

10 evidence-based recommendations to prevent surgical site infection after cesarean delivery

📌 Data-driven guidance on multiple aspects of cesarean delivery, from preoperative glycemic control to strategies for obese patients

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Infection is the second leading cause of pregnancy-related mortality in the United States, responsible for 13.6% of all maternal deaths.¹ Cesarean delivery is the single most important risk factor for puerperal infection, increasing its incidence approximately 5- to 20-fold.²

Given that cesarean deliveries represent 32.7% of all births in the United States,³ the overall health and socioeconomic burden of these infections is substantial. In addition, more than half of all pregnancies are complicated by maternal obesity, which is associated with an increased risk of cesarean delivery as well as subsequent wound complications.⁴

In this review, we offer 10 evidence-

based strategies to prevent surgical site infection (SSI) after cesarean delivery.

1 Maintain strict glycemic control in women with diabetes

Perioperative hyperglycemia is associated with an increased risk of postoperative infection in patients with diabetes

Ramos M, Khalpey Z, Lipsitz S, et al. Relationship of perioperative hyperglycemia and postoperative infections in patients who undergo general and vascular surgery. Ann Surg. 2008;248(4):585-591.

Hanazaki K, Maeda H, Okabayashi T. Relationship between perioperative glycemic control and postoperative infections. World J Gastroenterol. 2009;15(33):4122-4125.

Although data are limited on the impact of perioperative glycemic control on post-cesarean infection rates, the association has been well documented in the general surgery literature. Results of a retrospective cohort study of 995 patients undergoing general or vascular surgery demonstrated that postoperative hyperglycemia increased the risk of infection by 30% for every 40-point increase in serum glucose levels from normoglycemia (defined as <110 mg/dL) (odds ratio, 1.3; 95% confidence interval [CI], 1.03-1.64).⁵ Hyperglycemia causes abnormalities of leukocyte function, including impaired granulocyte adherence, impaired phagocytosis, delayed

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chemotaxis, and depressed bactericidal capacity. And all of these abnormalities in leukocyte function appear to improve with strict glycemic control, although the target range for blood glucose remains uncertain.⁶

2 Recommend preoperative antiseptic showering

Ask patients to shower with 4% chlorhexidine gluconate the night before surgery to reduce the presence of bacterial skin flora

Mangram AJ, Horan TC, Pearson ML, et al; Hospital Infection Control Practices Advisory Committee. Guideline for prevention of surgical site infection, 1999. Infect Control Hosp Epidemiol. 1999;20(4):247-278.

Chlebicki MP, Safdar N, O'Horo JC, Maki DG. Preoperative chlorhexidine shower or bath for prevention of surgical site infection: a meta-analysis. Am J Infect Control. 2013;41(2):167-173.

According to the Centers for Disease Control and Prevention, preoperative showering with chlorhexidine reduces the presence of bacterial skin flora. A study of more than 700 patients showed that preoperative showers with chlorhexidine reduced bacterial colony counts 9-fold, compared with only 1.3-fold for povidone-iodine.⁷ Whether this translates into a reduction in SSI remains controversial, in large part because of poor quality of the existing prospective trials, which used different agents, concentrations, and methods of skin preparation.⁸

Small clinical trials have found a benefit to chlorhexidine treatment the day before surgery.^{9,10} However, a recent meta-analysis of 16 randomized trials failed to show a significant reduction in the rate of SSI with chlorhexidine compared with soap, placebo, or no washing (relative risk [RR], 0.90; 95% CI, 0.77-1.05).¹¹

3 Administer intravenous antibiotic prophylaxis

All patients who undergo cesarean delivery should be given appropriate antibiotic prophylaxis within 60 minutes before the skin incision

American College of Obstetricians and Gynecologists. ACOG Practice Bulletin No. 120: Use of prophylactic antibiotics in labor and delivery. Obstet Gynecol. 2011;117(6):1472-1483.

Costantine MM, Rahman M, Ghulmiyah L, et al. Timing of perioperative antibiotics for cesarean delivery: a meta-analysis. Am J Obstet Gynecol. 2008;199(3):301.e1-e6.

