CONCISE COMMUNICATION

Statewide Collaboration to Evaluate the Effects of Blood Loss and Transfusion on Surgical Site Infection after Hysterectomy

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We used mandatory public reporting as an impetus to perform a statewide study to define risk factors for surgical site infection. Among women who underwent abdominal hysterectomy, blood transfusion was a significant risk factor for surgical site infection in patients who experienced blood loss of less than 500 mL.

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Healthcare-associated infections (HAIs) are among the top 10 leading causes of death in the United States according to the Centers for Disease Control and Prevention (CDC). Surgical site infections (SSIs) account for 17% of all HAIs.[1] Estimates from 2001 suggest that approximately 290,000 SSIs occur annually, and 8,000 patient deaths are associated with these infections.[2]

Few evidence-based measures are known to decrease SSI rates. In a pilot study at our institution, SSI after abdominal hysterectomy was associated with estimated blood loss (EBL) greater than or equal to 500 mL and blood transfusion.[3] In addition to our study, one other study has linked blood transfusion to increased risk of SSI after hysterectomy.[4]

The goal of this study was to determine whether the relationships between EBL, blood transfusion, and SSI after abdominal hysterectomy found in our pilot study are generalizable to a more diverse patient population.

METHODS

This is a retrospective cohort analysis of patients who underwent abdominal hysterectomy in Colorado from August 1, 2009, through July 31, 2010. The Colorado Hospital Association (CHA) provided a list of the 86 hospitals in Colorado. Each hospital was contacted to determine whether their physicians performed abdominal hysterectomy. Exclusion criteria were hospitals that reported either via telephone or e-mail that no one at their facility performed abdominal hysterectomy. The primary outcome was diagnosis of SSI after abdominal hysterectomy, using CDC criteria.[2] The Colorado Multiple Institutional Review Board (IRB) approved this study, and all participating hospitals granted permission through either an IRB or ethics committee. If a hospital did not have an IRB or ethics committee, Colorado Multiple IRB served as the overseeing review board.

The CDC defines SSI as infection occurring at the surgical site within 30 days of an operation or within 1 year if a foreign body is implanted. There are 3 classifications of SSI: superficial incisional, deep incisional, and organ/space. Superficial incisional SSIs involve skin and subcutaneous tissue of the incision and have (1) purulent drainage; (2) organisms isolated from a culture of fluid or tissue; (3) a diagnosis of superficial incisional SSI by the surgeon or attending physician; or (4) pain, swelling, redness, or heat in a wound that is opened by a surgeon and is culture positive or not cultured. Deep incisional SSIs involve fascia and/or muscle layers of the incision and have (1) purulent drainage; (2) an abscess; (3) a diagnosis of deep incisional SSI by the surgeon or attending physician; or (4) pain, swelling, redness, or heat in a wound that either dehisces spontaneously or is opened by a surgeon and is culture positive or not cultured. Organ/space SSIs are infections that involve any other part of the body that is manipulated during an operation. In addition, they have (1) purulent drainage from a drain into the organ or space, (2) organisms isolated from a culture of fluid or tissue, (3) an abscess, or (4) the diagnosis of an organ/space SSI by the surgeon or attending physician.[2]

An electronic survey was sent to infection control practitioners at hospitals that met inclusion criteria. The survey requested a deidentified line listing of sequential patients who underwent abdominal hysterectomy for 1, 3, 6, 9, or 12 months from August 1, 2009, through July 31, 2010. Age, body mass index (BMI, calculated as weight in kilograms divided by the square of height in meters), preoperative hematocrit, choice and timing of perioperative antibiotics, EBL, presence of blood transfusion in the 2 weeks before or after abdominal hysterectomy, and presence or absence of SSI were entered by infection control practitioners. If SSI was present, the survey requested the SSI classification, description of the SSI characteristics, and microbiology results. Additional information was gathered regarding the hospital size, community setting, and methods of surveillance after hospital discharge. The name and address of the reporting infection control practitioner were collected for the purpose of providing a stipend for participation.

