Cesarean delivery: Preoperative planning and patient preparation

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INTRODUCTION — Cesarean delivery (also called cesarean section and cesarean birth) is often cited as the most common major surgical procedure performed in an operating room in the United States [1]. Over 1.2 million cesarean deliveries are performed yearly in the US and comprise almost one-third of births [2].

This topic will review preoperative planning and patient preparation for cesarean delivery. Surgical technique, postoperative issues, repeat cesarean delivery, cesarean delivery on maternal request, and trial of labor after cesarean delivery are discussed separately:

- (See "Cesarean delivery: Surgical technique".)
- (See "Cesarean delivery: Postoperative issues".)
- (See "Repeat cesarean delivery".)
- (See "Cesarean delivery on maternal request".)
- (See "Choosing the route of delivery after cesarean birth".)

INDICATIONS — Cesarean delivery is performed when the clinician and/or patient believe that abdominal delivery is likely to provide a better maternal and/or fetal outcome than vaginal delivery. Thus, indications for cesarean delivery fall into two general categories:

- Medically/obstetrically indicated, or
- On maternal request

Approximately 70 percent of cesarean deliveries in the United States are primary (first) cesareans. The three most common indications for primary cesarean delivery in the US account for almost 80 percent of these deliveries [3]:

- Failure to progress during labor (35 percent)
- Non-reassuring fetal status (24 percent)
- Fetal malpresentation (19 percent)

Additionally, less common indications for primary cesarean delivery include, but are not limited to:

- Abnormal placentation (eg, placenta previa, vasa previa, placenta accreta)
- Maternal infection with significant risk of perinatal transmission during vaginal birth
- Some fetal bleeding diatheses
- Funic presentation or cord prolapse
- Suspected macrosomia (typically 5000 grams in women without diabetes, 4500 grams in women with diabetes)
- Mechanical obstruction to vaginal birth (eg, large fibroid, severely displaced pelvic fracture, severe fetal hydrocephalus)
- Uterine rupture
- Prior uterine surgery that entered the endometrial cavity, such as myomectomy

Although infrequent, cesarean delivery is also indicated in women who are at increased risk for complications/injury from cervical dilation, descent and expulsion of the fetus, or episiotomy. Some examples include women with invasive cervical cancer, active perianal inflammatory bowel disease, or history of repair of a rectovaginal fistula or pelvic organ prolapse. (See "Cervical cancer in pregnancy" and "Fertility, pregnancy, and nursing in inflammatory bowel disease" and "Effect of pregnancy and childbirth on urinary incontinence and pelvic organ prolapse" and "Effect of pregnancy and childbirth on anal sphincter function and fecal incontinence".)

Cesarean delivery on maternal request is uncommon, and discussed separately. (See "Cesarean delivery on maternal request".)

Cesarean delivery is not routinely indicated for low birth weight (see "Delivery of the preterm low birth weight singleton fetus") and most congenital anomalies. (Refer to topic reviews on individual anomalies.)

CONTRAINDICATIONS — There are no absolute contraindications to cesarean delivery. In contrast to other types of surgery, the risks and benefits of the procedure are considered as they apply to two patients (mother and fetus). However, many pregnant women have a low tolerance for accepting any fetal risk from vaginal birth, irrespective of the maternal risks associated with cesarean delivery [4,5].

PREOPERATIVE PLANNING

Checklists — Checklists can be helpful in preoperative planning and are available from various organizations, such as the American College of Obstetricians and Gynecologists (ACOG) (eg, patient safety checklists for preoperative planning and scheduling) [6,7].

Scheduling

Medically or obstetrically indicated procedures — Medically/obstetrically indicated cesarean deliveries are scheduled when clinically indicated. Indications for administration of a course of antenatal corticosteroids before delivery, if time permits, are reviewed separately. (See "Antenatal corticosteroid therapy for reduction of neonatal respiratory morbidity and mortality from preterm delivery", section on 'Gestational age at administration'.)

In suboptimally dated pregnancies, scheduling should be based on the best clinical estimate of gestational age [11]. Performing an amniocentesis for assessment of fetal lung maturity is not recommended as a component of this decision. (See "Assessment of fetal lung maturity".)

This approach is based on data from large, observational studies and randomized trials that consistently show that (1) neonatal respiratory morbidity and/or composite neonatal morbidity is higher after scheduled cesarean delivery than vaginal delivery and (2) decreases as gestational age increases from 37 to 40 weeks [12-20]. As an example, in a trial that evaluated adverse neonatal outcomes according to completed week of gestation in over 13,000 elective cesareans performed before the onset of labor, delivery <39 weeks of gestation was associated with a statistically higher risk of respiratory and other adverse neonatal outcomes compared with delivery ≥39 weeks of gestation [21]:

- Rates of respiratory distress syndrome/transient tachypnea by gestational age were 37 weeks (8.2 percent), 38 weeks (5.5 percent), 39 weeks (3.4 percent), 40 weeks (3.0 percent), and 41 weeks (5.2 percent)
- Rates of any adverse outcome/death by gestational were 37 weeks (15.3 percent), 38 weeks (11.0 percent), 39 weeks (8.0 percent), 40 weeks (7.3 percent), and 41 weeks (11.3 percent)

Elective repeat cesarean delivery — Timing of elective repeat cesarean delivery is based on the type of previous hysterotomy incision, and is reviewed separately. (See "Repeat cesarean delivery", section on 'Timing'.)

Cesarean delivery on maternal request — Cesarean delivery on maternal request is scheduled for the 39th or 40th week of gestation. (See "Cesarean delivery on maternal request".)

Hospital readiness for intrapartum cesarean — Intrapartum cesarean deliveries are sometimes classified by degree of urgency; for example: (1) an immediate threat to life of the mother or fetus is present, (2) signs of maternal or fetal compromise are present but are not immediately life threatening, or (3) delivery is needed, but there is no evidence of maternal or fetal compromise.

ACOG and the American Society of Anesthesiologists suggest that facilities providing obstetrical services should be capable of beginning an intrapartum cesarean delivery within 30 minutes of the decision to perform the operation [22]. This criterion is based upon the practical constraints most rural hospitals face in assembling the appropriate team of nurses, anesthetists, and surgeons. However, this threshold is not evidence based, universally achievable, or ideal from the perspective of decreasing perinatal mortality and morbidity [23-32].

The ability to begin an intrapartum cesarean delivery within 30 minutes of the decision to operate is a reasonable benchmark for monitoring the quality of labor and delivery units; the statement was not intended as a requirement that all cesarean deliveries be performed within 30 minutes of the decision. In human and animal studies, sudden complete anoxia, such as occurs with a total abruption or complete cord occlusion, probably necessitates delivery within five minutes to avoid fetal hypoxic injury [33-35], although intact survivors have been reported after longer durations of severe hypoxia. Most pregnancies with less severe fetal or maternal compromise or partial or complete recovery of non-reassuring fetal heart rate tracings will have good outcomes despite longer intervals before initiating surgery [32].

Compared with scheduled cesarean delivery, intrapartum cesarean is associated with increased risks of postpartum hemorrhage, anesthetic complications from rapid administration of general anesthesia, and accidental injury to the fetus or abdominopelvic organs.

Natural, gentle, or family-centered cesarean — The natural, gentle, or family-centered cesarean delivery approach was developed to improve the birth experience of women having uncomplicated cesarean deliveries. It attempts to replicate features of vaginal birth as much as possible to make cesarean surgery more family friendly. Components of this approach may include [36,37]:

- Playing background music of the mother's and father's choice during delivery and dimming lights, when safely possible. Reduction of extraneous noise.
- Using clear drapes or positioning the drapes to allow the mother (and father) to watch the birth.
- Avoiding maternal sedation.
- Allowing the baby to deliver by a combination of uterine expulsion and active physician assistance to mimic expulsion from the vagina.
- Freeing the mother's dominant hand/arm and chest/breasts from lines and monitors, when possible, so she can hold and nurse her infant.
- Promoting skin-to-skin contact and nursing immediately after birth.

We perform family-centered cesarean whenever feasible, ie, routinely unless an emergent cesarean needs to be performed. Patients become an active part of the cesarean delivery by directly observing the birth and by cutting the umbilical cord. In a randomized trial, family-centered cesarean was safe for both mother and infant and led to a better birth experience, higher rate of breastfeeding, and improved early mother-infant interaction [38].

PREPROCEDURE MATERNAL PREPARATIONS

Anesthesia consultation — As with any surgical procedure, women undergoing cesarean delivery should have a preoperative consultation with the anesthesia team. Those whose procedure-related risks are above baseline should have a **preadmission** consultation, if possible. Characteristics that place the patient at increased risk include, but are not limited to, those listed in the table (table 1).

The choice of regional or general anesthesia is influenced by factors such as the urgency of the procedure, maternal status, and physician and patient preference. Issues related to anesthesia for cesarean delivery are discussed in detail separately. (See "Anesthesia for cesarean delivery".)

Laboratory testing — A baseline hemoglobin or hematocrit measurement is recommended for patients who are undergoing major surgery, such as cesarean delivery, that is expected to result in significant blood loss. A normal value obtained within one month of surgery probably does not need to be repeated preoperatively in uncomplicated pregnancies. (See "Preoperative medical evaluation of the adult healthy patient".)

