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Infection Prevention and Evaluation of Fever After Laparoscopic Hysterectomy

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ABSTRACT

Background: Surgical site infection (SSI) is a common complication of hysterectomy. Minimally invasive hysterectomy has lower infection rates than abdominal hysterectomy. The lower SSI rates reflect the role and benefit in infection control of having minimal incisions, rather than a large anterior abdominal wall incision. Despite the lower rates, SSI after laparoscopic hysterectomy is not uncommon. In this article, we review pre-, intra-, and postoperative risk factors for infection. Rates of postoperative fever after laparoscopic hysterectomy and when evaluation for infection is warranted in a febrile patient are also reviewed.

Database: PubMed was searched for English-only articles using National Library of Medicine Medical Subject Headings (MESH) terms and keywords including but not limited to "postoperative," "surgical site," "infection," "fever," "laparoscopic," "laparoscopy," and "hysterectomy."

Conclusions: Reducing hospital-acquired infections such as SSI is one of the more effective ways of improving patient safety. Knowledge and understanding of risk factors for infection following laparoscopic hysterectomy enable the gynecologic surgeon or hospital to implement targeted preventive measures.

Key Words: Postoperative Fever, Hysterectomy, Surgical wound infection.

INTRODUCTION

The rate of surgical site infection (SSI) after abdominal hysterectomy is higher than after laparoscopic hysterectomy (4% vs 2%).[1] When SSI rates were compared based on abdominal access route in a cross-sectional study, cellulitis after total abdominal hysterectomy (TAH) was 2.6%, compared with 0.6% in total vaginal hysterectomy (TVH) and total laparoscopic hysterectomy (TLH). The deep/organ-space infection rate was 1.2% in TAH, 1.0% in TVH, and 0.5% in TLH.[2] These lower rates reflect the benefit of anterior abdominal wall punctures instead of larger anterior abdominal wall incisions.

Even though the rate of SSI is low for minimally invasive hysterectomy, there may still be room for improvement. The infection rates after laparoscopic hysterectomy were reported to be as high as 9% in one series of more than 10,000 cases, despite the advances in aseptic technique, antibiotic prophylaxis, and technology—hence, the need to discuss preventive methods and strategies.[3] Healthcare initiatives sponsored by the Centers for Medicare and Medicaid Services (CMS) and the Joint Commission target preventable hospital-acquired infections including SSI as one of the most effective ways of improving patient safety. Reducing the rate of SSI after laparoscopic hysterectomy is an important goal of the gynecologic surgeon, given that laparoscopic hysterectomy is widely used. Weight-based dosing with antimicrobial prophylaxis (AMP) is one of the positive steps that reduce SSI.[4] To prevent posthysterectomy infections, surgeons must understand the pre-, intra-, and postoperative risk factors. Knowledge and understanding of these risk factors enables the gynecologic surgeon or hospital to implement preventive measures.

In this article, we briefly review the pathogenesis of surgical site infections in laparoscopic hysterectomy and discuss prevention of postoperative infection by minimizing risks before, during, and after surgery. We focus on both general operative principles, when applicable, and those specific to gynecologic surgeons. We also review rates of postoperative fever after laparoscopic hysterectomy and when evaluation for infection is warranted in a febrile post-operative patient.

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METHODS

To begin this review of best practices to prevent infection after laparoscopic hysterectomy, we searched PubMed for English-only articles using various National Library of Medicine Medical Subject Headings (MESH) terms and keywords including but not limited to "postoperative," "surgical site," "infection," "fever," "laparoscopic," "laparoscopy," and "hysterectomy." Articles under each search attempt were reviewed and included if relevant. When the literature did not provide articles with specific recommendations for the prevention of infection after TLH, the search terms were broadened, and recommendations were extrapolated from articles and data on postoperative infection that included other laparoscopic or open surgical cases, including TAH.

