesthetics are used to reduce drug transfer to the fetus. Awareness during anesthesia can be minimized by administering an amnestic agent, such as a benzodiazepine, during the time of anesthesia induction. Inhalation anesthetics also provide amnesia.

At the end of surgery, the patient is awakened prior to extubation to be sure that airway reflexes are intact.

**Neonatal effects** — All anesthetic induction and maintenance agents cross the placenta and may result in neonatal depression if used in large doses or if the infant is delivered after eight minutes of induction [29]. Studies in immature animals have shown that a variety of sedatives and anesthetics may produce neurodegenerative effects. However, there is no strong evidence of adverse causal effects of anesthetics and related drugs on human brain development or risk of future learning disabilities [30-34]. Succinylcholine and other muscle relaxants have difficulty crossing the placenta because they are ionized. These drugs have no fetal or neonatal clinical effects at standard dosages.

If anesthetics result in neonatal depression, appropriate resuscitative measures, including ventilatory assistance, should be instituted until the effects abate. Alternatively, specific reversal agents for opioids (naloxone) and/or benzodiazepines (flumazenil) may be administered to the neonate. Although anesthetics may result in temporary neonatal depression, there is no evidence of any long-term effects. Personnel other than the surgical team should be immediately available to assume responsibility for resuscitation of the depressed newborn as the anesthesiologist and obstetrician are responsible for the mother, and may not be able to leave her to care for the newborn, even when a regional anesthetic is functioning adequately [35].

**Complications and side effects** — Pregnancy-specific complications and side effects of general anesthesia include neonatal depression (see above) and uterine relaxation, which is associated with increased blood loss [4]. Two potential serious complications associated with general anesthesia in any patient are esophageal intubation and pulmonary aspiration of gastric contents.

Potent inhalational agents, such as isoflurane, desflurane and sevoflurane, decrease uterine tone [36]. Inhaled nitrous oxide at any percentage mixture with oxygen has no effect on uterine tone [37,38].

**REGIONAL ANESTHESIA**

**Overview** — Techniques, medications, and complications associated with regional anesthesia are discussed separately. (See "Neuraxial analgesia and anesthesia for labor and delivery: Options" and "Neuraxial analgesia and anesthesia for labor and delivery: Drugs" and "Adverse effects of neuraxial analgesia and anesthesia for obstetrics").

Additional systemic medication may be required during the cesarean to enhance the comfort of women who received regional anesthesia. The surgeon should be notified when there is a need for such interventions. In healthy parturients with a reassuring fetal heart
rate pattern, supplemental oxygen is not necessary [39].

- **Restlessness and pain** — Some women become restless during cesarean delivery, and benefit from a low dose of a sedative. A benzodiazepine, such as midazolam, is an excellent anxiolytic that can be administered in 1 to 2 mg doses, as needed. The effect on the fetus appears negligible, but midazolam's amnestic properties may prevent the mother from remembering the moment of birth. An advantage of benzodiazepines is that their effect may be reversed by administration of a specific antagonist, flumazenil.

Other agents used to supplement regional anesthesia include ketamine, propofol, or small doses of opioids such as fentanyl or remifentanil. However, if an inadequate block results in pain, it is unwise to administer excessive doses of sedatives because they may obtund the patient and compromise airway reflexes, which may cause aspiration. Thus, the prudent approach is to intubate the trachea prior to administering large doses of these agents.

- **Nausea and vomiting** — Nausea is a common complaint during cesarean delivery. An antiemetic may be indicated after other causes of nausea (eg, hypotension, surgical manipulation with an inadequate level of anesthesia) are excluded. In one study of cesarean under spinal anesthesia, administration of 4 mg ondansetron after umbilical cord clamping reduced the incidence of vomiting compared to placebo (by 58 and 36 percent, respectively); the severity of nausea was also significantly reduced [40]. Another trial showed that 4 mg ondansetron was superior to 10 mg metoclopramide and placebo in preventing nausea in parturients receiving epidural anesthesia for cesarean delivery [41].

  Droperidol, a commonly used agent for treatment of nausea and vomiting, has been associated with cardiac dysrhythmias in nonpregnant women, even when used in doses as low as 2.5 mg. If the benefit of droperidol treatment is felt to outweigh the risks of potentially serious arrhythmias, cardiac monitoring should be performed prior to therapy and continued for two to three hours after completing treatment to monitor for arrhythmias.

**Fetal surveillance and regional anesthesia** — For patients undergoing cesarean delivery, fetal monitoring is continued until the abdominal sterile preparation has begun, at which time the external monitor is removed. If the patient has an internal fetal monitor, it is removed when abdominal sterile preparation is complete [42].

There are some situations in which the surgical incision is delayed while regional anesthesia is taking effect. This more commonly occurs with epidural, not spinal anesthesia, as epidural block has a slower onset than spinal block. In this situation, if the abdominal skin has been steriley prepared, but the level and/or intensity of anesthesia is insufficient to commence surgery, a choice needs to be made: continue to wait for the regional anesthetic to take effect, inject additional local anesthetic or convert to general anesthesia. This decision is best made after the obstetrician and the anesthesiologist have fully communicated their assessment of the situation with one another. In this setting, it may be helpful to continue monitoring the fetus by placing the transducer for monitoring the fetal
heart rate in a sterile sleeve (with a liberal amount of conductive gel), and applying it to the sterile abdomen.