Pregnant women generally have a blood type and antibody screen performed as part of routine prenatal care. While a repeat type and screen preoperatively probably could be safely omitted in women at low risk of severe bleeding during surgery and who do not have a known red blood cell antibody [39-43], we obtain this testing routinely on every woman preoperatively, either as outpatient within three days of planned delivery or on the morning of admission. Alternatively, the surgeon may consider a "hold clot" order in low-risk patients: Blood is drawn and held, but no tests are performed unless clinically indicated.

Less than 1 percent of low risk women receive a perioperative blood transfusion. Risk factors for requiring transfusion include placental abnormalities (eg, previa, placenta accreta spectrum, or placental abruption), eclampsia or HELLP syndrome (ie, Hemolysis, Elevated Liver function tests, Low Platelets), preoperative hematocrit <25 percent, use of general anesthesia, and a history of ≥5 cesarean deliveries.

Antibiotic prophylaxis

Cefazolin dosing is as follows:

- Women <120 kg: 2 g intravenously
- Women ≥120 kg: 3 g intravenously

Reasonable alternatives to cefazolin are described in the table (table 2).

We also perform antiseptic abdominal and vaginal preparations. (See 'Skin preparation' below and 'Vaginal preparation' below.)

Evidence — In the absence of antimicrobial prophylaxis, women undergoing cesarean delivery have a 5- to 20-fold greater risk for infection compared with women who give birth vaginally [44]. The benefit of antibiotic prophylaxis before cesarean delivery was illustrated in a systematic review of randomized trials that compared maternal outcomes "with" versus "without" use of prophylactic antibiotics and found that antibiotic prophylaxis reduced the risk of endometritis by about 60 percent in both antepartum and intrapartum cesarean deliveries (95 trials, n >15,000 women) [44]. The risks of wound infection, urinary tract infection, and serious maternal infectious complications were also reduced. In a smaller systematic review that evaluated neonatal outcomes (12 trials, n >5000 women), maternal antibiotic prophylaxis did not significantly impact the risk of neonatal sepsis (RR 0.76, 95% CI 0.51-1.13) or neonatal infection with antimicrobial-resistant bacteria (RR 0.70, 95% CI 0.32-4.14), but more data are needed to confirm these findings [45].

Although the relative risk [RR] reduction in maternal infection is statistically significant and similar for both scheduled and in labor procedures, the absolute risk of maternal infection is quite low in antepartum cases: In a large observational study, postpartum endometritis occurred in 2 percent of women with antibiotic prophylaxis versus 2.6 percent without antibiotic prophylaxis; wound infection occurred in 0.52 percent of women with antibiotic prophylaxis versus 0.96 percent without antibiotic prophylaxis [46]. Thus, 1000 women undergoing antepartum cesarean delivery would receive antibiotics to prevent 6 cases of endometritis and 4.4 cases of abdominal wound infection. The low risk of maternal infection in these cases and uncertainty about long-term effects in offspring have prompted a call for more research on potential long-term risks of exposure to antibiotic prophylaxis and strategies for risk stratification to identify the best candidates for antibiotic prophylaxis [47]. Until these data available, we administer antibiotics before all cesarean deliveries, in accordance with American College of Obstetricians and Gynecologists (ACOG) guidelines [48].

Antimicrobial therapy should be administered within 60 minutes before making the skin incision to ensure adequate drug tissue levels [48]. This recommendation is supported by a 2014 meta-analysis of randomized trials that compared infection rates in women assigned to a single pre-incision dose of antibiotic prophylaxis versus those assigned to administration after cord clamping [45]. Pre-incision prophylaxis was significantly more effective than delayed administration for prevention of endometritis (RR 0.54, 95% CI 0.36-0.79) and was not associated with an increase in proven neonatal sepsis, sepsis work-ups, or admission to the neonatal intensive care unit, although the trials had limited power to detect adverse neonatal effects. (See "Antimicrobial prophylaxis for prevention of surgical site infection in adults", section on 'Timing'.)

Comparative trials do not provide strong evidence on which to base a recommendation for the optimal drug and dose. Based on expert opinion from infectious disease experts, we administer cefazolin, with dosing based on weight [49]. The higher dose for women who are obese is based on pharmacokinetic data rather than surgical site infection rates, and these data have been inconsistent [50-54].

Cefazolin has a longer half-life than ampicillin (1.8 versus 0.7–1.5 hours in adults with normal renal function [55]), which is an advantage in long surgeries. In a 2014 systematic review of randomized trials, however, cefazolin and ampicillin appeared to be similarly effective for preventing postoperative maternal infection (endometritis, wound infection) after cesarean delivery [56]. Other systematic reviews of randomized trials have noted that a single dose of antibiotics is as effective as multiple doses [57,58].

Emerging data support use of extended-spectrum antibiotic combinations for women at high risk of postcesarean infection [59-62]. In a placebo-controlled multicenter randomized trial including over 2000 women, administration of azithromycin 500 mg intravenously before skin incision in addition to preoperative cefazolin resulted in a 50 percent reduction in the composite outcome of endometritis, wound infection, or other infection (endometritis 3.8 versus 6.1 percent, wound infection 2.4 versus 6.6 percent; composite RR 0.51, 95% CI 0.38-0.68), without impacting the frequency of adverse neonatal outcomes [62]. The authors also found that adjunctive azithromycin prophylaxis was cost-effective [63]. Of note, only women who had a cesarean delivery during labor or at least four hours after rupture of membranes were included, so these data do not apply to other cesarean deliveries, eg, antepartum cesarean deliveries with intact membranes. Specific tests for *Ureaplasma* or *Mycoplasma* species were not routinely performed, thus it is not known whether coverage against *Ureaplasma* and *Mycoplasma* species provided by the extended antibiotic regimen accounted for the reduction in postoperative infection.

This trial provides the best evidence to date of the benefits of an extended-spectrum regimen, and has led us to begin using preoperative cefazolin PLUS azithromycin for intrapartum cesareans and cesareans in women with ruptured membranes. Some clinicians also use this combination in other women at high risk for postoperative surgical site infection. However, we believe a strong recommendation in favor of routine or broader use of extended-spectrum prophylaxis is unwarranted at this time, given the high prevalence of obesity in at least one of the trial populations (>70 percent [62]), the lack of comparative data on the efficacy of high-dose (3 g) cefazolin for prevention of surgical site infection in obese women undergoing cesarean delivery, the lack of microbial data in these trials, concern about inducing resistance to azithromycin, and concern about possible effects on establishment of the indigenous intestinal microbiome [64-67].

Traditionally, prophylaxis has not been continued postpartum because studies in general surgical populations showed no benefit from postoperative antimicrobial prophylaxis. However, one trial in obese women undergoing cesarean delivery reported a benefit of antibiotic prophylaxis for 48 hours following cesarean delivery when given in addition to preoperative prophylaxis. (See "Cesarean delivery of the obese woman", section on 'Antibiotic prophylaxis'.)

Special populations

Women with penicillin allergy

- For women with a history of serious forms of penicillin allergy undergoing antepartum cesarean delivery with intact membranes, we suggest combination therapy with a single dose of [48,49]:
  - Clindamycin 900 mg intravenously PLUS
  - Gentamicin 5 mg/kg intravenously

  If cesarean is performed intrapartum or after rupture of membranes we add azithromycin 500 mg intravenously.

  Serious forms of penicillin allergy include immediate reactions (ie, anaphylactic) (table 3), as well several types of delayed reactions (Stevens-Johnson syndrome [SJS], toxic epidermal necrolysis [TEN], drug rash eosinophilia systemic symptoms [DRESS], drug-induced liver or other organ injury, and drug-induced cytopenias).

  When gentamicin is used for prophylaxis in combination with a parenteral antimicrobial with activity against anaerobic agents, we advise 4.5 to 5 mg/kg of gentamicin as a single dose as many studies support the safety and efficacy of this dose when used as a single dose for prophylaxis in patients without renal

auditory toxicity than multiple doses a day [69].

- For women at low risk of a serious immediate allergic reaction, cefazolin can be administered, as described above (see 'Regimen' above). The risk of a penicillin-allergic patient reacting to a cephalosporin may be assessed based upon the results of penicillin skin testing (if available), the clinical features of the penicillin reaction, and the time elapsed since the last reaction to penicillin (algorithm 1). If cesarean is performed intrapartum or after rupture of membranes we add azithromycin 500 mg intravenously. (See "Allergy evaluation for immediate penicillin allergy: Skin test-based diagnostic strategies and cross-reactivity with other beta-lactam antibiotics" and "Penicillin allergy: Immediate reactions".)

Woman already on antibiotics — There are no randomized trials assessing efficacy of antibiotic regimens in these clinical scenarios.

- **Woman receiving GBS prophylaxis** – When cesarean delivery is performed in a woman in labor or with ruptured membranes receiving penicillin G for neonatal Group B *Streptococcus* (GBS) prophylaxis, we do not add a cephalosporin or switch to ampicillin for surgical prophylaxis, but we add a dose of azithromycin. Alternatively, some clinicians add a single dose of a narrow-spectrum antibiotic (eg, cefazolin) as well as a dose of azithromycin to the penicillin G protocol for GBS prophylaxis.

