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Major Article

Incidence and risk factors for surgical site infection post-hysterectomy in a tertiary care center



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Key Words:

Post-surgical infection
Predictors

Background: Preoperative antibiotic prophylaxis and surgical technological advances have greatly reduced, but not totally eliminated surgical site infection (SSI) posthysterectomy. We aimed to identify risk factors for SSI posthysterectomy among women with a high prevalence of gynecologic malignancies, in a tertiary care setting where compliance with the Joint Commission's Surgical Care Improvement Project core measures is excellent.

Methods: The study was a matched case-control, 2 controls per case, matched on date of surgery. Study time was January 2, 2012-December 31, 2015. Procedures included abdominal and vaginal hysterectomies (open, laparoscopic, and robotic). SSI (superficial incisional or deep/organ/space) was defined as within 30 days postoperatively, per Centers for Disease Control and Prevention criteria. Statistical analysis included bivariate analysis and conditional logistic regression controlling for demographic and clinical variables, both patient-related and surgery-related, including detailed prophylactic antibiotic exposure.

Results: Of the total 1,531 hysterectomies performed, we identified 52 SSIs (3%), with 60% being deep incisional or organ/space infections. All case patients received appropriate preoperative antibiotics (timing, choice, and weight-based dosing). Bivariate analysis showed that higher median weight, higher median Charlson comorbidity index, immune suppressed state, American Society of Anesthesiologists score ≥ 3 , prior surgery within 60 days, clindamycin/gentamicin prophylaxis, surgery involving the omentum or gastrointestinal tract, longer surgery duration, ≥ 4 surgeons present in the operating room, higher median blood loss, ≥ 7 catheters or invasive devices in the operating room, and higher median length of hospital stay increased SSI risk ($P < .05$ for all). Cefazolin preoperative prophylaxis, robot-assisted surgery, and laparoscopic surgery were protective ($P < .05$ for all). Duration of surgery was the only independent risk factor for SSI identified on multivariate analysis (odds ratio, 3.45; 95% confidence interval, 1.21-9.76; $P = .02$).

Conclusions: In our population of women with multimorbidity and hysterectomies largely due to underlying gynecologic malignancies, duration of surgery, presumed a marker of surgical complexity, is a significant SSI risk factor. The choice of preoperative antibiotic did not alter SSI risk in our study.

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Surgical site infections (SSIs) are the most frequent health-care associated infections,¹ and are associated with significant morbidity, prolonged hospital stays, and increased health-care costs.²⁻⁴

Hysterectomy is a common major surgery in the United States; up to 4% of the approximately 433,000 hysterectomies performed annually may be complicated by SSI.⁵

Preventing SSI posthysterectomy is a major focus for quality improvement across the hospital setting. Posthysterectomy SSI is a metric tied to hospitals' ranking and financial penalties because it is included in the Centers for Medicare and Medicaid Services calculations for the Hospital-Acquired Condition Reduction Program. Most institutions have taken considerable steps toward SSI prevention. Compliance with the Joint Commission's Surgical Care

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Improvement Project core measures, with particular attention to preoperative antibiotic choice and timing, is high.⁶ Despite these efforts, SSIs are not eliminated, and, in fact, the SSI reduction seems to be more modest than hoped.⁷⁻⁹ Patients undergoing hysterectomies as part of complex surgical and medical treatments for advanced gynecologic malignancies, for example, might pose additional challenges. In this context, we aimed to study a population of women undergoing hysterectomies at a large, university-affiliated tertiary care center in an effort to identify additional, potentially modifiable SSI risk factors.

METHODS

Study design and population

We performed a matched case-control study of women aged ≥ 18 years undergoing hysterectomy (abdominal, vaginal, laparoscopic, or robotic-assisted) at University of Wisconsin Hospitals between January 1, 2012, and December 31, 2015. The study was conducted as part of a larger quality improvement initiative aimed at reducing posthysterectomy SSI, and thus met criteria for exempt status by the University of Wisconsin Institutional Review Board.