Data were collected on a secure, password-protected Web site designed and maintained by the CHA. Categorical and continuous variables were investigated using 2-sided Fisher's exact and Wilcoxon rank-sum tests, respectively. Tests were performed at the .05 significance level. After the bivariate analysis, unadjusted odds ratios (ORs) for the associations between risk factors and SSI were calculated using logistic regression. Data analysis was performed using SAS, version 9.2 (SAS Institute).

RESULTS

Fifty-one hospitals in Colorado reported that they performed abdominal hysterectomy, and 35 approved the IRB protocol. Six hospitals participated in the study, representing urban (2 hospitals), suburban (2 hospitals), and rural (2 hospitals) community settings. One site contributed sequential cases from 9 months, whereas the other 5 sites contributed sequential cases from 12 months. Participating hospitals ranged in size from less than 50 to greater than 400 licensed beds.

Five hundred sixty-seven patients underwent abdominal hysterectomy at the 6 hospitals; 20 patients were excluded because they experienced "emergent" surgeries. The mean age (± standard deviation [SD]) of the patients was 45.5 ± 9.4 years, and the mean BMI (± SD) was 29.8 ± 7.9. Thirty-eight patients (6.9%) had EBL greater than or equal to 500 mL, and 27 (4.9%) had a preoperative hematocrit less than 30 mg/dL. Over 95% of patients received perioperative antibiotics within the 60 minutes before surgical incision. Ten patients (1.8%) developed SSI: 4 developed superficial incisional SSIs, 4 developed deep incisional SSIs, and 2 developed organ/space SSIs.

SSI was not associated with age, obesity, preoperative hematocrit, or absence of perioperative antibiotics in the 60 minutes before surgical incision (Table 1). EBL greater than or equal to 500 mL and the presence of a blood transfusion both trended toward an association with SSI ($P = .15$ and $P = .13$, respectively). The use of cefotetan also trended toward an association with SSI.

Thirty-five patients (6.4%) received a blood transfusion. Blood transfusion was associated with EBL greater than or equal to 500 mL ($P < .0001$) and with preoperative hematocrit less than 30 mg/dL ($P = .020$). No patients with preoperative hematocrit less than 30 mg/dL developed SSI. The relationship between transfusion and SSI was examined with stratification by EBL and by preoperative hematocrit (Table 2). Blood transfusion contributed most to SSI in patients with EBL less than 500 mL (OR, 7.20; 95% confidence interval [CI], 1.37–37.72) and in patients with hematocrit greater than 30 mg/dL (OR, 4.28; 95% CI, 0.87–21.1).

TABLE 2. Unadjusted Odds Ratios (ORs) and 95% Confidence Intervals (CIs) for Developing Surgical Site Infection in the Presence or Absence of Blood Transfusion

Variable	OR (95% CI)
EBL <500 mL	
Blood transfusion	7.20 (1.37–37.72)
No blood transfusion	1.00 (Reference)
EBL ≥500 mL	
Blood transfusion	0.00 (0.00–8.64)
No blood transfusion	1.00 (Reference)
Preoperative hematocrit <30 mg/dL	
Blood transfusion	...[a]
No blood transfusion	1.00 (Reference)
Preoperative hematocrit ≥30 mg/dL	
Blood transfusion	4.28 (0.87–21.1)
No blood transfusion	1.00 (Reference)

NOTE. EBL, estimated blood loss.

[a] Not calculated. No patients with surgical site infection had preoperative hematocrit <30 mg/dL independent of transfusion status.