- **Women with chorioamnionitis** – Ampicillin plus gentamicin is a common regimen for treatment of chorioamnionitis. For women already on this regimen, we also administer either one dose of clindamycin 900 mg or metronidazole 500 mg before beginning the cesarean. We do not give these patients azithromycin.

  Postpartum, it is reasonable to either continue ampicillin plus gentamicin or switch to ampicillin-sulbactam until the patient is afebrile for at least 24 hours. *Bacteroides* resistance to clindamycin is increasing, thus, in areas of high resistance, ampicillin-sulbactam is preferable. (See "Intra-amniotic infection (clinical chorioamnionitis or triple I)", section on 'Postpartum regimens'.)

Prolonged surgery or excessive blood loss — Antibiotic levels fall over time and with blood loss. Although redosing is the standard of care in other surgeries, there are no specific data for cesarean delivery [70]. A second dose of cefazolin is appropriate for the rare complicated cesarean delivery that extends beyond three to four hours, since the half-lives of cefazolin and azithromycin are approximately 1.8 and 68 hours, respectively. A second dose of cefazolin is also reasonable in patients with postpartum hemorrhage, which is more common.

A joint guideline of the American Society of Health-System Pharmacists, the Infectious Diseases Society of America, the Surgical Infection Society, and the Society for Healthcare Epidemiology of America suggests consideration of additional intraoperative doses in patients with excessive blood loss (>1500 mLs) or extended surgery (duration exceeding two half-lives of the drug) [49,71].

Nasal colonization with methicillin-resistant S. aureus — (See "Antimicrobial prophylaxis for prevention of surgical site infection in adults", section on 'Role of vancomycin'.)

Thromboembolism prophylaxis — Compared with vaginal delivery, a meta-analysis found that the odds of VTE (deep vein thrombosis and/or pulmonary embolism) following elective and emergency cesarean delivery were OR 2.3 and 3.6, respectively, and the overall pooled incidence of VTE was 260 per 100,000 cesareans [72]. Although pulmonary embolism is a common cause of maternal mortality [73] and over 80 percent of fatal puerperal pulmonary embolism occurs after cesarean delivery [74], these data suggest that the absolute level of risk for clinically important events is modest and similar to that seen in very low-risk surgical patients, in whom routine thromboprophylaxis is not recommended (other than early ambulation). (See "Prevention of venous thromboembolic disease in adult nonorthopedic surgical patients", section on 'Very low thrombosis risk: Early ambulation'.)

The value of thromboprophylaxis for cesarean delivery has not been studied in adequately powered, randomized trials [75]. International guidelines for thromboprophylaxis after cesarean differ markedly in selection of patients for this therapy because both the optimal threshold for initiating pharmacological thromboprophylaxis and optimal duration of therapy are unclear [76]. Furthermore, no easy to use, validated tool is available for accurately determining absolute risk of postpartum VTE in an individual patient, although pilot studies of such tools have been reported [77,78]. Clinical validation is difficult given the relatively low incidence of VTE.

Our approach

- **Low-risk women** – We agree with the ACOG recommendation to place pneumatic compression devices on all patients not already receiving pharmacologic thromboprophylaxis before cesarean delivery [79]. Observational studies of pregnant women suggest that pneumatic compression devices, as well as graduated compression stockings, are safe and effective [80,81]. We continue pneumatic compression until the patient is fully ambulatory [82]. Pneumatic compression devices may be removed while the patient is ambulating, but should be put back on when she returns to a seated or supine position.

- **High-risk women** – We agree with the ACOG recommendation for consideration of both mechanical and pharmacologic thromboprophylaxis in women at high risk of VTE undergoing cesarean delivery [79]. Criteria for selecting these women is challenging as high-quality data are not available [83]. We consider any of the following reasonable criteria for mechanical plus pharmacologic prophylaxis:

  - Body mass index (BMI) >35 kg/m^2
  - Previous VTE
  - Any thrombophilia (inherited or acquired)
  - ≥2 less prominent risk factors for VTE – Numerous less prominent risk factors for VTE are described in the literature and some are listed below (see 'ACCP recommendations' below and 'RCOG recommendations' below) [84-95]. This decision is made on a case-by-case basis.

Pharmacologic prophylaxis is begun 6 to 12 hours postoperatively, after concerns about hemorrhage have decreased, and is continued until the woman is fully ambulating, except for women with significant risk factors for VTE persisting following delivery: These women should receive six weeks of thromboprophylaxis, and, depending on their medical history, they may require an indefinite period of anticoagulation (see "Use of anticoagulants during pregnancy and postpartum", section on 'Duration of postpartum anticoagulation' and "Treatment of antiphospholipid syndrome" and "Rationale and indications for indefinite anticoagulation in patients with venous thromboembolism"). However, there are no data from randomized trials to support or refute this approach.

Unfractionated or low-molecular-weight heparin can be used. For women with BMI <40 kg/m^2, options include:

- Enoxaparin 40 mg subcutaneous injection daily (this is our preference), or
- Unfractionated heparin 5000 units subcutaneous injection every 12 hours

For severely obese women (BMI ≥40 kg/m^2), we prefer weight-based enoxaparin dosing rather than fixed dosing [96-98]:

- Begin enoxaparin 0.5 mg/kg subcutaneous injection every 12 hours, and increase the dose as needed to achieve anti-factor Xa levels 0.1 to 0.5 international units/mL. The maximum single dose should not exceed 150 mg.

Recommendations of others

ACCP recommendations — This is a partial synopsis of ACCP guidelines for antithrombotic therapy and prevention of thrombosis in pregnancy [84]:

- For women whose only risk factors for VTE are pregnancy and cesarean delivery, the ACCP recommends only early ambulation postpartum
- For women undergoing cesarean delivery with one additional major risk factor for VTE or at least two additional minor risk factors for VTE, the ACCP recommends pharmacologic thromboprophylaxis while in the hospital following delivery. If anticoagulants are contraindicated, graduated compression stockings or a pneumatic compression device is recommended.
- For women undergoing cesarean delivery who are very high risk for VTE and have multiple additional risk factors for VTE that persist in the puerperium, the ACCP recommends pharmacologic thromboprophylaxis PLUS graduated compression stockings and/or pneumatic compression devices while in the hospital following delivery.
- For selected high-risk women in whom significant risk factors persist following delivery, the ACCP suggests extended pharmacologic prophylaxis for up to 6 weeks after delivery following discharge from the hospital.

Major risk factors include: strict bedrest for ≥1 week antepartum, postpartum hemorrhage ≥1000 mL at cesarean, previous VTE, preeclampsia with fetal growth restriction, antithrombin deficiency, factor V Leiden (homozygous or heterozygous), prothrombin G20210A (homozygous or heterozygous), blood transfusion, postpartum infection, and some medical conditions (lupus, heart disease, sickle cell disease).

Minor risk factors include: BMI >30 kg/m^2, multiple gestation, postpartum hemorrhage >1000 mL, smoking >10 cigarettes/day, birth weight <25th centile, protein C or S deficiency, or preeclampsia.

RCOG recommendations — The Royal College of Obstetricians and Gynaecologists (RCOG) stated that "all women who have had caesarean sections should be considered for thromboprophylaxis with LMWH for 10 days after delivery, apart from those having an elective caesarean section who should be considered for thromboprophylaxis with LMWH for 10 days after delivery if they have any additional risk factors. Thromboprophylaxis should be continued for six weeks in high-risk women and for 10 days in intermediate-risk women" [95]. The RCOG considers the following risk factors for VTE (refer to RCOG guideline for detailed description of risk assessment): previous VTE, thrombophilia, some medical comorbidities (eg, cancer; heart failure; active SLE, inflammatory polyarthropathy, or bowel disease; nephrotic syndrome; type I diabetes mellitus with nephropathy; sickle cell disease; current intravenous drug user), age >35 years, BMI ≥30 kg/m^2, parity ≥3, gross varicose veins (symptomatic or above knee or with associated phlebitis, edema/skin changes), paraplegia, multiple pregnancy, preeclampsia, preterm birth, postpartum hemorrhage >1 L/requiring transfusion, admission/immobility ≥3 days, current systemic infection [95].

However, RCOG criteria for thromboprophylaxis after cesarean delivery would apply to half of United States cesarean delivery patients (1.2 million a year), and the drugs alone could cost up to $52 million for a 4-day course and $130 million for a 10-day course [83].

Preparation for postpartum hemorrhage — (See "Overview of postpartum hemorrhage", section on 'Planning'.)

FETOPLACENTAL ASSESSMENT

Fetal heart rate monitoring — For women waiting to undergo a scheduled cesarean delivery, the value of continuous or intermittent fetal heart rate monitoring following admission is unclear [99], no randomized trials examining this issue have been performed. At a minimum, the fetal heart rate should be documented upon admission, similar to other vital signs. If the pregnancy is high risk and has been undergoing antepartum fetal testing, it is reasonable to perform an admission nonstress test and discontinue monitoring if the tracing is reactive. If there is an excessive delay between anesthetic placement and abdominal preparation for surgery, it is appropriate to recheck the fetal heart rate during this interval.

For laboring patients, fetal heart rate monitoring should continue after transfer to the operating room, to the extent possible. External monitors are removed when the abdominal preparation is begun; internal monitors are removed when the abdominal preparation is completed.