PATHOGENESIS OF SURGICAL SITE INFECTIONS

The skin, muscle, and abdominal tissue are exposed to endogenous flora when the integrity of the skin is breached in surgery, and the same exposure occurs when the vagina is opened. The source of pathogens for trocar-related infection is predominantly aerobic Gram-positive cocci originating from the endogenous flora of the patient's skin. Frequently encountered organisms in abdominal incisions are *Staphylococcus aureus*, coagulase-negative *Staphylococcus* spp., *Enterococcus* spp., and *Escherichia coli*.[5] However, hysterectomies are unique from other abdominal and gynecologic procedures, in that potential pathogenic microorganisms may ascend from the breached vagina and endocervix to the operative site, in addition to the microorganisms from the skin. Vaginal flora is a complex and dynamic mix of facultative and obligate anaerobic Gram-positive and -negative species. Therefore, gynecologic SSIs are usually polymicrobial.[6,7]

Infection often results in the setting of ineffective host defense mechanisms, insufficient AMP, and a high bacterial inoculum.[8] Both systemic and local host immune mechanisms function to contain inoculated bacteria and prevent infection, and adequate antimicrobials in the tissue augment natural host immunity. The risk of infection increases as concentrations and virulence of contaminating bacteria increase. Quantitatively, it has been shown that the infection rate is markedly higher if the operative site is contaminated with $>10^5$ microorganisms per gram of tissue. However, in the presence of foreign bodies, such as suture material or mesh, the required inoculum decreases to 10^3 microorganisms per gram of tissue.[9–11]

RISK FACTORS FOR POSTOPERATIVE INFECTION

Preoperative Factors

The increase in SSIs has been associated directly and indirectly with certain characteristics of patients. Uncontrolled diabetes, tobacco use, prolonged steroid use, prolonged hospital stay, and coincidental infections are risk factors for SSI.[12] Most of these host factors can be modified in nonemergent cases.[2,12,13] Blood glucose levels should be controlled in diabetic patients.[1] Increased glucose levels (>140 mg/dL) in the immediate pre- and postoperative periods (≤48 h) have been implicated in increased risk of postoperative infection; therefore, diabetes should be controlled when possible.[12–14]

Smoking cessation should always be encouraged. Patients should be asked to stop smoking at least 30 days before an elective surgery.[15] A prolonged hospital stay before surgery should be discouraged, as it may lead to acquisition of nosocomial infection, thereby increasing the risk of SSI.[12,16] When possible, all infections should be identified and treated appropriately before surgery, especially in nonemergent cases. Attention should be paid to urinary tract infection and upper and lower respiratory tract infections, which, if not treated, may be inappropriately classified as a postoperative infection.

S. *aureus*, a frequent isolate of an SSI, is carried in the nares of ~20–30% of healthy humans.[17] An association between nasal carriage of *S. aureus* and postoperative infection has been documented. In a nongynecologic study, preoperative application of mupirocin to the nares decreased the risk of SSI.[18] Although preoperative screening for methicillin resistant *S. aureus* (MRSA) is not recommended, a systemic review and meta-analysis showed that decolonized MRSA carriers who were administered an anti-MRSA prophylactic antibiotic were significantly protected (against Gram-positive SSI).[18] Therefore, surgeons are encouraged to consider adding an anti-MRSA antibiotic such as vancomycin to the routine AMP given to patients with a documented (even remote) history of MRSA colonization or infection.

Bacterial vaginosis (BV) has also been linked to SSI. Researchers have advocated routine presurgical screening for BV in patients who undergo hysterectomy or other surgery involving the vagina.[8,19] Preoperative screening is prudent because, if diagnosis is made, adequate therapy involves 7 days of antibiotics including oral or intravaginal clindamycin or metronidazole. Patients who are not

treated before surgery should receive perioperative treatment. One study demonstrated that it is also cost effective to add metronidazole to cefazolin for AMP, because BV may recur or patients may not take their medication.[20] Surgeons are encouraged to perform preoperative screening for BV and treat with metronidazole or add it to the AMP if results are positive.

