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Risk Factors and Indications for 30-Day Readmission After Primary Surgery for Epithelial Ovarian Cancer

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Abstract

Background—To identify patients at risk for postoperative morbidities, we evaluated indications and factors associated with 30-day readmission after epithelial ovarian cancer surgery.

Methods—Patients undergoing primary surgery for epithelial ovarian cancer between January 2, 2003, and December 29, 2008, were evaluated. Univariable and multivariable logistic regression models were fit to identify factors associated with 30-day readmission. A parsimonious multivariable model was identified using backward and stepwise variable selection.

Results—In total, 324 (60.2%) patients were stage III and 91 (16.9%) were stage IV. Of all 538 eligible patients, 104 (19.3%) were readmitted within 30 days. Cytoreduction to no residual disease was achieved in 300 (55.8%) patients, and 167 (31.0%) had measurable disease (≤1 cm residual disease). The most common indications for readmission were surgical site infection (SSI; 21.2%), pleural effusion/ascites management (14.4%), and thromboembolic events (12.5%). Multivariate analysis identified American Society of Anesthesiologists score of 3 or higher (odds ratio, 1.85; 95% confidence interval, 1.18–2.89; $P = 0.007$), ascites [1.76 (1.11–2.81); $P = 0.02$], and postoperative complications during initial admission [grade 3–5 vs none, 2.47 (1.19–5.16); grade 1 vs none, 2.19 (0.98–4.85); grade 2 vs none, 1.28 (0.74–2.21); $P = 0.048$] to be independently associated with 30-day readmission (c-index = 0.625). Chronic obstructive pulmonary disease was the sole predictor of readmission for SSI (odds ratio, 3.92; 95% confidence interval, 1.07–4.33; $P = 0.04$).

Conclusions—Clinically significant risk factors for 30-day readmission include American Society of Anesthesiologists score of 3 or higher, ascites and postoperative complications at initial

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admission. The SSI and pleural effusions/ascites are common indications for readmission. Systems can be developed to predict patients needing outpatient management, improve care, and reduce costs.

Keywords

Readmission; Ovarian cancer; Primary cytoreduction

During the last 4 decades, the treatment of advanced epithelial ovarian cancer (EOC) has centered on aggressive surgical cytoreduction to minimal residual disease (RD) in addition to platinum-based adjuvant chemotherapy.[1] Along with an improvement in overall survival independent of disease stage that is incurred with aggressive surgical effort, women undergoing surgery for EOC are at increased risk of postoperative complications and perioperative morbidity.[2] Achieving a balance between maximal surgical effort and prevention of postoperative complications is a challenge faced by gynecologic oncologists caring for women with EOC.

Major surgical morbidity with in 30 days of surgery for EOC has been attributed to increased surgical complexity, poor nutritional status (as measured by preoperative albumin), and compromised performance status.[3] It has additionally been shown that a subgroup of patients with EOC can be identified to be most at risk of adverse surgical outcomes on the basis of their age (older than 75 years), poor nutritional or performance status, and high tumor dissemination (stage IV disease).[4] Despite advances made in understanding factors that elevate surgical risk and the widespread uptake of quality improvement initiatives, limited progress has been made in circumventing increased hospital costs of care that directly result from postoperative morbidity. Patient-centered outcomes of care are emerging as a metric within various surgical disciplines,[5] providing an opportunity to evaluate contributors to increased costs of care, one of which is the cost of hospital readmissions. In June 2009, the Centers for Medicare and Medicaid Services began acknowledging rates of 30-day readmission, thereby highlighting the importance of hospital readmission as an important quality metric.[6] Approximately 1 of 5 Medicare patients are expected to be readmitted within 30 days, and 72.6% of surgical readmissions are due to underlying comorbidities that require management.[7] In the effort to improve the quality of perioperative care for patients with complex surgery and preexisting comorbidities, we sought to evaluate the factors associated with 30-day readmissions after EOC surgery and investigate the indications for these readmissions. Identifications of such risk factors may also help with postoperative care planning or monitoring.

METHODS

Between January 1, 2003, and December 29, 2008, all patients who underwent primary debulking surgery or surgical staging for EOC (including primary peritoneal carcinoma, fallopian tube cancer) at Mayo Clinic, Rochester, were retrospectively evaluated. Patients with recurrent disease, nonepithelial histology, a prior surgical diagnosis of their cancer via laparoscopy or laparotomy, or receipt of neoadjuvant chemotherapy were excluded from this study. In addition, patients who declined consent to the use of their medical records for

research were excluded from the analyses. This study was approved by the Mayo Clinic Institutional Review Board.