Fetal presentation and placental location — An ultrasound for assessment of placental location and fetal presentation, or Leopold maneuvers to assess fetal presentation, may be useful before surgery, but not required. This information may help the surgeon avoid disturbing the placenta at hysterotomy and plan delivery of a fetus in nonvertex presentation.

INTRAOPERATIVE MATERNAL PREPARATION

Bladder catheterization — Most clinicians insert a urethral catheter at the start of the case to maintain bladder drainage and thereby improve visualization during surgery and minimize bladder injury. The catheter is also useful for instilling dye if a cystotomy is suspected and for monitoring urine output. Potential harms include an increased risk of urinary tract infection, urethral pain, voiding difficulties after removal of the catheter, delayed ambulation, and longer hospital stay [100].

However, there is no high quality evidence that routine placement of an indwelling catheter is advantageous [100,101]. As an alternative, patients at low risk of intraoperative complications can be asked to void shortly before entering the operating room. If subsequently required, an indwelling catheter can be inserted intraoperatively or postoperatively, and removed as soon as possible [102-105].

Hair removal — Meta-analyses of randomized trials in nonpregnant patients report no difference in the rate of surgical site infection in those who had hair removed prior to surgery versus those who did not [106,107]. No randomized trials assessing this intervention specifically before cesarean delivery have been performed.

If hair needs to be removed, it should be clipped rather than shaved as patients who are shaved are more likely to develop surgical site infection. Use of a depilatory cream is also preferable to shaving. Clipping should be performed just before surgery. (See "Overview of control measures for prevention of surgical site infection in adults", section on 'Hair removal'.)

Skin preparation — We prep the abdominal surgical site with a chlorhexidine-alcohol scrub before cesarean delivery based on data from randomized trials, two in women undergoing cesarean delivery [108,109] and the other in adults undergoing clean-contaminated surgery [110], that reported a reduction in surgical-site infection (SSI) or positive bacterial wound cultures compared with iodine-alcohol skin preparation. However, other trials have reported that the two methods had similar rates of SSI [111,112], so either approach is reasonable. A meta-analysis of available data may be helpful in determining whether one approach is more beneficial than the other.

Alcohol-based surgical prep solutions contain approximately 70 to 75 percent isopropyl alcohol and serve as fuels if not allowed to dry sufficiently before use of an ignition source; at least three minutes are required. Therefore, preparation with povidone-iodine or chlorhexidine soap (eg, Hibiclens) is advantageous when surgery cannot be delayed, as these solutions are not flammable.

The benefit of bathing with an antiseptic preparation prior to surgery to reduce the risk of surgical site infection is unproven. In a 2006 meta-analysis of six trials involving 10,000 participants undergoing general surgery, preoperative bathing with chlorhexidine conferred no benefit over preoperative bathing with other products

before cesarean delivery. Metronidazole gel 5 mg intravaginally [114] and chlorhexidine gluconate soap scrub with 4% alcohol [115] are alternative options, but less well-studied. Preparations with a high alcohol content (chlorhexidine gluconate with 70% alcohol used for skin prep) should be avoided in the vagina because alcohol irritates mucous membranes.

In a 2017 meta-analysis of randomized trials of vaginal cleansing versus placebo/no intervention before cesarean delivery, vaginal cleansing resulted in a lower incidence of endometritis (4.5 versus 8.8 percent; relative risk [RR] 0.52, 95% CI 0.37-0.72; 15 trials, 4726 participants) and postoperative fever (9.4 versus 14.9 percent; relative risk 0.65, 95% CI 0.50-0.86; 11 trials, 4098 participants) [115]. In subgroup analysis, the reduction in endometritis was significant only among women in labor before the cesarean delivery (8.1 versus 13.8 percent; RR 0.52, 95% CI 0.28-0.97; four studies, 440 participants) and those with ruptured membranes (4.3 versus 20.1 percent; RR 0.23, 95% CI 0.10-0.52; three studies, 272 participants), and remained significant even in women who received preoperative antibiotics. Most of the trials used a povidone-iodine scrub.

Drapes — The surgical site is draped with nonadhesive drapes as two randomized trials in patients undergoing cesarean delivery reported that these drapes resulted in a lower rate of wound infection than adhesive drapes [116,117].

Uterine displacement — The uterus is typically displaced at least 15 degrees to the left to reduce aortocaval compression ("supine hypotensive syndrome"), which occurs in the supine position when the uterus is at or above the umbilicus [118-122]. A foam or wood wedge, pillow, or rolled blanket may be used, or the table can be tilted, or the uterus can be manually displaced. A 2013 systematic review was not able to determine the optimum method or maternal position [123]. (See "Anesthesia for cesarean delivery", section on 'Intraoperative positioning'.)

Perioperative management of medication — Perioperative medication is similar to that for other surgical procedures, and discussed separately. (See "Perioperative medication management".)

SOCIETY GUIDELINE LINKS — Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: Cesarean delivery".)

INFORMATION FOR PATIENTS — UpToDate offers two types of patient education materials, "The Basics" and "Beyond the Basics." The Basics patient education pieces are written in plain language, at the 5th to 6th grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on "patient info" and the keyword(s) of interest.)

- Basics topics (see "Patient education: C-section (cesarean delivery) (The Basics)")
- Beyond the Basics topics (see "Patient education: C-section (cesarean delivery) (Beyond the Basics)")

SUMMARY AND RECOMMENDATIONS

- Cesarean delivery is performed when the clinician and patient believe that abdominal delivery is likely to provide a better maternal or fetal outcome than vaginal delivery. A wide variety of conditions fulfill these criteria. (See 'Indications' above.)
- Scheduled primary cesarean delivery at term should be performed in the 39th or 40th week of gestation, rather than in the 37th or 38th week. Medically/obstetrically indicated cesarean deliveries are performed when clinically indicated. (See 'Scheduling' above.)
- Timing of elective repeat cesarean delivery is based on the type of previous hysterotomy incision, and is reviewed separately. (See "Repeat cesarean delivery", section on 'Timing'.)
- For all women undergoing cesarean delivery, we recommend preoperative antibiotic prophylaxis rather than no prophylaxis or prophylaxis after cord clamping (**Grade 1A**). Antibiotics are given up to 60 minutes before making the incision.
  - We use a single intravenous dose of a narrow-spectrum antibiotic, such as cefazolin (2 grams for patients <120 kg and 3 grams for patients ≥120 kg) (table 2). Multiple doses are more costly, without clearly improving outcome in the absence of prolonged surgery or excessive blood loss. If the cesarean delivery is performed intrapartum or after rupture of membranes, we add a dose of azithromycin 500 mg intravenously. (See 'Regimen' above and 'Prolonged surgery or excessive blood loss' above.)
  - For women with a history of serious forms of penicillin allergy, we substitute clindamycin and gentamicin for cefazolin. Women at low risk of a serious immediate allergic reaction can receive cefazolin. If the cesarean delivery is performed intrapartum or after rupture of membranes, we add a dose of azithromycin 500 mg intravenously. (See 'Women with penicillin allergy' above.)
  - For women already receiving penicillin G for prophylaxis of neonatal Group B *Streptococcus* (GBS) infection, we do not add cefazolin or switch to ampicillin for surgical prophylaxis. If the cesarean delivery is performed intrapartum or after rupture of membranes, we add a dose of azithromycin 500 mg intravenously. (See 'Woman already on antibiotics' above.)
  - For women receiving ampicillin and gentamicin for chorioamnionitis, we add either one dose of clindamycin 900 mg or metronidazole 500 mg before making the incision, and continue ampicillin and gentamicin or switch to ampicillin-sulbactam postpartum until the patient is afebrile for at least 24 hours. *Bacteroides* resistance to clindamycin is increasing; in areas of high resistance, ampicillin-sulbactam is preferable. We do not administer preincision prophylactic azithromycin in this setting. (See 'Woman already on antibiotics' above.)
- We use a chlorhexidine-based antiseptic agent rather than an iodine-based antiseptic agent for skin preparation, but either approach is reasonable. Chlorhexidine-alcohol solutions should be allowed to dry for at least three minutes before using an ignition source, otherwise a nonflammable preparation (povidone-iodine or chlorhexidine soap) should be used. (See 'Skin preparation' above.)
- For women in labor and women with ruptured membranes, we suggest vaginal cleansing before cesarean delivery rather than no vaginal cleansing (**Grade 2C**). We use a povidone-iodine vaginal scrub for 30 seconds. Vaginal cleansing in these high risk populations reduces the frequency of postpartum endometritis. (See 'Vaginal preparation' above.)
- For all women undergoing cesarean delivery, we suggest mechanical thromboprophylaxis (**Grade 2C**). For women undergoing cesarean delivery at high risk of venous thromboembolism (VTE), we suggest mechanical thromboprophylaxis plus pharmacologic thromboprophylaxis (**Grade 2C**). Pharmacologic prophylaxis is begun 6 to 12 hours postoperatively, after concerns for hemorrhage have decreased. Mechanical and pharmacologic prophylaxis are continued until the woman is fully ambulating. Women with significant risk factors for VTE persisting following delivery should receive a full six weeks of thromboprophylaxis. (See 'Thromboembolism prophylaxis' above.)