Table 1.
Recommended Agents for Antimicrobial Prophylaxis in Hysterectomy

Recommended Agents	Alternative Agents in Patients With β-Lactam Allergy
Cefazolin	Clindamycin or vancomycin
OR	PLUS
Cefotetan	Gentamicin or aztreonam or fluoroquinolone[a,b]
OR	OR
Cefoxitin	Metronidazole
OR	PLUS
Ampicillin-sulbactam[b]	aminoglycoside or fluoroquinolone

Adapted from Bratzler DW, Dellinger EP, Olsen KM, et al. Clinical practice guidelines for antimicrobial prophylaxis in surgery. *Am J Health Syst Pharm*. 2013;70:195–283 and ACOG Practice Bulletin No.104. *Obstet Gynecol*. 2009113:1180–1189. The alternative drugs for cefotetan also apply to cefoxitin and ampicillin-sulbactam.

[a]Ciprofloxacin or levofloxacin; fluoroquinolones are associated with an increased risk of tendonitis and tendon rupture in all ages. However, this risk would be expected to be small with single-dose AMP.

[b]Because of the increasing resistance of *E. coli* to fluoroquinolones and ampicillin-sulbactam, local population susceptibility profiles should be reviewed before use.

Preincision Factors

Preoperative showers with chlorhexidine have been shown in some nongynecologic studies to reduced the rate of SSI.[21] However, a *Cochrane Review* did not find adequate evidence to recommend routine use.[22] Chlorhexidine washes reduce the skin's microbial colony counts and may decrease the risk of SSI in some patients. Given the lack of conclusive evidence, it is reasonable for surgeons to offer preoperative showers using chlorhexidine soaps or impregnated sponges for elective surgical cases as a simple step that patients can take on their own to reduce microbial counts before an operation and therefore decrease the possibility of an SSI.

The use of chlorhexidine-alcohol for surgical site skin preparation is not a new concept. It is widely accepted and used and has been shown to be superior to povidone-iodine.[23,24] A solution of chlorhexidine gluconate with low or no alcohol (eg, 4% chlorhexidine scrub) is a safe and effective alternative for preparation of the vagina and is a good alternative for patients with iodine allergy.[25,26] A randomized controlled trial comparing the efficacy of povidone-iodine and chlorhexidine for vaginal hysterectomy found chlorhexidine to be more effective in decreasing bacterial colony counts in the vaginal operative field.[26] Surgeons should consider the 4% chlorhexidine scrub without alcohol when prepping the vagina for laparoscopic hysterectomy.

Preoperative shaving of the surgical site has been associated with a higher risk of SSI.[12] The acceptable methods are removal with electric clippers or depilatory or no removal. Patient should be discouraged from shaving with a razor immediately before surgery, and hair should only be removed if it affects the surgical site.[27]

AMP reduces the risk of SSI and leads to a reduction in hospital stay.[4,28] It should be safe, inexpensive, and effective against most microorganisms commonly encountered during surgery and should be given in a timely fashion that will achieve adequate tissue and serum levels before the skin and vagina are breached in surgery. The agents should be maintained at therapeutic levels in serum and tissue throughout the procedure.[4] Cephalosporins are commonly used in the United States. They are effective against Gram-positive and -negative microorganisms. Cefazolin is the most commonly used AMP in the United States. AMP should be administered at least 30 minutes before the procedure (30–60 minutes is acceptable), to allow antibiotics to reach the operative site. Studies of intraoperative concentrations of cefazolin in various tissue samples suggest that the tissue concentration is inversely proportional to the patient's body mass index (BMI) and dose should therefore be according to weight.[28]

There have been recent changes in AMP guidelines for hysterectomy. For example, 2 g cefazolin is recommended for patients weighing up to 120 kg and 3 g for patients weighing more than 120 kg.[4] Redosing is recommended based on approximately 2 times the drug's half-life (ie, cefazolin should be redosed 4 hours from the first dose). Patients should also be redosed with antimicrobials if there is increased blood loss (>1500 mL).[4] Recommended agents for AMP for laparoscopic hysterectomy, doses, and redosing intervals are listed in **Tables 1** and **2**.