The first readmission within 30 days after the date of dismissal from the hospital after primary EOC surgery was defined as the event of interest. Planned admissions for administration of chemotherapy were not considered to be a 30-day readmission event. Indications for readmission were assessed individually and a predominant indication for readmission was determined.

Factors associated with readmission were abstracted from a large surgical database developed using American College of Surgeons' National Surgical Quality Improvement Program–defined variables as previously described.[8] Patient-specific characteristics including age, body mass index, and medical comorbidities were assessed. Preoperative Eastern Cooperative Oncology Group performance status was assigned retrospectively based on information obtained from preoperative consultation notes.[9] Medical comorbidities included history of cardiac event (patients with a history of coronary artery disease, myocardial infarction, or other cardiac event), cardiovascular risk factors (hypertension, hyperlipidemia, or peripheral vascular disease), chronic obstructive pulmonary disease (COPD), diabetes, and other pulmonary disease (asthma, sleep apnea, or other pulmonary diagnoses excluding pleural effusion). Ascites was defined as fluid aspirated from the peritoneal cavity at the time of surgery of any volume. The volume of ascites was recorded. Preoperative laboratory values (hemoglobin, creatinine, albumin, and cancer antigen 125) were abstracted from patient charts. Surgical variables considered included surgical complexity scores (assigned based on an established protocol by Aletti et al[10]; 0–3 = low, 4–7= intermediate, and 8+ = high), RD (microscopic, measurable disease ≤1 cm, and >1 cm), estimated blood loss, operating time, and postoperative complications during initial hospitalization (by Accordion grade classification) (Table 1).[11]

Statistical Analysis

Statistical analyses were performed using the SAS version 9.2 software package (SAS Institute, Inc, Cary, NC). Standard descriptive statistics [mean SD)] were used for continuous variables and frequency and percentage for categorical variables. The first readmission within 30 days was defined as the event of interest. Univariable logistic regression models were fit to evaluate the association of clinical and pathologic characteristics, surgical variables, presence of postoperative complications during the initial hospitalization, and length of initial hospitalization with30-day readmission. Associations were summarized using the odds ratio (OR) and corresponding 95% confidence interval (CI) estimated from the models. Multivariable models were fit using stepwise and backward variable selection methods considering all variables with a *P* value of less than 0.20 based on univariable analysis. Variables with a *P* value of less than 0.05 were retained in the final model. An unbiased estimate of the overall predictive ability of the final multivariable model was derived using 300 bootstrap resamples.

The time to initiation of adjuvant chemotherapy was compared between patients with and without an unplanned 30-day readmission using the Wilcoxon rank sum test. The association

between 30-day readmission and cause-specific survival was evaluated based on fitting a Cox proportional hazards model.

RESULTS

Within our cohort of 587 patients with EOC undergoing primary surgical management, 12 (2.0%) patients were excluded due to death during their initial hospital stay, and 37 patients were excluded as they were lost to clinical follow-up after their initial hospitalization. Of the 538 eligible patients, the mean (SD) age at surgery was 63.1 (11.6) years and the mean (SD) body mass index was 28.1 (6.3) kg/m^2. Nearly 20% (104, 19.3%) had an unplanned readmission within 30 days of surgery. The median time from initial hospital dismissal to first readmission was 8 [interquartile range (IQR), 5–14] days and 13 patients had more than one readmission. Of the 104 readmitted patients, 9 patients underwent reoperation at the time of readmission.

Table 2 summarizes the clinical and pathologic characteristics that were evaluated for an association with 30-day readmission. Preoperative ascites was present in 298 (55.4%) patients, and it was significantly associated with 30-day readmission (OR, 1.96; 95% CI, 1.25–3.09; $P = 0.004$) based on univariable analysis. Among patients with ascites in which ascites volume at the time of surgery was recorded, the median volume of ascites was 2300 mL (IQR, 1000–4000) and 2000 mL (IQR, 775–4000), respectively, among the patients who did versus did not have a readmission within 30 days ($P = 0.39$).

Most of the patients had serous histology and stage III or IV disease (72.7% and 77.1%, respectively), with 16.9% of patients having stage IV disease. Eastern Cooperative Oncology Group performance status did not confer an increased odds of 30-day readmission, whereas American Society of Anesthesiologists (ASA) score of 3 or higher was significantly associated with 30-day readmission (OR, 1.94; 95% CI, 1.26–3.00; $P = 0.003$). Individual comorbidities [cardiovascular risk factors, deep vein thrombosis/pulmonary embolism (DVT/PE), diabetes, COPD, and other pulmonary disease] were not associated with 30-day readmission based on univariable analyses; however, having a history of cardiac event was associated with 30-day readmission on univariable analysis (OR, 2.12; 95% CI, 1.10–4.08; $P = 0.02$) (Table 2).