REFERENCES

1. Pfuntner A, Wier LM, Stocks C. Statistical brief #149: Most frequent procedures performed in US hospitals, 2010. 2013.
2. Centers for Disease Control and Prevention. Births - Method of delivery, 2015. https://www.cdc.gov/nchs/fastats/delivery.htm (Accessed on May 05, 2017).
3. Boyle A, Reddy UM, Landy HJ, et al. Primary cesarean delivery in the United States. Obstet Gynecol 2013; 122:33.
4. Walker SP, McCarthy EA, Ugoni A, et al. Cesarean delivery or vaginal birth: a survey of patient and clinician thresholds. Obstet Gynecol 2007; 109:67.
5. Lyerly AD, Mitchell LM, Armstrong EM, et al. Risks, values, and decision making surrounding pregnancy. Obstet Gynecol 2007; 109:979.
6. American College of Obstetricians and Gynecologists. Patient Safety Checklist no. 4: preoperative planned cesarean delivery. Obstet Gynecol 2011; 118:1471.
7. American College of Obstetricians and Gynecologists. Patient Safety Checklist no. 3: scheduling planned cesarean delivery. Obstet Gynecol 2011; 118:1469.
8. Sentilhes L, Vayssière C, Beucher G, et al. Delivery for women with a previous cesarean: guidelines for clinical practice from the French College of Gynecologists and Obstetricians (CNGOF). Eur J Obstet Gynecol Reprod Biol 2013; 170:25.
9. http://www.nice.org.uk/guidance/cg132 (Accessed on October 22, 2014).
10. American College of Obstetricians and Gynecologists. ACOG committee opinion no. 561: Nonmedically indicated early-term deliveries. Obstet Gynecol 2013; 121:911. Reaffirmed 2017.
11. Committee on Obstetric Practice. Committee Opinion No. 688: Management of Suboptimally Dated Pregnancies. Obstet Gynecol 2017; 129:e29.
12. Hansen AK, Wisborg K, Uldbjerg N, Henriksen TB. Risk of respiratory morbidity in term infants delivered by elective caesarean section: cohort study. BMJ 2008; 336:85.
13. Zanardo V, Simbi AK, Franzoi M, et al. Neonatal respiratory morbidity risk and mode of delivery at term: influence of timing of elective caesarean delivery. Acta Paediatr 2004; 93:643.
14. Morrison JJ, Rennie JM, Milton PJ. Neonatal respiratory morbidity and mode of delivery at term: influence of timing of elective caesarean section. Br J Obstet Gynaecol 1995; 102:101.
15. Wax JR, Herson V, Carignan E, et al. Contribution of elective delivery to severe respiratory distress at term. Am J Perinatol 2002; 19:81.
16. Yee W, Amin H, Wood S. Elective cesarean delivery, neonatal intensive care unit admission, and neonatal respiratory distress. Obstet Gynecol 2008; 111:823.
17. Clark SL, Miller DD, Belfort MA, et al. Neonatal and maternal outcomes associated with elective term delivery. Am J Obstet Gynecol 2009; 200:156.e1.
18. Wilmink FA, Hukkelhoven CW, Lunshof S, et al. Neonatal outcome following elective cesarean section beyond 37 weeks of gestation: a 7-year retrospective analysis of a national registry. Am J Obstet Gynecol 2010; 202:250.e1.
19. Nir V, Nadir E, Feldman M. Late better than early elective term Cesarean section. Acta Paediatr 2012; 101:1054.
20. Glavind J, Kindberg SF, Uldbjerg N, et al. Elective caesarean section at 38 weeks versus 39 weeks: neonatal and maternal outcomes in a randomised controlled trial. BJOG 2013; 120:1123.
21. Tita AT, Landon MB, Spong CY, et al. Timing of elective repeat cesarean delivery at term and neonatal outcomes. N Engl J Med 2009; 360:111.
22. ACOG Committee on Obstetric Practice. ACOG committee opinion No. 433: optimal goals for anesthesia care in obstetrics. Obstet Gynecol 2009; 113:1197.
23. MacKenzie IZ, Cooke I. Prospective 12 month study of 30 minute decision to delivery intervals for "emergency" caesarean section. BMJ 2001; 322:1334.
24. James D. Caesarean section for fetal distress. BMJ 2001; 322:1316.
25. Helmy WH, Jolaoso AS, Ifaturoti OO, et al. The decision-to-delivery interval for emergency caesarean section: is 30 minutes a realistic target? BJOG 2002; 109:505.
26. Tuffnell DJ, Wilkinson K, Beresford N. Interval between decision and delivery by caesarean section-are current standards achievable? Observational case series. BMJ 2001; 322:1330.
27. Chauhan SP, Roach H, Naef RW 2nd, et al. Cesarean section for suspected fetal distress. Does the decision-incision time make a difference? J Reprod Med 1997; 42:347.
28. MacKenzie IZ, Cooke I. What is a reasonable time from decision-to-delivery by caesarean section? Evidence from 415 deliveries. BJOG 2002; 109:498.
29. Thomas J, Paranjothy S, James D. National cross sectional survey to determine whether the decision to delivery interval is critical in emergency caesarean section. BMJ 2004; 328:665.
30. Holcroft CJ, Graham EM, Aina-Mumuney A, et al. Cord gas analysis, decision-to-delivery interval, and the 30-minute rule for emergency cesareans. J Perinatol 2005; 25:229.
31. Bloom SL, Leveno KJ, Spong CY, et al. Decision-to-incision times and maternal and infant outcomes. Obstet Gynecol 2006; 108:6.
32. Tolcher MC, Johnson RL, El-Nashar SA, West CP. Decision-to-incision time and neonatal outcomes: a systematic review and meta-analysis. Obstet Gynecol 2014; 123:536.
33. Stallings SP, Edwards RK, Johnson JW. Correlation of head-to-body delivery intervals in shoulder dystocia and umbilical artery acidosis. Am J Obstet Gynecol 2001; 185:268.
34. Katz VL, Dotters DJ, Droegemueller W. Perimortem cesarean delivery. Obstet Gynecol 1986; 68:571.
35. Myers RE. Two patterns of perinatal brain damage and their conditions of occurrence. Am J Obstet Gynecol 1972; 112:246.
36. Smith J, Plaat F, Fisk NM. The natural caesarean: a woman-centred technique. BJOG 2008; 115:1037.
37. Magee SR, Battle C, Morton J, Nothnagle M. Promotion of family-centered birth with gentle cesarean delivery. J Am Board Fam Med 2014; 27:690.
38. Armbrust R, Hinkson L, von Weizsäcker K, Henrich W. The Charité cesarean birth: a family orientated approach of cesarean section. J Matern Fetal Neonatal Med 2016; 29:163.
39. Cousins LM, Teplick FB, Poeltler DM. Pre-cesarean blood bank orders: a safe and less expensive approach. Obstet Gynecol 1996; 87:912.
40. Ransom SB, Fundaro G, Dombrowski MP. Cost-effectiveness of routine blood type and screen testing for cesarean section. J Reprod Med 1999; 44:592.
41. Rouse DJ, MacPherson C, Landon M, et al. Blood transfusion and cesarean delivery. Obstet Gynecol 2006; 108:891.
42. American Society of Anesthesiologists Task Force on Obstetric Anesthesia. Practice guidelines for obstetric anesthesia: an updated report by the American Society of Anesthesiologists Task Force on Obstetric Anesthesia. Anesthesiology 2007; 106:843.
43. Chua SC, Joung SJ, Aziz R. Incidence and risk factors predicting blood transfusion in caesarean section. Aust N Z J Obstet Gynaecol 2009; 49:490.