Table 2.
Recommended Doses and Redosing Intervals for Commonly Used Antimicrobials for Surgical Prophylaxis for Laparoscopic Hysterectomy[a]

Antimicrobial	Recommended Dose	Half-life (hours)	Recommended Redosing Interval (hours)[b]
Ampicillin-sulbactam	3 g (ampicillin 2g/sulbactam 1 g)	0.8–1.3	2
Aztreonam	2 g	1.3–2.4	4
Cefazolin	2 g, 3 g for patients weighing ≥120 kg	1.2–2.2	4
Cefuroxime	1.5 g	1.0–2.0	4
Cefoxitin	2 g	0.7–1.1	2
Cefotetan	2 g	2.8–4.6	6
Ciprofloxacin	400 mg	3.0–7.0	NA
Clindamycin	900 mg	2.0–4.0	6
Gentamicin	5 mg/kg based on body weight (single dose)[c]	2.0–3.0	NA
Levofloxacin	500 mg	6.0–8.0	NA
Metronidazole	500 mg	6.0–8.0	NA
Vancomycin	15 mg/kg	4.0–8.0	NA

Adapted from: Bratzler DW, Dellinger EP, Olsen KM, et al. Clinical practice guidelines for antimicrobial prophylaxis in surgery. *Am J Health Syst Pharm*. 2013;70:195–283.

[a]Initial doseand redosing interval for adult patients with normal renal function.

[b]Redosing in the operating room is recommended at an interval of approximately two times the half-life of the agent in patients with normal renal function. Recommended redosing intervals marked as not applicable (NA) are based on typical case length; for unusually long procedures, redosing may be needed.

[c]In general, gentamicin for surgical antibiotic prophylaxis should be limited to a single dose given before the operation. The doses is based on the patient's actual body weight. If the patient's actual weight is more than 20% above ideal body weight (IBW), the dosing weight (DW) can be determined as follows: DW = IBW + 0.4 (actual weight − IBW).

Intraoperative Factors

During laparoscopic hysterectomy, there are many surgical and aseptic techniques that should be applied to prevent SSI. A randomized prospective trial suggests that direct trocar insertion or an open entry technique may confer a lower postoperative infection rate than entry with the Veress needle. Single-port laparoscopic hysterectomy has been reported to have a lower infection rate than traditional 4-port procedures.[30] Robot-assisted hysterectomy does not to confer an advantage over the conventional laparoscopic approach, from a postoperative infection standpoint. However, a robotic approach should be considered and used before laparotomy is performed, as laparotomy is associated with higher infection rates.[2,3,31,32]

Although the rate of SSI is lower in minimally invasive hysterectomy than in abdominal hysterectomy, a comparison of SSIs after laparoscopic supracervical hysterectomy (LSH), TLH, laparoscopic-assisted vaginal hysterectomy (LAVH), and TVH showed rates of cellulitis after use of these minimally invasive routes to be 1.3, 0.6, 0.8, and 0.6%, respectively, and deep/organ-space infection rates to be 0.7, 0.5, 1.5, and 1.0% respectively.[2] TLH had the lowest combined rate of cellulitis and deep/organ-space infections. Of note, no statistical analysis of the minimally invasive hysterectomy subgroups was performed. Therefore, it is unclear whether these differences should play a role in determining which technique is used or whether there is more than 1 appropriate option.