Surgical variables are illustrated in Table 3. Most patients (55.8%) had no evidence of RD, and 86.8% underwent optimal debulking (≤1 cm RD). Extent of RD was significantly associated with 30-day readmission on univariable analysis ($P = 0.02$), although surgical complexity score did not seem to be associated with 30-day readmission. Furthermore, performance of upper abdominal debulking procedures involving diaphragm, liver parenchyma, and/or spleen parenchyma did not influence the odds of 30-day readmission (OR, 1.30; 95% CI, 0.84–1.99; $P = 0.24$). However, operative time, receipt of perioperative packed red blood cell transfusion, estimated blood loss, and lowest intraoperative and final intraoperative body temperature were not significantly associated with an increased rate of unplanned 30-day readmission on univariable analysis.

Median length of stay during initial hospitalization for EOC surgery was 7 (IQR, 5–10) days and was significantly associated with 30-day readmission (OR, 1.04; 95% CI, 1.00–1.07 per day; $P = 0.04$). One in 10 patients had a grade 3 to 5 (severe) postoperative complication during the initial hospitalization. The presence of postoperative complications during the initial hospitalization significantly increased the odds of 30-day readmission in our cohort [OR, 3.03; 95% CI, 1.48–6.22 for grade 3–5 complications vs none; 2.20 (1.00–4.82) for grade 1 vs none; 1.57 (0.92–2.66) for grade 2 vs none; $P = 0.02$]. Of the 538 patients, 50 (9.3%) were discharged to a non-home location. It was notable that discharge disposition did not impact the odds of 30-day readmission; patients dismissed to non-home locations were just as likely as those who were dismissed to home to be readmitted (OR, 1.20; 95% CI, 0.59–2.43; $P = 0.62$.

On multivariable analysis, factors independently associated with 30-day readmission were ASA score of 3 or higher, presence of preoperative ascites, and the development of any postoperative complication during the initial hospital stay (c-index = 0.646; Table 4). It is notable that patients with ASA scores of 3 or higher were nearly twice as likely to be readmitted within 30 days as their counterparts with ASA scores of less than 3 (adjusted OR, 1.85; 95% CI, 1.18–2.89; $P = 0.007$). Furthermore, patients who developed grade 3 to 5 postoperative complications during initial hospitalization were twice as likely to be readmitted within 30 days than patients without postoperative complications during initial hospitalization (adjusted OR, 2.47; 95% CI, 1.19–5.16; $P = 0.02$). Ascites was independently predictive of 30-day readmission on multivariable analysis (adjusted OR, 1.76; 95% CI, 1.11–2.81, $P = 0.02$). An unbiased estimate of the overall predictive ability of the final multivariable model based on 300 bootstrap resamples was 0.625. Table 5 shows the predicted probabilities of readmission based on ASA score, ascites, and postoperative complications.

Figure 1 illustrates the distribution of the predominant admission indications. If more than one readmission within 30 days occurred, findings from the first 30-day readmission were considered. The most prevalent indication for readmission among all 104 readmitted patients was surgical site infection (SSI) (n = 22, 21.2%), where 12 patients were readmitted due to an organ/space SSI, and 10 patients had a superficial incisional SSI. Multivariable logistic regression analysis identified COPD as the sole predictor of SSI in our cohort (OR, 3.92; 95% CI, 1.07–14.33; $P = 0.04$). A total of 15 patients out of those readmitted within 30 days (14.4%) were readmitted for management of ascites (n = 7) or pleural effusion (n = 8), specifically to undergo therapeutic thoracentesis or paracentesis. The third most common indication for readmission was thromboembolic events (DVT/PE) (n = 13, 12.5% of patients readmitted), followed by dehydration, nausea and vomiting, and bowel obstruction or other bowel complication (9.6% each). The deviance residuals from the multivariable logistic regression model summarized in Table 4 were examined to identify any readmission indications that were poorly predicted by the model. Among the 104 patients with a readmission, the deviance residuals all ranged between 1.3 and 2.2 and the distribution was similar across the 5 most common categories of readmission indications, suggesting that there were no categories of readmissions that were fit more poorly by the model.

Importantly, 30-day readmission negatively impacted the time to initiation of adjuvant chemotherapy. Among the patients with a 30-day readmission, the median time to initiation of adjuvant chemotherapy was 35 days (IQR, 28–46) compared to 31 days (IQR, 27–39) for the patients without a 30-day readmission ($P = 0.03$). Furthermore, patients with a 30-day readmission were more likely to have poorer cause specific survival (hazard ratio, 1.64; 95% CI, 1.20–2.24; $P = 0.002$).