45. Mackeen AD, Packard RE, Ota E, et al. Timing of intravenous prophylactic antibiotics for preventing postpartum infectious morbidity in women undergoing cesarean delivery. Cochrane Database Syst Rev 2014; :CD009516.
46. Dinsmoor MJ, Gilbert S, Landon MB, et al. Perioperative antibiotic prophylaxis for nonlaboring cesarean delivery. Obstet Gynecol 2009; 114:752.
47. Ledger WJ, Blaser MJ. Are we using too many antibiotics during pregnancy? BJOG 2013; 120:1450.
48. American College of Obstetricians and Gynecologists. ACOG Practice Bulletin No. 120: Use of prophylactic antibiotics in labor and delivery. Obstet Gynecol 2011; 117:1472.
49. Bratzler DW, Dellinger EP, Olsen KM, et al. Clinical practice guidelines for antimicrobial prophylaxis in surgery. Am J Health Syst Pharm 2013; 70:195.
50. Forse RA, Karam B, MacLean LD, Christou NV. Antibiotic prophylaxis for surgery in morbidly obese patients. Surgery 1989; 106:750.
51. Wurtz R, Itokazu G, Rodvold K. Antimicrobial dosing in obese patients. Clin Infect Dis 1997; 25:112.
52. Swank ML, Wing DA, Nicolau DP, McNulty JA. Increased 3-gram cefazolin dosing for cesarean delivery prophylaxis in obese women. Am J Obstet Gynecol 2015; 213:415.e1.
53. Young OM, Shaik IH, Twedt R, et al. Pharmacokinetics of cefazolin prophylaxis in obese gravidae at time of cesarean delivery. Am J Obstet Gynecol 2015; 213:541.e1.
54. Maggio L, Nicolau DP, DaCosta M, et al. Cefazolin prophylaxis in obese women undergoing cesarean delivery: a randomized controlled trial. Obstet Gynecol 2015; 125:1205.
55. www.drugs.com.
56. Gyte GM, Dou L, Vazquez JC. Different classes of antibiotics given to women routinely for preventing infection at caesarean section. Cochrane Database Syst Rev 2014; :CD008726.
57. Hopkins L, Smaill F. Antibiotic prophylaxis regimens and drugs for cesarean section. Cochrane Database Syst Rev 2000; :CD001136.
58. Pinto-Lopes R, Sousa-Pinto B, Azevedo LF. Single dose versus multiple dose of antibiotic prophylaxis in caesarean section: a systematic review and meta-analysis. BJOG 2017; 124:595.
59. Andrews WW, Hauth JC, Cliver SP, et al. Randomized clinical trial of extended spectrum antibiotic prophylaxis with coverage for Ureaplasma urealyticum to reduce post-cesarean delivery endometritis. Obstet Gynecol 2003; 101:1183.
60. Tita AT, Hauth JC, Grimes A, et al. Decreasing incidence of postcesarean endometritis with extended-spectrum antibiotic prophylaxis. Obstet Gynecol 2008; 111:51.
61. Tita AT, Owen J, Stamm AM, et al. Impact of extended-spectrum antibiotic prophylaxis on incidence of postcesarean surgical wound infection. Am J Obstet Gynecol 2008; 199:303.e1.
62. Tita AT, Szychowski JM, Boggess K, et al. Adjunctive Azithromycin Prophylaxis for Cesarean Delivery. N Engl J Med 2016; 375:1231.
63. Harper LM, Kilgore M, Szychowski JM, et al. Economic Evaluation of Adjunctive Azithromycin Prophylaxis for Cesarean Delivery. Obstet Gynecol 2017; 130:328.
64. Weinstein RA, Boyer KM. Antibiotic Prophylaxis for Cesarean Delivery - When Broader Is Better. N Engl J Med 2016; 375:1284.
65. Ragusa A, Svelato A. Adjunctive Azithromycin Prophylaxis for Cesarean Delivery. N Engl J Med 2017; 376:181.
66. Greig JR, Jones L. Adjunctive Azithromycin Prophylaxis for Cesarean Delivery. N Engl J Med 2017; 376:181.
67. Tita ATN, Boggess K, Saade G. Adjunctive Azithromycin Prophylaxis for Cesarean Delivery. N Engl J Med 2017; 376:182.
68. Zelenitsky SA, Silverman RE, Duckworth H, Harding GK. A prospective, randomized, double-blind studyof single high dose versus multiple standard dose gentamicin both in combination withmetronidazole for colorectal surgicalprophylaxis. J Hosp Infect 2000; 46:135.
69. Rao SC, Srinivasjois R, Hagan R, Ahmed M. One dose per day compared to multiple doses per day of gentamicin for treatment of suspected or proven sepsis in neonates. Cochrane Database Syst Rev 2011; :CD005091.
70. Fay KE, Yee L. Applying surgical antimicrobial standards in cesarean deliveries. Am J Obstet Gynecol 2018; 218:416.e1.
71. Bratzler DW, Dellinger EP, Olsen KM, et al. Clinical practice guidelines for antimicrobial prophylaxis in surgery. Surg Infect (Larchmt) 2013; 14:73.
72. Blondon M, Casini A, Hoppe KK, et al. Risks of Venous Thromboembolism After Cesarean Sections: A Meta-Analysis. Chest 2016; 150:572.
73. https://www.cdc.gov/mmwr/preview/mmwrhtml/ss5202a1.htm#tab3 (Accessed on February 14, 2017).
74. Greer IA. Thrombosis in pregnancy: maternal and fetal issues. Lancet 1999; 353:1258.
75. Bain E, Wilson A, Tooher R, et al. Prophylaxis for venous thromboembolic disease in pregnancy and the early postnatal period. Cochrane Database Syst Rev 2014; :CD001689.
76. Seeho S, Nassar N. Thromboprophylaxis after caesarean: when even the 'experts' disagree. BJOG 2016; 123:2163.
77. O'Shaughnessy F, Donnelly JC, Cooley SM, et al. Thrombocalc: implementation and uptake of personalized postpartum venous thromboembolism risk assessment in a high-throughput obstetric environment. Acta Obstet Gynecol Scand 2017; 96:1382.
78. Taylor GM, McKenzie CA, Mires GJ. Use of a computerised maternity information system to improve clinical effectiveness: thromboprophylaxis at caesarean section. Postgrad Med J 2000; 76:354.
79. James A, Committee on Practice Bulletins—Obstetrics. Practice bulletin no. 123: thromboembolism in pregnancy. Obstet Gynecol 2011; 118:718. Reaffirmed 2017.
80. Clark SL, Belfort MA, Dildy GA, et al. Maternal death in the 21st century: causes, prevention, and relationship to cesarean delivery. Am J Obstet Gynecol 2008; 199:36.e1.
81. Clark SL, Christmas JT, Frye DR, et al. Maternal mortality in the United States: predictability and the impact of protocols on fatal postcesarean pulmonary embolism and hypertension-related intracranial hemorrhage. Am J Obstet Gynecol 2014; 211:32.e1.
82. Committee on Practice Bulletins--Gynecology, American College of Obstetricians and Gynecologists. ACOG Practice Bulletin No. 84: Prevention of deep vein thrombosis and pulmonary embolism. Obstet Gynecol 2007; 110:429. Reaffirmed 2018.
83. Sibai BM, Rouse DJ. Pharmacologic Thromboprophylaxis in Obstetrics: Broader Use Demands Better Data. Obstet Gynecol 2016; 128:681.
84. Bates SM, Greer IA, Middeldorp S, et al. VTE, thrombophilia, antithrombotic therapy, and pregnancy: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. Chest 2012; 141:e691S.
85. Dargaud Y, Rugeri L, Vergnes MC, et al. A risk score for the management of pregnant women with increased risk of venous thromboembolism: a multicentre prospective study. Br J Haematol 2009; 145:825.