The American College of Obstetricians and Gynecologists (ACOG) recommends the use of a single dose of a narrow-spectrum, first-generation cephalosporin (or a single dose of clindamycin with an aminoglycoside for those with a significant penicillin allergy) as SSI chemoprophylaxis for cesarean delivery.¹² Due to concerns about fetal antibiotic exposure, such prophylaxis traditionally has been given after clamping of the umbilical cord. However, results of a recent meta-analysis of 5 randomized controlled trials demonstrated that antibiotic prophylaxis significantly reduced infectious morbidity (RR, 0.50; 95% CI, 0.33-0.78) when it was given 60 minutes before the skin incision, with no significant effect on neonatal outcome.¹³

4 Give a higher dose of preoperative antibiotics in obese women

Given the increased volume of distribution and the increased risk of postcesarean infection in the obese population, a higher dose of preoperative antibiotic prophylaxis is recommended

Robinson HE, O'Connell CM, Joseph KS, McLeod NL. Maternal outcomes in pregnancies complicated by obesity. Obstet Gynecol. 2005;106(6):1357-1364.

Pevzner L, Swank M, Krepel C, et al. Effects of maternal obesity on tissue concentrations of prophylactic cefazolin during cesarean delivery. Obstet Gynecol. 2011;117(4):877-882.

The impact of maternal obesity on the risk of SSI after cesarean delivery was illustrated in a 2005 retrospective cohort study of 10,134 obese women. Moderately obese women with a prepregnancy weight of 90 to 100 kg were 1.6 times (95% CI, 1.31-1.95) more likely to have a wound infection,



Antibiotic prophylaxis significantly reduced infectious morbidity when it was given 60 minutes before the skin incision, with no significant effect on neonatal outcome

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and severely obese women (>120 kg) were 4.45 times (95% CI, 3.00–6.61) more likely to have a wound infection after cesarean delivery, compared with women of normal weight.¹⁴

Moreover, a study of tissue concentrations of prophylactic cefazolin in obese women demonstrated that concentrations within adipose tissue at the site of the skin incision were inversely proportional to maternal body mass index (BMI).¹⁵ Given these findings, consideration should be given to using a higher dose of preoperative antibiotic prophylaxis in obese women, specifically 3 g of intravenous (IV) cefazolin for women with a BMI greater than 30 kg/m² or an absolute weight of more than 100 kg.¹²

5 Use clippers for preoperative hair removal

If hair removal is necessary to perform the skin incision for cesarean delivery, the use of clippers is preferred

Tanner J, Norrie P, Melen K. Preoperative hair removal to reduce surgical site infection. Cochrane Database Syst Rev. 2011;11:CD004122.

In a Cochrane review of 3 randomized clinical trials comparing preoperative hair-removal techniques, shaving was associated with an increased risk of SSI, compared with clipping (RR, 2.09; 95% CI, 1.15–3.80).¹⁵ Shaving is thought to result in microscopic skin abrasions that can serve as foci for bacterial growth.

Interestingly, in this same Cochrane review, a separate analysis of 6 studies failed to show a benefit of preoperative hair removal by any means, compared with no hair removal,¹⁵ suggesting that routine hair removal may not be indicated for all patients.

6 Use chlorhexidine-alcohol for skin prep

Prepare the skin with chlorhexidine-alcohol immediately before surgery

Darouiche RO, Wall MJ Jr, Itani KM, et al. Chlorhexidine-alcohol versus povidone-iodine for surgical-site antisepsis. N Engl J Med. 2010;362(1):18–26.

Kunkle CM, Marchan J, Safadi S, Whitman S, Chmait RH. Chlorhexidine gluconate versus povidone iodine at cesarean delivery: a randomized controlled trial. J Matern Fetal Neonatal Med. 2014;18:1–5.

Data from a randomized multicenter trial of 849 patients showed that the use of a chlorhexidine-alcohol skin preparation immediately before surgery lowered the rate of SSI after clean-contaminated surgery, compared with povidone-iodine (RR, 0.59; 95% CI, 0.41–0.85).¹⁶ Studies focusing on cesarean delivery alone are limited, although 1 small randomized trial found that chlorhexidine treatment significantly reduced bacterial growth at 18 hours after cesarean, compared with povidone-iodine (RR, 0.23; 95% CI, 0.07–0.70).¹⁷

7 Consider an alcohol-based hand rub for preoperative antisepsis

Alcohol-based hand rubs may be more effective than conventional surgical scrub

Shen NJ, Pan SC, Sheng WH, et al. Comparative antimicrobial efficacy of alcohol-based hand rub and conventional surgical scrub in a medical center [published online ahead of print September 21, 2013]. J Microbiol Immunol Infect. pii:S1684-1182(13)00150-3.