DISCUSSION

This study lends strength to the findings in our pilot study that higher amounts of EBL and blood transfusion are associated with SSI after abdominal hysterectomy. The SSI rate in this study was consistent with nationally published rates of SSI after abdominal hysterectomy (1%–4%).[5] The blood transfusion rate after abdominal hysterectomy is variable, with published estimates between 2.6% and 41%.[4,6] The rate

TABLE 1. Patient Characteristics

Variable	Total (n = 547)	SSI (n = 10)	No SSI (n = 537)	P
Age, mean years ± SD	45.5 ± 9.4	43.3 ± 7.1	45.5 ± 9.4	.40
Body mass index, mean value ± SD	29.8 ± 7.9	31.8 ± 8.1	29.8 ± 7.9	.39
Hematocrit, mean mg/dL ± SD	40.6 ± 4.5	40.3 ± 2.5	40.6 ± 4.5	.60
Estimated blood loss, mean mL ± SD	183.3 ± 238.6	239.5 ± 156.7	182.2 ± 239.8	.06
Blood transfusion	35 (6.4)	2 (20.0)	33 (6.1)	.13
Antibiotics within 60 min of surgical incision	404 (96.4)	8 (100.0)	396 (96.4)	1.00
Preoperative antibiotic prophylaxis				
Cefazolin	209 (38.2)	3 (30.0)	206 (38.3)	.75
Levofloxacin	95 (17.4)	2 (20.0)	93 (17.3)	.69
Cefotetan	58 (10.6)	3 (30.0)	55 (10.2)	.08
Clindamycin	29 (5.3)	1 (10.0)	28 (5.2)	.42
Other	17 (3.1)	1 (10.0)	16 (3.0)	.27

NOTE. Data are no. (%) of patients unless otherwise indicated. SD, standard deviation; SSI, surgical site infection.

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of blood transfusion in this study (6.4%) is within this range. Interestingly, we found that the relationship between blood transfusion and SSI was strongest in patients with EBL less than 500 mL or preoperative hematocrit greater than 30 mg/dL. This finding is also consistent with published literature. Recent large studies involving patients with acute coronary syndrome have shown that blood transfusion is associated with higher mortality if the nadir hematocrit is greater than 25 mg/dL.[7,8]

There is growing evidence that blood transfusion is a potent immunomodulator. It has been associated with increased risk of postoperative infection in cardiac, colorectal, and venous grafting surgeries.[9-12] The mechanism of this relationship is unclear; donor monocytes, leukocyte-derived soluble mediators, and soluble human leukocyte antigen proteins and peptides have been implicated in this phenomenon.[13] Longer shelf time of blood products has been associated with increased risk of infection, perhaps as a result of the accumulation of these factors over time.[14]

Limitations of this study include a low participation rate (11.8%) and our inability to provide interrater reliability; although participants entered the type of SSI, they did not uniformly enter criteria that were used for the diagnosis of SSI. In addition, surveillance methods after hospital discharge varied. Laboratory and microbiology studies, emergency department visits, and inpatient records were reviewed by all facilities. Four facilities relied heavily on SSI reporting by the surgeon. One facility, which had an integrated inpatient and outpatient electronic medical record, reviewed all healthcare encounters for 30 days after the surgical procedure.

Strengths of this study include the collaboration between hospitals and the CHA. The pilot study was done at a 397-bed urban public safety net hospital, whereas this study included hospitals of varying sizes and community settings. The pilot study was performed to investigate an unacceptably high rate of SSI at a single institution, whereas this study was not performed to investigate a localized problem. Thus, the results are generalizable to a wide range of patient populations.

The CHA is an organization that provides advocacy and leadership to all hospitals (public and private) in the state of Colorado; they coordinate educational collaboratives and help hospitals comply with public reporting mandates. Because the rates of SSI are publicly reported in Colorado, infection control practitioners have no reason to "hide" cases of SSI when providing data for this study. Therefore, it is likely that the SSI rates are neither overreported nor underreported in this study.

In conclusion, we confirm that higher amounts of EBL and blood transfusion are associated with SSI after abdominal hysterectomy in a multicenter study in Colorado. Public reporting requirements can be used to encourage nonacademic hospitals to participate in research; the information obtained from private facilities allows findings to be applicable to a wider population base. Organizations such as the CHA are indispensable resources to encourage hospital participation and complete multicenter studies.

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