87. Ettema HB, Kollen BJ, Verheyen CC, Buller HR. Prevention of venous thromboembolism in patients with immobilization of the lower extremities: a meta-analysis of randomized controlled trials. J Thromb Haemost 2008; 6:1093.
88. Jacobsen AF, Skjeldestad FE, Sandset PM. Ante- and postnatal risk factors of venous thrombosis: a hospital-based case-control study. J Thromb Haemost 2008; 6:905.
89. James AH, Jamison MG, Brancazio LR, Myers ER. Venous thromboembolism during pregnancy and the postpartum period: incidence, risk factors, and mortality. Am J Obstet Gynecol 2006; 194:1311.
90. Lindqvist P, Dahlbäck B, Maršál K. Thrombotic risk during pregnancy: a population study. Obstet Gynecol 1999; 94:595.
91. Macklon NS, Greer IA. Venous thromboembolic disease in obstetrics and gynaecology: the Scottish experience. Scott Med J 1996; 41:83.
92. Simpson EL, Lawrenson RA, Nightingale AL, Farmer RD. Venous thromboembolism in pregnancy and the puerperium: incidence and additional risk factors from a London perinatal database. BJOG 2001; 108:56.
93. Blondon M, Perrier A, Nendaz M, et al. Thromboprophylaxis with low-molecular-weight heparin after cesarean delivery. Thromb Haemost 2010; 103:129.
94. Kobayashi T, Nakabayashi M, Ishikawa M, et al. Pulmonary thromboembolism in obstetrics and gynecology increased by 6.5-fold over the past decade in Japan. Circ J 2008; 72:753.
95. Reducing the Risk of Venous Thromboembolism during Pregnancy and the Puerperium. Green-top Guideline No. 37a. April 2015 https://www.rcog.org.uk/globalassets/documents/guidelines/gtg-37a.pdf (Accessed on October 05, 2016).
96. Overcash RT, Somers AT, LaCoursiere DY. Enoxaparin dosing after cesarean delivery in morbidly obese women. Obstet Gynecol 2015; 125:1371.
97. He Z, Morrissey H, Ball P. Review of current evidence available for guiding optimal Enoxaparin prophylactic dosing strategies in obese patients-Actual Weight-based vs Fixed. Crit Rev Oncol Hematol 2017; 113:191.
98. Hagopian JC, Riney JN, Hollands JM, Deal EN. Assessment of bleeding events associated with short-duration therapeutic enoxaparin use in the morbidly obese. Ann Pharmacother 2013; 47:1641.
99. Committee on Obstetric Practice. ACOG Committee Opinion No. 382: Fetal Monitoring Prior to Scheduled Cesarean Delivery. Obstet Gynecol 2007; 110:961.
100. Abdel-Aleem H, Aboelnasr MF, Jayousi TM, Habib FA. Indwelling bladder catheterisation as part of intraoperative and postoperative care for caesarean section. Cochrane Database Syst Rev 2014; :CD010322.
101. Li L, Wen J, Wang L, et al. Is routine indwelling catheterisation of the bladder for caesarean section necessary? A systematic review. BJOG 2011; 118:400.
102. Senanayake H. Elective cesarean section without urethral catheterization. J Obstet Gynaecol Res 2005; 31:32.
103. Ghoreishi J. Indwelling urinary catheters in cesarean delivery. Int J Gynaecol Obstet 2003; 83:267.
104. Barnes JS. Is it better to avoid urethral catheterization at hysterectomy and caesarean section? Aust N Z J Obstet Gynaecol 1998; 38:315.
105. Nasr AM, ElBigawy AF, Abdelamid AE, et al. Evaluation of the use vs nonuse of urinary catheterization during cesarean delivery: a prospective, multicenter, randomized controlled trial. J Perinatol 2009; 29:416.
106. Tanner J, Norrie P, Melen K. Preoperative hair removal to reduce surgical site infection. Cochrane Database Syst Rev 2011; :CD004122.
107. Lefebvre A, Saliou P, Lucet JC, et al. Preoperative hair removal and surgical site infections: network meta-analysis of randomized controlled trials. J Hosp Infect 2015; 91:100.
108. Tuuli MG, Liu J, Stout MJ, et al. A Randomized Trial Comparing Skin Antiseptic Agents at Cesarean Delivery. N Engl J Med 2016; 374:647.
109. Kunkle CM, Marchan J, Safadi S, et al. Chlorhexidine gluconate versus povidone iodine at cesarean delivery: a randomized controlled trial. J Matern Fetal Neonatal Med 2015; 28:573.
110. Darouiche RO, Wall MJ Jr, Itani KM, et al. Chlorhexidine-Alcohol versus Povidone-Iodine for Surgical-Site Antisepsis. N Engl J Med 2010; 362:18.
111. Ngai IM, Van Arsdale A, Govindappagari S, et al. Skin Preparation for Prevention of Surgical Site Infection After Cesarean Delivery: A Randomized Controlled Trial. Obstet Gynecol 2015; 126:1251.
112. Springel EH, Wang XY, Sarfoh VM, et al. A randomized open-label controlled trial of chlorhexidine-alcohol vs povidone-iodine for cesarean antisepsis: the CAPICA trial. Am J Obstet Gynecol 2017; 217:463.e1.
113. Webster J, Osborne S. Preoperative bathing or showering with skin antiseptics to prevent surgical site infection. Cochrane Database Syst Rev 2006; :CD004985.
114. Pitt C, Sanchez-Ramos L, Kaunitz AM. Adjunctive intravaginal metronidazole for the prevention of postcesarean endometritis: a randomized controlled trial. Obstet Gynecol 2001; 98:745.
115. Caissutti C, Saccone G, Zullo F, et al. Vaginal Cleansing Before Cesarean Delivery: A Systematic Review and Meta-analysis. Obstet Gynecol 2017; 130:527.
116. Cordtz T, Schouenborg L, Laursen K, et al. The effect of incisional plastic drapes and redisinfection of operation site on wound infection following caesarean section. J Hosp Infect 1989; 13:267.
117. Ward HR, Jennings OG, Potgieter P, Lombard CJ. Do plastic adhesive drapes prevent post caesarean wound infection? J Hosp Infect 2001; 47:230.
118. Lee SW, Khaw KS, Ngan Kee WD, et al. Haemodynamic effects from aortocaval compression at different angles of lateral tilt in non-labouring term pregnant women. Br J Anaesth 2012; 109:950.
119. Bamber JH, Dresner M. Aortocaval compression in pregnancy: the effect of changing the degree and direction of lateral tilt on maternal cardiac output. Anesth Analg 2003; 97:256.
120. Kundra P, Velraj J, Amirthalingam U, et al. Effect of positioning from supine and left lateral positions to left lateral tilt on maternal blood flow velocities and waveforms in full-term parturients. Anaesthesia 2012; 67:889.
121. Kinsella SM, Harvey NL. A comparison of the pelvic angle applied using lateral table tilt or a pelvic wedge at elective caesarean section. Anaesthesia 2012; 67:1327.
122. Calvache JA, Muñoz MF, Baron FJ. Hemodynamic effects of a right lumbar-pelvic wedge during spinal anesthesia for cesarean section. Int J Obstet Anesth 2011; 20:307.
123. Cluver C, Novikova N, Hofmeyr GJ, Hall DR. Maternal position during caesarean section for preventing maternal and neonatal complications. Cochrane Database Syst Rev 2013; :CD007623.

Topic 4475 Version 136.0

Indications for antenatal anesthesia consultation

Patients should ideally be referred for anesthesiology consultation by 32 weeks gestation, or earlier if premature birth is anticipated.
1. **Cardiac issues** a. Valvular disease (excluding asymptomatic mitral valve prolapse) b. History of chest pain without cardiac workup c. History of arrhythmias (specifically SVT, atrial fibrillation, VT) d. Complex congenital cardiac defects e. Pacemakers/ICDs f. History of cardiomyopathy or IHSS
2. **Pulmonary disease** a. Asthma - poorly controlled or worsening during pregnancy b. History of pulmonary hypertension c. Other pulmonary disease (eg, previous chest surgery, cystic fibrosis, sarcoid) that compromises ability to perform usual ADLs
3. **Neurologic/neurosurgical disease** a. Current or prior history of intracranial vascular malformation, hemorrhage, tumor or any mass lesion b. Arnold chiari malformation c. Multiple sclerosis (compromising ability to perform ADLs) d. Spinal anatomy concerns: Hardware (eg, lumbar drains, nerve stimulators for chronic pain), prior surgery (including Harrington Rod placement), major or minor paralysis, diagnosed spina bifida, low back pain if it significantly compromises ability to perform ADLs e. Neuromuscular disease (eg, multiple sclerosis or myasthenia gravis) that compromises ability to perform ADLs
4. **Hematologic** a. History of thrombocytopenia (platelet count <100,000/microL) b. History of bleeding disorder c. Anticoagulation therapy
5. **Chronic pain syndrome involving visits to pain clinics or neurologists**
6. **Severe obesity**
7. **Allergy to local anesthetics** (eg, lidocaine, novocaine) **or opioids** (eg, morphine, fentanyl, hydromorphone, meperidine, codeine)
8. **History of anesthetic complications or problems in the patient or in a family member** a. Malignant hyperthermia b. Airway concerns (history of difficult intubation, history of oral or facial surgery)
9. **Specific questions, special requests, or significant anxiety regarding anesthesia care** (eg, complicated birth plans or requests for general anesthesia)
10. **Refusal of transfusion, including Jehovah's Witness**
11. **Opioid abuse disorder, not on stable methadone or buprenorphine regimen**

SVT: supraventricular tachycardia; VT: ventricular tachycardia; ICD: implantable cardioverter-defibrillator; IHSS: idiopathic hypertrophic subaortic stenosis; ADL: activity of daily living.

Graphic 68666 Version 3.0

Procedure	Preferred regimen Δ	Dose	Alternative regimens	Dose
Hysterectomy (abdominal, vaginal, laparoscopic, or robotic) Urogynecology procedures including those involving mesh	Cefazolin, cefoxitin or cefotetan	Cefazolin: <120 kg: 2 g IV ≥120 kg: 3 g IV Cefoxitin or cefotetan: 2 g IV	**Regimen:**	
			Ampicillin-sulbactam	3 g IV
			Regimen:	
			Clindamycin **OR**	900 mg IV◇
			Vancomycin¶	15 mg/kg IV (not to exceed 2 g per dose)
			PLUS one of the following:	
			Gentamicin **OR**	5 mg/kg IV (if overweight or obese, based on dosing weight)§
			Aztreonam **OR**	2 g IV
			Fluoroquinolone¶¥	
			Regimen:	
			Metronidazole	500 mg IV
			PLUS one of the following:	
			Gentamicin **OR**	5 mg/kg IV (if overweight or obese, based on dosing weight)§
			Fluoroquinolone¶¥	
Cesarean section	Cefazolin	<120 kg: 2 g IV ≥120 kg: 3 g IV	**Regimen:**	
			Ampicillin-sulbactam	3 g IV
			Regimen:	
			Clindamycin **OR**	900 mg IV◇
			Vancomycin¶	15 mg/kg IV (not to exceed 2 g per dose)
			PLUS one of the following:	
			Gentamicin **OR**	5 mg/kg IV (if overweight or obese, based on dosing weight)§
			Aztreonam	2 g IV
			Regimen:	
			Metronidazole **PLUS**	500 mg IV
			Gentamicin	5 mg/kg IV (if overweight or obese, based on dosing weight)§
Abortion, surgical	Doxycycline	100 mg orally one hour before procedure and 200 mg orally after procedure	Metronidazole	500 mg orally twice daily for five days
			Azithromycin	1 g orally one hour before procedure
Hysterosalpingogram or chromotubation	Doxycycline‡	100 mg orally twice daily for five days		
Laparoscopy (diagnostic, tubal sterilization, operative except for hysterectomy) Other transcervical procedures: Hysteroscopy (diagnostic or operative, including hysteroscopic sterilization) Intrauterine device insertion Endometrial biopsy	None			

IV: intravenous; IDSA: Infectious Diseases Society of America; ASHP: American Society of Health-System Pharmacists; ACOG: American College of Obstetricians and Gynecologists.

* Common pathogens: Enteric gram-negative bacilli, anaerobes, group B *Streptococcus*, enterococci.