**Complications** — A detailed discussion of complications from neuraxial anesthesia can be found separately. (See "Adverse effects of neuraxial analgesia and anesthesia for obstetrics").

**PROPHYLAXIS AGAINST POSTPARTUM HEMORRHAGE** — (see "Management of the third stage of labor" and "Overview of postpartum hemorrhage").

**POSTOPERATIVE ANALGESIA** — Cesarean delivery results in considerably more postpartum pain than does vaginal delivery. Unrelieved pain causes maternal suffering and prevents optimal interaction with the newborn. The pathophysiological consequences of unrelieved pain may result in medical complications, as well. As an example, pain induced by movement may result in reticence to ambulate and thus increase the risk of formation of venous thrombi. Shallow breathing and splinting promotes atelectasis and predisposes to pneumonia. Good pain relief may help to prevent these effects.

The risk of postpartum pain is not limited to untoward physiological effects; psychological sequelae may also occur. The presence of severe acute pain during the first 36 hours after delivery was noted to be associated with a three-fold increased likelihood of developing postpartum depression [43].

Multimodal analgesia refers to the concurrent administration of different classes of analgesics [44]. The rationale of the multimodal approach is that each class of analgesic acts to inhibit pain at different sites of the pain pathway. Furthermore, the different analgesics potentiate one another, allowing use of relatively small doses of each agent. As each class of analgesic is associated with distinct side effects and only a relatively small dose of each agent is administered, the net effect is reduced incidence and severity of side effects and enhanced analgesia.

Options for postoperative analgesia include:

- **Parenteral opioids** — (see "Management of postoperative pain", section on 'Parenteral opioids').
- **Neuraxial opioids** — (see "Management of postoperative pain", section on 'Neuraxial analgesia').
- **Patient controlled epidural analgesia** — (see "Management of postoperative pain", section on 'Patient controlled analgesia').
- **Oral analgesics** — (see "Management of postoperative pain", section on 'Oral opioids' and "NSAIDs: Therapeutic use and variability of response in adults").

**LOCAL INFILTRATION** — Injecting local anesthetics into the surgical site or using local anesthetics to perform an abdominal nerve block (transversus abdominis plane block) appear to enhance postoperative analgesia and decrease opioid consumption [45]. Local infiltration should be considered as an adjunct for post-cesarean analgesia, especially in patients who undergo general anesthesia for cesarean delivery, or who do not receive perioperative neuraxial opioids or postoperative patient-controlled epidural analgesia. A limitation of the efficacy of local infiltration is the relatively brief duration of action of
existing local anesthetics. An increase in the duration of analgesic action may be achieved by the use of continuous local anesthetic wound infiltration [46], or an ultra-long acting local anesthetic formulation, currently in development [47]. (See "Management of postoperative pain".)

**SUMMARY AND RECOMMENDATIONS**

- Regional anesthesia for cesarean delivery requires a more intense block and a higher dermatomal level than analgesia for labor. (See 'Introduction' above.)

- The choice of regional or general anesthesia is influenced by factors such as the urgency of the procedure, maternal status, the presence of specific contraindications and physician and patient preference. (See 'Choice of anesthetic approach' above.)

- Physiological changes associated with pregnancy can affect management of anesthesia. These include relative incompetence of the gastroesophageal sphincter, lowered pulmonary functional residual capacity, edema of upper airway tissues, and uterine compression of the aorta and vena cava. (See 'Anesthesia issues in pregnant women' above.)

- Antepartum consultation with an anesthesiologist is particularly important in women with coagulopathy, severe obesity, restriction or abnormality of the spine, and cardiovascular or respiratory disease. (See 'Patient evaluation' above.)

- Clear liquids may be ingested until two hours prior to surgery. (See 'Diet' above.)

- For patients who are to undergo general anesthesia, administration of drugs to reduce gastric acidity may be beneficial (Grade 2C). Options include a nonparticulate antacid (eg, sodium citrate), histamine 2-receptor antagonist (eg, ranitidine), proton pump inhibitor (eg, omeprazole), or prokinetic drug (eg, metoclopramide). The goal is to raise intragastric pH and, for some agents, increase lower esophageal sphincter tone and lower intragastric volume. Although these drugs have been shown to increase pH and some decrease gastric volume, they have not been proven to reduce the frequency of aspiration pneumonitis due to the low incidence of this event. (See 'Reduction of gastric acidity/volume' above.)

- Preoxygenation before general anesthesia is particularly important in pregnant women because of their reduced functional residual capacity. (See 'General anesthesia' above.)

- Prophylactic strategies to prevent regional anesthesia-induced hypotension include volume expansion using intravenous fluids, administration of vasopressors, and mechanical interventions. Nevertheless, hypotension often occurs, especially with spinal anesthesia, and should be promptly treated with vasopressor administration (phenylephrine, ephedrine), intravenous fluids, and uterine displacement. (See 'Prevention and management of hypotension' above.)

- Postoperative analgesia is important for patient comfort, as well as prevention of untoward physiological and psychological effects. (See 'Postoperative analgesia' above.)
REFERENCES