DISCUSSION

Hospital expenditures resulting from unplanned readmissions have become an issue of increasing public health importance. A considerable proportion of healthcare cost in gynecologic oncology is for EOC management—particularly elderly patients undergoing primary debulking surgery.[12] Patients with ovarian cancer are expected to have an elevated risk of perioperative and postoperative complications by virtue of the aggressive surgical efforts used to achieve improved disease outcomes as well as the propensity for EOC to be prevalent in older patients that inherently harbor elevated surgical risks.[2,13] Yet, despite the complex natural history of the disease as well as its affected population, a proportion of hospital readmissions may be preventable.

Our study indicates a 19% rate of unplanned hospital readmission within 30 days of surgery among patients undergoing primary cytoreduction. This is consistent with previously described rates in similar EOC populations in the United States of 13% to 16% as well as the national average of readmissions across all disciplines.[7,14,15] We noted that extent of RD and surgical complexity did not increase the odds of hospital readmissions within 30 days, which emphasizes that aggressive surgical effort in patients with advanced EOC is advantageous. Additionally, we observed that 30-day readmissions resulted in delays in initiation of chemotherapy as well as poorer cause-specific survival which further emphasizes the importance of this quality-care variable. Although the absolute difference in time to initiation of chemotherapy (35–31 days) is minimal, it is unclear whether there is a direct relationship between delay in time to chemotherapy and worse cause-specific survival in our cohort.

The most common indications for readmission were for management of SSIs (n = 12 organ/site infections and n = 10 superficial SSI, 21.2% overall), ascites or pleural effusion (n = 15, 14.4%), DVT/PE (n = 13, 12.5%), dehydration/nausea/vomiting (n = 10, 9.6%), and bowel obstruction or other bowel complication (n = 10, 9.6%). Although the inpatient setting may remain appropriate for management of some complications, outpatient alternatives and preventive measures may decrease cost and incidence of complications, such as readmissions for therapeutic paracentesis or thoracentesis (15 cases in our study).

Efforts that implement accelerated patient recovery programs that ultimately shorten the length of hospitalization may theoretically lead to higher readmission rates. In our study, although increased length of hospital stay was associated with 30-day readmission on univariable analysis, this factor did not seem to be independently predictive of 30-day readmission and may be a surrogate for complications incurred during the initial hospitalization. Furthermore, an enhanced recovery program at our institution was not found

to negatively impact rates of hospital readmission.[16] Therefore, measures that promote efficient surgical recovery seem to complement rather than hinder efforts that reduce hospital readmission rates.

Additionally, following prophylactic guidelines and protocols demonstrated to reduce postoperative morbidity could prevent a proportion of postoperative complications and decrease the overall cost of care by reducing readmissions. Risk-associated guidelines for venous thromboembolism (VTE) prophylaxis have been shown to significantly decrease VTE,[17,18] and it should be noted that our study presents data from a period during which dual prophylaxis with compression devices and heparin or extended outpatient heparin prophylaxis was not in practice as it is at the present time. However, the choice of VTE prophylaxis was relatively consistent in our study for each year included and patients were followed up for an extended duration of time.[19]

Additionally, superficial incisional SSI risk may be reducible in type II surgical cases. At the time of the study, prophylactic antibiotic use within 30 minutes of incision was standard practice. In addition, to prophylactic antibiotics, use of a “SSI reduction bundle” of preoperative, intraoperative, and postoperative measures to reduce bacterial contamination, ensure appropriate timing of perioperative antibacterial prophylaxis, and enhance patient education to promote proper hygiene and recognition of early SSI signs/symptoms has been reported in cases of bowel resection.[20] Quality improvement measures aimed at reducing SSI in gynecologic surgery have recently been instituted in our practice. In addition to efforts targeted on an institutional level at reducing SSI, our study highlights the importance of a history of COPD as a strong predictor of SSI with COPD patients having approximately 4-fold increased odds of SSI. As SSI was the primary indication for readmission in 21% of patients in our study, identifying COPD patients known to be at risk for SSI would allow perioperative SSI reduction precautions to be directed at this patient population. In this limited population of readmitted patients, higher ASA, ascites and the presence of other complications may indicate a higher propensity for poorer wound healing in this cohort. Further identification of risk factors for SSI in patients undergoing primary debulking surgery is warranted.

Certain postoperative complications may be able to be managed as an outpatient if system changes occur. The availability of ambulatory clinics that address the intravenous fluid needs in the setting of dehydration, management of recurrent ascites/pleural effusion, and outpatient initiation of therapeutic anticoagulation in the stable EOC patient diagnosed with postoperative VTE may reduce unplanned inpatient admissions and help reduce costs while still providing excellent care.