¶ Parenteral prophylactic antimicrobials can be given as a single IV dose begun within 60 minutes before the procedure. If vancomycin or a fluoroquinolone is used, the infusion should be given over 60 to 90 minutes and started within 60 to 120 minutes before the initial incision.

Δ An alternative regimen should be used in women with history of immediate hypersensitivity to beta-lactam agents. Due to increasing resistance of *Escherichia coli* to ampicillin-sulbactam and fluoroquinolones, local sensitivity profiles should be reviewed prior to use.

◇ When clindamycin prophylaxis is warranted, UpToDate authors prefer a single dose of 900 mg based upon pharmacokinetic considerations according to 2013 IDSA/ASHP surgical antibiotic prophylaxis guidelines.[1] However, a 600 mg dose consistent with ACOG guidance may be sufficient.[2,3]

§ Gentamicin use for surgical antibiotic prophylaxis should be limited to a single dose given preoperatively. Based on evidence from colorectal procedures, a single dose of approximately 5 mg/kg gentamicin appears more effective for the prevention of surgical site infection than multiple doses of gentamicin 1.5 mg/kg every eight hours.[4] However, a lower dose of 1.5 mg/kg, consistent with ACOG guidance, may be adequate.[2,3] For overweight and obese patients (ie, actual weight is >125% of ideal body weight), a dosing weight should be used. A calculator to determine ideal body weight and dosing weight is available in UpToDate.

¥ Ciprofloxacin 400 mg IV **OR** levofloxacin 500 mg IV **OR** moxifloxacin 400 mg IV. Fluoroquinolones are contraindicated in pregnancy and in women who are breastfeeding.

‡ Prophylaxis is warranted for patients with history of pelvic inflammatory disease or if the procedure demonstrates dilated fallopian tubes. No prophylaxis is indicated for patients without dilated tubes.

3. *ACOG practice bulletin No. 120: Use of prophylactic antibiotics in labor and delivery. Obstet Gynecol 2011;117:1472.*
4. *Zelenitsky SA, Silverman RE, Duckworth H, Harding GK. A prospective, randomized, double-blind study of single high dose versus multiple standard dose gentamicin both in combination with metronidazole for colorectal surgical prophylaxis. J Hosp Infect 2000; 46:135.*

Adapted from: Antimicrobial prophylaxis for surgery. Med Lett Drugs Ther 2016; 58:63.

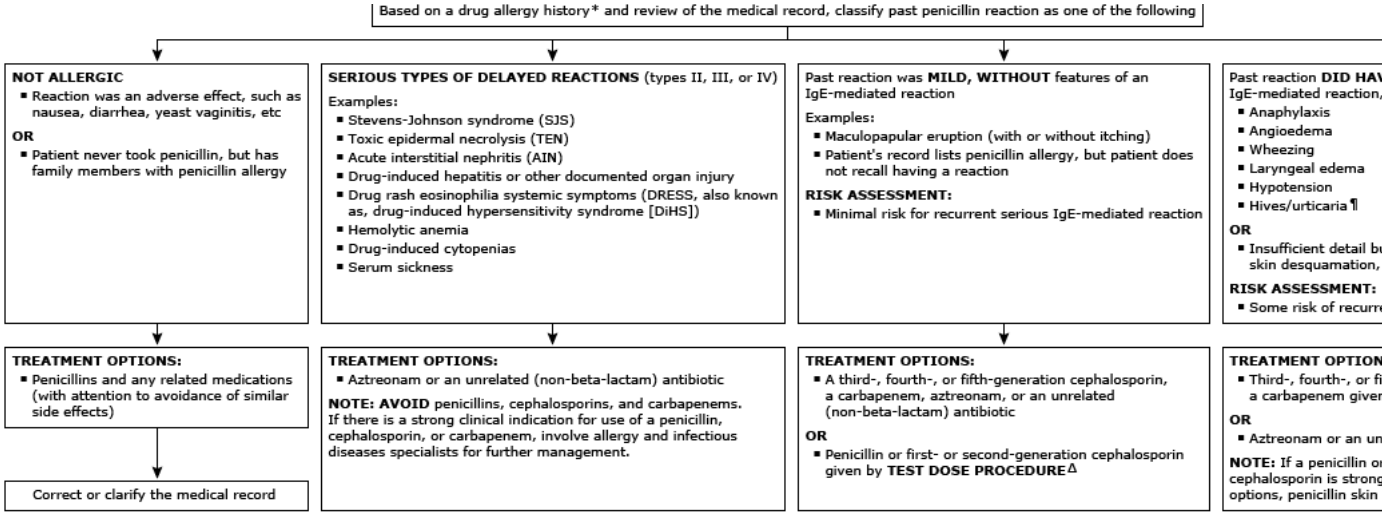
Graphic 87200 Version 29.0

Skin
▪ **Itching*** ▪ **Urticaria*** ▪ **Angioedema*** ▪ Warmth ▪ Flushing ▪ Other exanthema
Eyes, ears, nose
▪ **Periorbital edema*** ▪ **Rhinorrhea*** ▪ **Nasal itching*** ▪ **Nasal congestion*** ▪ Ocular itching ▪ Tearing ▪ Conjunctival injection and/or edema ▪ Sneezing
Mouth
▪ **Itching or tingling of lips, tongue, oral mucosa*** ▪ **Angioedema of lips, tongue, or uvula*** ▪ Metallic taste
Throat
▪ **Itching*** ▪ **Sense of constriction or swelling in throat*** ▪ **Change in voice quality*** ▪ **Difficulty swallowing*** ▪ **Stridor*** ▪ Hoarseness ▪ Drooling
Lungs
▪ **Shortness of breath*** ▪ **Chest tightness*** ▪ **Repetitive cough*** ▪ **Wheezing*** ▪ Drop in oxygen saturation, cyanosis
Cardiovascular
▪ **Lightheadedness/faintness/dizziness*** ▪ **Tachycardia or occasionally, bradycardia*** ▪ **Hypotension*** ▪ Syncope/loss of consciousness ▪ Palpitations ▪ Tunnel vision ▪ Difficulty hearing ▪ Urinary or fecal incontinence ▪ Cardiac arrest
Gastrointestinal
▪ Nausea ▪ Vomiting ▪ Abdominal cramping or pain ▪ Diarrhea
Gynecologic
▪ Vaginal itching ▪ Uterine cramping or bleeding
Neurologic
▪ Anxiety ▪ Sense of impending doom ▪ Altered mental status/confusion ▪ Seizures

Immediate reactions to drugs often present with combinations of the signs and symptoms listed in the table. Those bolded and marked with an asterisk (*) are more consistent and representative than the others, and one or more of these should be present to consider the reaction immediate.

IgE: immunoglobulin E.

Graphic 100732 Version 5.0



This algorithm is intended for use in conjunction with the UpToDate content on choice of antibiotics in penicillin-allergic hospitalized patients. It is oriented toward hospitalized outpatients if test dose procedures can be performed in an appropriately monitored setting with the staff and equipment needed to manage allergic reactions, including anaph

IgE: immunoglobulin E.

* Ask the following:

1. What exactly were the symptoms?
   - Raised, red, itchy spots with each lesion lasting less than 24 hours (hives/urticaria)?
   - Swelling of the mouth, eyes, lips, or tongue (angioedema)?
   - Blisters or ulcers involving the lips, mouth, eyes, urethra, vagina, or peeling skin (seen in SJS, TEN, other severe type IV reactions)?
   - Respiratory or hemodynamic changes (anaphylaxis)?
   - Joint pains (seen in serum sickness)?
   - Did the reaction involve organs like the kidneys, lungs, or liver (seen in DRESS, other severe type IV reactions)?
2. What was the timing of the reaction after taking penicillin: Minutes, hours, or days later? Was it after the first dose or after multiple doses?
3. How long ago did the reaction happen? (After 10 years of avoidance, only 20% of patients with IgE-mediated penicillin allergy will still be allergic).
4. How was the reaction treated? Was there a need for urgent care or was adrenaline/epinephrine administered?
5. Has the patient tolerated similar medications, such as ampicillin, amoxicillin, or cephalexin since the penicillin reaction?

¶ Isolated mild hives, without other symptoms of an IgE-mediated reaction, can often occur in the setting of an infection. Patients with this history, especially if it occurred in also be considered to be at minimal risk for a recurrent serious reaction.

Δ This algorithm is intended for use in conjunction with additional UpToDate content. For a description of how to safely perform a TEST DOSE PROCEDURE, refer to the UpToD in penicillin-allergic hospitalized patients.

◇ Consult allergist to perform skin testing. If skin testing is not possible, patient may still be able to receive penicillins or first- or second-generation cephalosporins using a d tolerance induction) procedure. Refer to the UpToDate topic on rapid drug desensitization for immediate hypersensitivity reactions.

Original figure modified for this publication. Blumenthal KG, Shenoy ES, Varughese CA, et al. Impact of a clinical guideline for prescribing antibiotics to inpatients reporting pe Ann Allergy Asthma Immunol 2015; 115:294. Illustration used with the permission of Elsevier Inc. All rights reserved.

Graphic 112936 Version 5.0

Contributor disclosures are reviewed for conflicts of interest by the editorial group. When found, these are addressed by vetting through a multi-level review process, and through requirements for references to be provided to support the content. Appropriately referenced content is required of all authors and must conform to UpToDate standards of evidence.

Conflict of interest policy