Tanner J, Swarbrook S, Stuart J. Surgical hand antisepsis to reduce surgical site infection. Cochrane Database Syst Rev. 2008;1:CD004288.

Several agents are available for preoperative surgical hand antisepsis, including newer alcohol-based rubs and conventional aqueous scrubs that contain either chlorhexidine gluconate or povidone-iodine. In a prospective cohort study of 128 health care providers, use of an alcohol-based rub for surgical hand antisepsis was associated with a lower rate of positive bacterial culture (6.2%), compared with a chlorhexidine-based conventional scrub (47.6%; $P < .001$).¹⁸ However, if an aqueous-based scrub is the only option available for surgical hand antisepsis, a Cochrane review found that chlorhexidine gluconate scrubs were more effective than povidone-iodine scrubs in 3 trials, resulting



Shaving for hair removal was associated with an increased risk of surgical site infection, compared with clipping

in fewer colony-forming units of bacteria on the hands of the surgical team.¹⁹

8 Close the skin with subcuticular sutures

Use of subcuticular sutures for skin closure is associated with a lower risk of wound complications, compared with staples

Mackeen AD, Schuster M, Berghella V. Suture versus staples for skin closure after cesarean: a meta-analysis [published online ahead of print December 19, 2014]. Am J Obstet Gynecol. doi:10.1016/j.ajog.2014.12.020.

A meta-analysis of 12 randomized controlled trials including 3,112 women demonstrated that subcuticular closure is associated with a decreased risk of wound complications, compared with staple closure (RR, 0.49; 95% CI, 0.28–0.87). The reduced risk remained significant even when stratified by obesity. Both closure techniques were shown to be equivalent with regard to postoperative pain, cosmetic outcome, and patient satisfaction.²⁰

9 Close the subcutaneous tissue

Closure of the subcutaneous fat is associated with a decreased risk of wound disruption for women with a tissue thickness of more than 2 cm

Chelmow D, Rodriguez EJ, Sabatini MM. Suture closure of subcutaneous fat and wound disruption after cesarean delivery: a meta-analysis. Obstet Gynecol. 2004;103(5 pt 1):974–980.

Dahlke JD, Mendez-Figueroa H, Rouse DJ, Berghella V, Baxter JK, Chauhan SP. Evidence-based surgery for cesarean delivery: an updated systematic review. Am J Obstet Gynecol. 2013;209(4):294–306.

A meta-analysis of 5 randomized controlled trials demonstrated that suture closure of subcutaneous fat is associated with a 34% decrease in the risk of wound disruption in women with fat thickness greater than 2 cm (RR, 0.66; 95% CI, 0.48–0.91).²¹

A recent systematic review of evidence-based guidelines for surgical decisions during cesarean delivery also recommended this practice based on results of 9 published

studies.²² In this review, however, subcutaneous drain placement did not offer any additional benefit, regardless of tissue thickness.²²

10 Avoid unproven techniques

Several commonly performed techniques have not been associated with a decreased risk of SSI after cesarean delivery

Dahlke JD, Mendez-Figueroa H, Rouse DJ, Berghella V, Baxter JK, Chauhan SP. Evidence-based surgery for cesarean delivery: an updated systematic review. Am J Obstet Gynecol. 2013;209(4):294–306.

CORONIS Trial Collaborative Group. The CORONIS Trial. International study of caesarean section surgical techniques: a randomised fractional, factorial trial. BMC Pregnancy Childbirth. 2007;7:24. doi:10.1186/1471-2393-7-24.

Familiarity with the obstetric literature will help providers determine which interventions prevent SSI and which do not. Well-designed clinical studies have demonstrated no significant difference in the rate of post-cesarean infectious morbidity with the administration of high concentrations of perioperative oxygen,²² saline wound irrigation,²² placement of subcutaneous drains,²² blunt versus sharp abdominal entry,²³ and exteriorization of the uterus for repair.²³ ❌

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Subcuticular closure is associated with a decreased risk of wound complications, compared with staple closure

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