Excellent surgical technique is important in the prevention of SSI. Maintaining hemostasis, gentle handling of tissue, removing devitalized tissues, eradicating dead space hematoma or seromas, and preventing hypothermia are all important intraoperative steps in preventing infection.[12] Appropriate and judicious use of irrigation and hemostatic agents, such as oxidized regenerated cellulose (Surgicel Fibrillar Absorbable Hemostat; Ethicon, Somerville, New Jersey), is also advocated. However, hemostatic agents, if overused, can serve as a nidus for infection.[11]

Postsurgical Care

Preventing infections in the postoperative period includes removal of the urinary catheter when it is no longer needed.[33] Early removal of the catheter after completion of the procedure or after 6 hours appears to be advantageous over removal 24 hours after hysterectomy.[34] For patients who remain in the hospital overnight, early ambulation and use of incentive spirometry should be encouraged for the prevention of postoperative pulmonary infection.[35] Anemia and blood transfusion are associated with SSI. Optimizing hemoglobin before surgery, when possible, and judicious use of postoperative blood transfusion are advocated.[2,36]

EVALUATION OF POSTOPERATIVE FEVER

It is important to state at the end of this review article that some patients will still have a postoperative infection or a fever, despite optimal patient care. It is important to recognize and treat SSIs, but not all fevers are evidence of postoperative infection. Fever is a response to endogenous and exogenous pyrogens. Endogenous pyrogens, which are released during surgery, stimulate the release of prostaglandins that elevate the thermoregulatory set point of the body.[37] Exogenous pyrogens are usually from microorganisms or their byproducts. Their potential to cause fever is therefore important to remember when called to evaluate a patient with postoperative fever.[38]

As is true of infection, laparoscopic hysterectomy has lower rates of postoperative fever when compared to surgery by open routes.[39,40] The rate of postoperative fever after laparoscopic hysterectomy varies widely by institution, between 0 and 15% of patients. However, only a small fraction are attributable to infection.[41–47] In general, it is likely to be more cost effective to observe patients with fever within the first 24–48 hours after hysterectomy, rather than to treat immediately.[48–49]

Patients with persistent fever ≥38.3°C (101°F) at 24 hours after surgery, 2 temperature readings of ≥38.0°C (100.4°F) taken at least 4–6 hours apart after 24 hours, or at high risk for infection based on their medical history (eg, diabetic or immunocompromised patients) and surgical history (surgery lasting >2 hours and American Society of Anesthesiologist [ASA] Clinical Status Classification >3) should undergo a thorough history and physical examination.

Patients with early postoperative fevers should be evaluated by using the 5 W's mnemonic (wind, water, wound, walking, and wonder drug)[50] to identify the focus of infection. Investigation (blood work and imaging studies) of fever should be focused and based on the surgeon's evaluation. Most routine investigations are low yield if obtained without a focused evaluation to determine the cause of fever.[38] Administration of empiric antibiotics or extending the AMP should be discouraged if there is no evidence of infection, especially in the first 24–48 hours after completion of surgery.

For those patients in whom workup for fever is indicated, the differential diagnosis of infection-related fever after gynecologic surgery may include cellulitis, necrotizing fasciitis, superficial abscess, deep abscess, urinary tract infection, and pelvic thrombophlebitis. Non-SSIs often related to operative management, such as pneumonia, should also be considered. Recommendations for evaluation and treatment of these conditions have been discussed elsewhere in the literature in great detail.[51,52]

SUMMARY AND RECOMMENDATIONS

1. SSI after laparoscopic hysterectomy is rare, but is potentially preventable with careful evaluation and management of patient risk factors.
2. Preoperative skin preparation with chlorhexidine-alcohol will decrease the risk of superficial SSI.
3. AMP dose should be weight based (ie, cefazolin < 120 kg = 2 g; >120 kg = 3 g).
4. Add an anti-MRSA antibiotic (eg, vancomycin) to the AMP for women with a history of MRSA.
5. Screen for BV and add metronidazole to cefazolin for AMP if the patient has a history of BV.
6. Fevers within the first 24–48 hours after hysterectomy are usually observed. Patients with persistent fever ≥38.3°C (101°F), 2 temperature readings of ≥38.0°C (100.4°F) taken at least 4–6 hours apart, or at high risk of infection based on medical history should undergo a thorough history and physical examination. Investigation of fever should be focused and based on the surgeon's evaluation.

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