Risk factors for hospital readmission identified in this study—specifically ASA score of 3 or higher, the presence of preoperative ascites, and the occurrence of postoperative complications during initial hospitalization—are not exclusively modifiable, and the utility of these predictors in directing postoperative management decisions in our patient population is relatively low. Furthermore, the predictive ability of this model, as measured by the c-index, was modest at 0.625. The discrepancies between some actual and predicted probabilities can be attributed to small numbers of readmissions in patient groups as seen in

Table 5. However, an opportunity to maintain a high threshold for anticipation of 30-day readmission and close follow-up of patients who sustain severe postoperative complications (Accordion grade 3–5) and even mild complications (According grade 1) does exist. Previous studies have shown that poor communication with patients, insufficient follow-up, and lack of coordination may contribute to increased 30-day readmission rates.[15] Thus, patients who are dismissed from the hospital after experiencing a postoperative complication are likely to benefit from early follow-up and enhanced education regarding the signs or symptoms of potential complications.[20] In addition, patients with severe systemic illness who require surgery for EOC may be counseled preoperatively regarding their potentially increased risk of both perioperative and post-dismissal morbidity. These data can be potentially used in a larger decision making model for determining the suitability of patients for neoadjuvant chemotherapy.

Two prior studies have addressed risk factors for 30-day readmission among patients undergoing primary EOC debulking surgery. Similar to our study, Clark et al[14] showed that perioperative complications significantly increased patients'risk of 30-day readmission. In addition, the distribution of indications for 30-day readmission in the study by Clark et al closely paralleled those noted in our study. Fauci et al[7] demonstrated a 30-day readmission rate of 16% and identified patient comorbidities and higher estimated blood loss to be predictive of 30-day readmission. As such, this current study is consistent with previous findings in this high-risk patient population and emphasizes the importance of post-operative complications in addition to perioperative variables in determining the risk of 30-day hospital readmission. In addition, our study gives important context to the range of services needed to potentially reduce the incidence of 30-day readmission.

One limitation to this study is that we excluded patients managed with neoadjuvant chemotherapy. However, EOC management at our institution during the study period involved the use of neoadjuvant chemotherapy in less than 5% of our EOC patient population. Among patients who were deemed to have operable disease, only those who were deemed to be surgical candidates by an independent anesthesiology review were offered primary debulking. To control for the variability in surgical fitness among patients, we included ASA score in addition to Eastern Cooperative Oncology Group performance status and medical comorbidities. The retrospective approach to classification of readmission indications is also a limiting factor. Patients in our study may have had more than one indication that could have led to readmission, and retrospective review of these cases allowed us to classify patients according to their predominant reason for readmission. Restriction of 30-day readmission indications to a single predominant indication may have diluted the effect of other important admission factors, as the indications for readmission are often multifactorial.

One of the main strengths of our study was the large database used and thorough criteria used for classification of postoperative complications by Accordion grade. In addition, close follow-up is generally maintained with patients referred from distant areas and details regarding readmission at outside facilities can be easily captured. The percentage of patients lost to follow-up within the first 30 days after surgery, and therefore removed from the analysis was low (6.3%).

In summary, to uphold efforts commensurate with the national priority to improve the value of patient care, critical evaluation of perioperative processes of care is essential. As such, we shed light on factors that could be mitigated by prophylactic measures and/or alternative approaches to complication management that could reduce hospital readmissions in the EOC primary cytoreduction population. Further analysis of direct and indirect costs of care as a result of hospital readmission in our system, in addition to an analysis of readmission rates after implementation of SSI risk reduction approaches and DVT prophylaxis guidelines, are needed to build on our current findings.