Definitions

Cases were defined as women diagnosed with SSI within 30 days posthysterectomy, and were identified through the hospital's active surveillance system for nosocomial infections. For each case, 2 controls were chosen from women undergoing hysterectomy on the same day, or chronologically as close as possible to the same day of surgery as the cases, who did not develop SSI. For days with more than 3 hysterectomies per day, procedures were chosen randomly from various times of the day. We defined SSI within 30 days of surgery as superficial, deep, or organ space infections according to the Centers for Disease Control and Prevention criteria.¹⁰

Data collection

We collected demographic and clinical variables, both patient-related and surgery-related, including detailed information on timing, choice, and weight-based dosing and/or redosing of preoperative antibiotics. Our institution follows Infectious Disease Society of America guidelines for weight-based dosing and intraoperative interval redosing of preoperative antimicrobial agents.¹¹

Statistical analysis

For bivariate analyses, we used the χ^2 test for categorical variables, the Student *t* test for continuous variables, and the Wilcoxon and Mann-Whitney tests for nonparametric distributions. To identify independent risk factors for posthysterectomy SSI, we included variables found to be statistically significant on crude analysis ($P \leq .05$) into a conditional logistic regression model. All analyses were performed using Stata version 14.1 SE for Windows (StataCorp, College Station, TX).

RESULTS

Among the 1,531 hysterectomies performed during the study period, a total of 52 (3.4%) were complicated by an SSI. Of these, 31 (60%) were classified as deep incisional or organ/space infection. The majority (40%) were polymicrobial, with mixed aerobic and anaerobic flora, followed by infection with gram-negative bacilli (14%). Table 1 presents SSI details related to type of surgery and organisms recovered in clinical cultures.

Table 1

Surgical site infections (SSIs) by type of surgery and organisms recovered in clinical cultures

Type of surgery	n (%)	SSI incidence n (%)
Open abdominal [†]	67 (43)	34 (65)
Robot-assisted	9 (13)	
Laparoscopic	87 (56)	17 (33)
Robot-assisted	46 (53)	
Vaginal	2 (1)	1 (2)
Total	156 (100)	52 (100)
SSI organisms recovered		
Mixed aerobes and anaerobes		21 (40)
<i>Escherichia coli</i>		6 (12)
Coagulase negative <i>staphylococcus</i>		4 (8)
Methicillin-resistant <i>Staphylococcus aureus</i>		3 (5)
Anaerobes		2 (4)
<i>Streptococcus agalactiae</i>		1 (2)
<i>Pseudomonas</i> spp		1 (2)
No organism recovered [‡]		14 (27)
Total		52 (100)

[†]Includes 3 laparoscopic and 2 robot-assisted surgeries converted to open abdominal hysterectomies.

[‡]Cultures not obtained, or showed no growth, likely due to previous receipt of broad-spectrum antibiotics.

All patients (cases and controls) received antimicrobial prophylaxis within 60 minutes of incision. The most common antibiotics received were cefazolin (49%), ceftiofloxacin (30%), and clindamycin plus gentamicin (17%). All preoperative antibiotics were appropriately dosed according to the patient's weight, although the opportunity for intraoperative redosing was missed in 25 of the 68 patients (37%) where this would have been appropriate. There was no significant difference between cases and controls in regard to missed antibiotic intraoperative redosing opportunities.

Demographic and clinical variables, both patient-related and surgery-related, that were significantly associated with posthysterectomy SSI on bivariate analysis are presented in Table 2. On multivariate analysis, duration of surgery was the only independent risk factor associated with posthysterectomy SSI in our study (odds ratio, 3.5; 95% confidence interval, 1.2-9.8; $P = .02$) (Table 3). Duration of surgery was significantly higher in patients undergoing hysterectomy due to underlying malignancy ($P = .0136$), in surgical procedures involving the bowel ($P < .001$), in procedures requiring ≥ 4 surgeons ($P < .001$), and in patients requiring placement of ≥ 7 invasive devices intraoperatively. Laparoscopic surgeries were associated with a shorter duration of surgery ($P < .001$).

DISCUSSION

We found that surgical duration was the only independent factor associated with SSI in our study. Data exploring the association between hysterectomy duration and postoperative infection risk are sparse, with 1 previous retrospective, multicenter study finding a marginal association.¹² However, duration of surgery is a well-recognized risk factor for SSI, and is in fact included in the National Nosocomial Infection Surveillance risk index, which is widely used to stratify SSI surveillance data by risk¹³ and for benchmark comparisons of SSI rates.¹⁴ Previous studies of surgeries other than hysterectomies have also identified duration of surgery as an important risk factor for SSI.¹⁵⁻¹⁷ Laparoscopic surgeries in our study had a shorter duration, and were associated with less SSI risk on bivariate analysis. Although this association was not maintained in our multivariate analysis, previous retrospective studies for patients undergoing hysterectomies have found robot-assisted and laparoscopic surgeries to have significantly lower SSI risks than open abdominal approaches.^{18,19}

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