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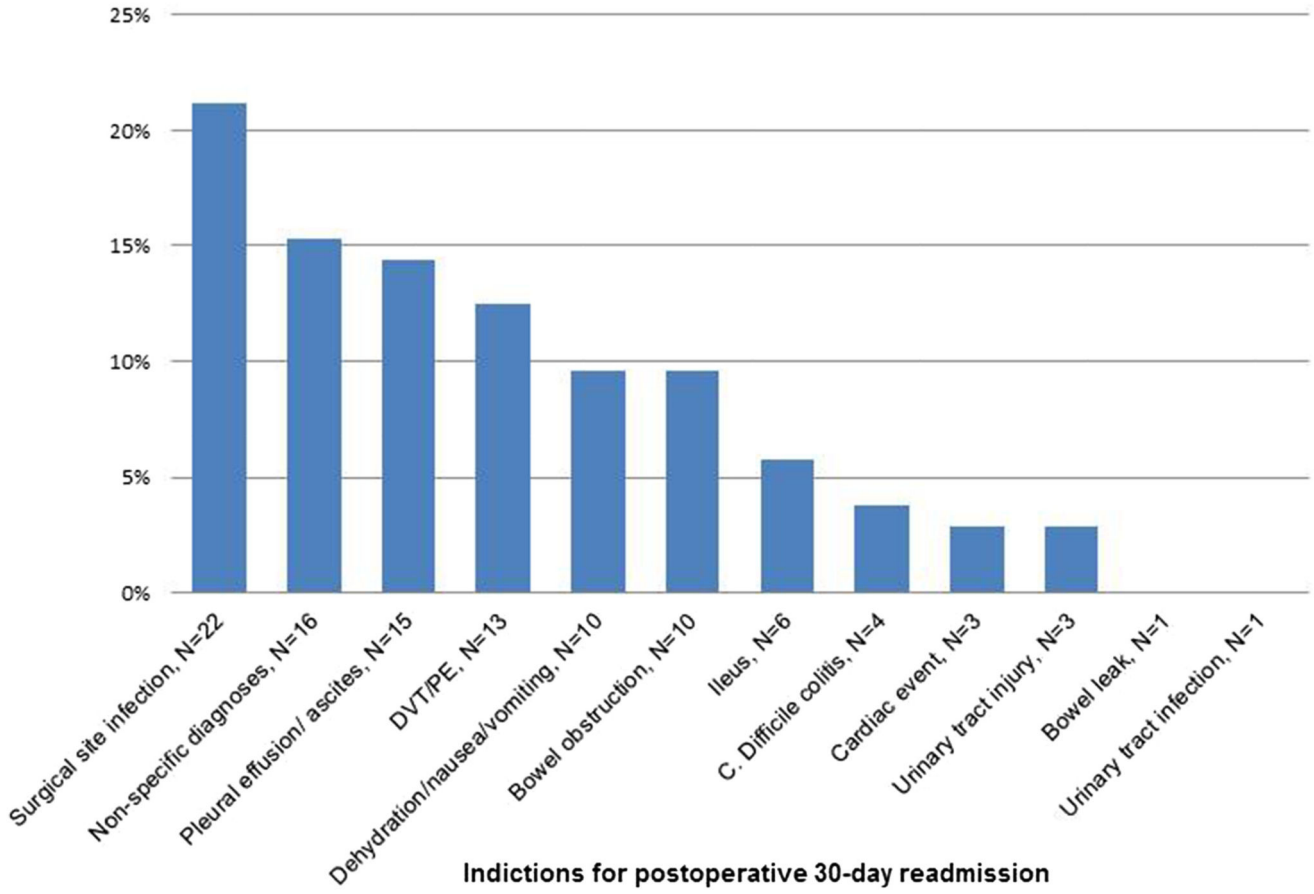

FIGURE 1.
Primary indications for 30-day readmission in 104 patients.

TABLE 1

Accordion severity classification of postoperative complications: expanded classification

1	Mild complication
	Requires only minor invasive procedures that can be done at the bedside such as insertion of intravenous lines, urinary catheters, and nasogastric tubes, and drainage of wound infections. Physiotherapy and the following drugs are allowed-antiemetics, antipyretics, analgesics, diuretics, electrolytes, and physiotherapy.
2	Moderate complication
	Requires pharmacologic treatment with drugs other than such allowed for minor complications, for instance antibiotics.
	Blood transfusions and total parenteral nutrition are also included.
3	Severe: invasive procedure without general anesthesia
	Requires management by an endoscopic, interventional procedure or reoperation* without general anesthesia
4	Severe: operation under gender anesthesia
	Requires management by an operation under general anesthesia
5	Severe: organ system failure†
6	Death
	Postoperative death

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*An example would be a wound exploration under conscious sedation and/or local anesthetic.

†Such complications would normally be managed in an increased acuity setting, but in some cases, patients with complications of lower severity might also be admitted to an ICU.

TABLE 2

Clinical and pathologic characteristics associated with 30-day readmission

Characteristic	No. (%) With 30-d Readmission	Univariate OR (95% CI)	*P*
Age at surgery, y	—	1.03 (0.85–1.23)*	0.79
BMI, kg/m^2	—	1.10 (0.93–1.29)*	0.28
ECOG performance status			0.11
0 (n = 402)	72 (17.9)	Reference	
1 (n = 94)	19 (20.2)	1.16 (0.66–2.04)	
2+ (n = 41)	13 (31.7)	2.13 (1.05–4.31)	
ASA score			0.003
<3 (n = 299)	44 (14.7)	Reference	
≥ (n = 239)	60 (25.1)	1.94 (1.26–3.00)	
Medical comorbidities			
Cardiac event†			0.02
No (n = 491)	89 (18.1)	Reference	
Yes (n = 47)	15 (31.9)	2.12 (1.10–4.08)	
Cardiovascular risk factors‡			0.88
No (n = 224)	44 (19.6)	Reference	
Yes (n = 314)	60 (19.1)	0.97 (0.63–1.49)	
DVT/PE			0.73
No (n = 503)	98 (19.5)	Reference	
Yes (n = 35)	6 (17.1)	0.86 (0.35–2.12)	
Diabetes			0.21
No (n = 488)	91 (18.6)	Reference	
Yes (n = 50)	13 (26.0)	1.53 (0.78–3.00)	
COPD			0.81
No (n = 515)	100 (19.4)	Reference	
Yes (n = 23)	4 (17.4)	0.87 (0.29–2.63)	
Pulmonary disease§			0.63
No (n = 478)	91 (19.0)	Reference	
Yes (n = 60)	13 (21.7)	1.18 (0.61–2.27)	
Smoking history			0.45
No (n = 333)	61 (18.3)	Reference	
Yes (past or current; n = 205)	43 (21.0)	1.18 (0.77–1.83)	
Preoperative creatinine, mg/dL	—	1.08 (0.45–2.61)*	0.86
Preoperative albumin, g/dL			0.38
Not available (n = 261)	50 (19.2)	—	
≥3 (n = 263)	50 (19.0)	Reference	
<3 (n = 14)	4 (28.6)	1.70 (0.51–5.66)	
Preoperative hemoglobin, g/dL	—	0.89 (0.77–1.03)*	0.11
Preoperative CA-125, U/mL	—	1.09 (1.00–1.19)*	0.04

Characteristic	No. (%) With 30-d Readmission	Univariate OR (95% CI)	*P*
Surgical approach			0.68
Laparotomy only (n = 502)	98 (19.5)	Reference	
Laparoscopy/robotic ± laparotomy (n = 36)	6 (16.7)	0.83 (0.33–2.04)	
Ascites			0.004
No (n = 240)	33 (13.8)	Reference	
Yes (n = 298)	71 (23.8)	1.96 (1.25–3.09)	
FIGO stage			0.31
Stage I/II (n = 123)	18 (14.6)	Reference	
Stage III (n = 324)	66 (20.4)	1.49 (0.85–2.63)	
Stage IV (n = 91)	20 (22.0)	1.64 (0.81–3.32)	
Histology			0.28
Non-serous (n = 147)	24 (16.3)	Reference	
Serous (n = 391)	80 (20.5)	1.32 (0.80–2.18)	

BMI, Body mass index; CA-125, cancer antigen 125; ECOG, Eastern Cooperative Oncology Group.

*Odds ratio per 10-year increment for age, 5-U increase for BMI, doubling for CA-125, 1 mg/dL increase in creatinine, and 1 g/dL increase in hemoglobin.

†Cardiac event represents patients with a history of coronary artery disease, myocardial infarction, or other cardiac event.

‡Cardiovascular risk factors represent patients with a history of hypertension, hyperlipidemia, or peripheral vascular disease.

§Other pulmonary disease represents patients with asthma, sleep apnea, or other pulmonary diagnoses.

//Results are presented as frequency and percentage out of 538 unless otherwise noted.

TABLE 3

Surgical variables associated with 30-day readmission

Characteristic	No. (%) With 30-d Readmission	Univariate OR (95% CI)	*P*
Extent of cancer			
Uterus			0.34
No (n = 399)	81 (20.3)	Reference	
Yes (n = 139)	23 (16.5)	0.78 (0.47–1.30)	
Ovaries			0.01
No (n = 103)	29 (28.2)	Reference	
Yes (n = 435)	75 (17.2)	0.53 (0.32–0.87)	
Fallopian tubes			0.64
No (n = 362)	72 (19.9)	Reference	
Yes (n = 176)	32 (18.2)	0.90 (0.56–1.42)	
Cul-de-sac			0.46
No (n = 271)	49 (18.1)	Reference	
Yes (n = 267)	55 (20.6)	1.18 (0.77–1.80)	
Omentum			0.08
No (n = 211)	33 (15.6)	Reference	
Yes (n = 327)	71 (21.7)	1.50 (0.95–2.36)	
Diaphragm			0.18
No (n = 280)	48 (17.1)	Reference	
Yes (n = 258)	56 (21.7)	1.34 (0.87–2.06)	
Liver parenchyma			0.08
No (n = 507)	102 (20.1)	Reference	
Yes (n = 31)	2 (6.5)	0.27 (0.06–1.17)	
Spleen parenchyma			0.15
No (n = 499)	93 (18.6)	Reference	
Yes (n = 39)	11 (28.2)	1.72 (0.82–3.57)	
Diaphragm, liver parenchyma, and/or spleen parenchyma			0.24
No (n = 266)	46 (17.3)	Reference	
Yes (n = 272)	58 (21.3)	1.30 (0.84–1.99)	
Small or large bowel mesentery			0.83
No (n = 300)	57 (19.0)	Reference	
Yes (n = 238)	47 (19.7)	1.05 (0.68–1.61)	
Small or large bowel serosa			0.04
No (n = 219)	33 (15.1)	Reference	
Yes (n = 319)	71 (22.3)	1.61 (1.02–2.54)	
Bladder			0.65
No (n = 378)	75 (19.8)	Reference	
Yes (n = 160)	29 (18.1)	0.89 (0.56–1.44)	
General carcinomatosis			0.13
No (n = 360)	63 (17.5)	Reference	

Characteristic	No. (%) With 30-d Readmission	Univariate OR (95% CI)	*P*
Yes (n = 178)	41 (23.0)	1.41 (0.91–2.20)	
Surgical complexity			0.28
Low (n = 90)	13 (14.4)	Reference	
Intermediate (n = 323)	62 (19.2)	1.41 (0.73–2.69)	
High (n = 125)	29 (23.2)	1.79 (0.87–3.67)	
RD			0.02
No (n = 300)	47 (15.7)	Reference	
Yes, measurable (≤1 cm; n = 167)	44 (26.3)	1.93 (1.21–3.06)	
Yes, suboptimal or extensive (>1 cm; n = 71)	13 (18.3)	1.21 (0.61–2.38)	
Estimated blood loss, mL	—	1.18 (0.96–1.44)*	0.12
Blood transfusion			0.47
No (n = 123)	21 (17.1)	Reference	
Yes (n = 415)	83 (20.0)	1.21 (0.72–2.06)	
Operating time, min	—	1.11 (0.97–1.26)*	0.13
Lowest intraoperative body temperature, °C	—	0.90 (0.67–1.20)*	0.46
Final intraoperative body temperature, °C	—	1.00 (0.76–1.31)*	0.98
Postoperative complication classification			0.02
None (n = 178)	24 (13.5)	Reference	
Mild (Accordion grade 1; n = 47)	12 (25.5)	2.20 (1.00–4.82)	
Moderate (Accordion grade 2; n = 260)	51 (19.6)	1.57 (0.92–2.66)	
Severe (Accordion grade 3–5; n = 53)	17 (32.1)	3.03 (1.48–6.22)	
Length of stay, d	—	1.04 (1.00–1.07)*	0.04
Time to first postoperative flatus, d	—	1.11 (1.01–1.22)*	0.04
Time to first general diet intake, d	—	1.04 (0.98–1.10)*	0.22

FIGO, International Federation of Gynecology and Obstetrics.

* Odds ratio per 60-minute increment for operative time, doubling in estimated blood loss, 1°C increase in body temperature, and 1 day increase in length of stay, time to first postoperative flatus, and time to first general diet intake, respectively.

TABLE 4

Multivariable analysis of factors associated with 30-day readmission

Characteristic	Adjusted OR (95% CI)	*P*
ASA score		0.007
<3	Reference	
≥3	1.85 (1.18–2.89)	
Ascites		0.02
No	Reference	
Yes	1.76 (1.11–2.81)	
Postoperative complication classification		0.048
None	Reference	
Mild (Accordion grade 1)	2.19 (0.98–4.85)	
Moderate (Accordion grade 2)	1.28 (0.74–2.21)	
Severe (Accordion grade 3–5)	2.47 (1.19–5.16)	

TABLE 5

Predicted probabilities of readmission based on multivariable model

ASA score	Ascites	Postoperative Complication Classification*	Proportion With 30-d Readmission	Predicted Probability From Model, %
<3	No	None	7.7% (6/78)	8.4
<3	No	Mild	35.7% (5/14)	16.8
<3	No	Moderate	10.6% (5/47)	10.6
<3	No	Severe	12.5% (1/8)	18.6
<3	Yes	None	15.8% (6/38)	14.0
<3	Yes	Mild	15.8% (3/19)	26.2
<3	Yes	Moderate	16.7% (13/78)	17.2
<3	Yes	Severe	29.4% (5/17)	28.7
≥3	No	None	7.7% (2/26)	14.6
≥3	No	Mild	14.3% (1/7)	27.1
≥3	No	Moderate	20.0% (10/50)	17.9
≥3	No	Severe	30.0% (3/10)	29.7
≥3	Yes	None	27.8% (10/36)	23.1
≥3	Yes	Mild	42.9% (3/7)	39.6
≥3	Yes	Moderate	27.1% (23/85)	27.8
≥3	Yes	Severe	44.4% (8/18)	42.6

* Mild, Accordion grade 1; moderate, Accordion grade 2; severe, Accordion grades 3–5.