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Venous Thromboembolism After Surgery for Inflammatory Bowel Disease: Are There Modifiable Risk Factors? Data from ACS NSQIP

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Abstract

BACKGROUND—Although it is commonly reported that IBD patients are at increased risk for venous thromboembolic events, little real-world data exist regarding their postoperative incidence and related outcomes in everyday practice.

OBJECTIVE—We aimed to identify the rate of venous thromboembolism and modifiable risk factors within a large cohort of surgical IBD patients.

DESIGN—We performed a retrospective review of IBD patients who underwent colorectal procedures.

PATIENTS—Patient data were obtained from the American College of Surgeons National Surgical Quality Improvement Program 2004 to 2010 Participant Use Data Files.

MAIN OUTCOME MEASURES—The primary outcomes measured were short-term (30-day) postoperative venous thromboembolism (deep vein thrombosis and pulmonary embolism). Clinical variables were analyzed by univariate and multivariate analyses to identify modifiable risk factors for these events.

RESULTS—A total of 10,431 operations were for Crohn's disease (52.1%) or ulcerative colitis (47.9%), and 242 (2.3%) venous thromboembolic events occurred (178 deep vein thromboses, 46 pulmonary embolisms, 18 both) for a combined rate of 1.4% in Crohn's disease and 3.3% in ulcerative colitis. Deep vein thrombosis and pulmonary embolism each occurred at a mean of 10.8 days postoperatively (range for each, 0–30 days). A multivariate model found that bleeding disorder, steroid use, anesthesia time, emergency surgery, hematocrit <37%, malnutrition, and functional status were potentially modifiable risk factors that remained associated ($p < 0.05$) with venous thromboembolism on regression analysis. Patients with thromboembolism had longer

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length of stay (18.8 vs 8.9 days), more complications (41% vs 18%), and a higher risk of death (4% vs 0.9%).

LIMITATIONS—This study was limited by its retrospective design and its limited generalizability to nonparticipating hospitals.

CONCLUSIONS—Inflammatory bowel disease patients are at increased risk for postoperative venous thromboembolism. Reducing preoperative anemia, steroid use, malnutrition, and anesthesia time may also reduce venous thromboembolism in this at-risk population. Risk-reducing, preventative strategies are needed in this at-risk population.

Keywords

Chronic ulcerative colitis; Crohn's disease; Outcomes; Deep vein thrombosis; Pulmonary embolism

Venous thromboembolic disease (VTE), which includes deep vein thromboses (DVT) as well as pulmonary emboli (PE), is a preventable cause of morbidity and mortality in hospitalized patients. Each year in the United States, there are more than 1 million DVT events and more than 100,000 deaths from PE.¹ VTE is one of the major extraintestinal manifestations of IBD that is associated with substantial mortality. Although the most common location for thrombus formation is within the deep veins of the leg, other reported sites include cerebral, hepatic, and mesenteric vessels.²

Previous studies have demonstrated that patients with IBD are at a higher risk for VTE than the average population.^{3–6} They have a 1.5- to 3.5-fold increased risk of VTE with an associated 2.5-fold increased risk of mortality.⁷ Factors including increased age, IBD type (Crohn's disease (CD) vs chronic ulcerative colitis (UC)), inpatient vs ambulatory status, and active disease vs clinical remission have all been implicated. Although this increased risk is well established in medical IBD patients,⁸ less data are available for IBD patients undergoing colorectal surgery.

Currently, there are no standardized guidelines for VTE prophylaxis in IBD patients. Although early ambulation and mechanical prophylaxis (eg, sequential compression devices or graduated compression stockings) are the standard of care, the incidence of postoperative VTE in IBD patients remains high enough to warrant further study. Identification of modifiable pre- and perioperative risk factors, in addition to improved prophylactic strategies, may minimize this risk. The purpose of this study was to define the incidence of postoperative VTE in a large cohort of IBD patients who have undergone colorectal surgery. In addition, we sought to identify specific potentially modifiable perioperative risk factors associated with VTE in this high-risk population to aid in identifying processes of care to reduce the incidence of VTE, and thus improve outcomes in postoperative IBD patients.

METHODS

NSQIP Dataset and Study Population

The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) is a multi-institutional cohort study of patients undergoing surgery within participating hospitals.⁹ Data are recorded on preoperative, operative, and postoperative outcomes for 30-days after the index procedure. Participant hospitals are then provided risk-adjusted outcomes for quality improvement purposes. Data abstraction methods and variable definitions are available from the ACS NSQIP Web site. Patients who underwent any operative procedure with the primary *International Classification of Diseases, Ninth Revision* diagnosis codes of CD (555.X) and UC (556.X) were identified by using the ACS

NSQIP Participant Use File for 2005 to 2010. The initial cohort of IBD patients was then limited to those who underwent small-bowel or colon surgery (Current Procedural Terminology (CPT) codes 44000–44999), rectal surgery (CPT codes 45000–45999), or anorectal surgery (CPT codes 46000–46999), all other patients were excluded.

Main Outcome Measures: DVT, PE, and VTE

Our end points for analysis were postoperative DVT, PE, and overall VTE. Deep vein thrombosis is currently defined within ACS NSQIP as the “identification of a new blood clot or thrombus within the venous system, which may be coupled with inflammation within 30 days of the operation. This diagnosis is confirmed by a duplex (ultrasound), venogram or CT scan. The patient must be treated with anticoagulation therapy or placement of a vena cava filter or clipping of the vena cava.”¹⁰ Pulmonary embolism is defined as “lodging of a blood clot in a pulmonary artery with subsequent obstruction of blood supply to the lung parenchyma. PE [is] documented if the patient has a V-Q scan interpreted as high probability of pulmonary embolism or a positive CT spiral exam, pulmonary arteriogram or CT angiogram.” VTE is defined as the presence of DVT and/or PE during the postoperative period.

Statistical Analysis

First, univariate relationships between preoperative, operative, and postoperative variables and the development of VTE were compared by using 2 for categorical variables with Fisher exact correction as indicated, and 2-sample *t* tests for continuous variables. Variables of clinical significance and those with a *p* value of <0.2 by univariate analysis were included in a backward stepwise multiple logistic regression to identify significant predictors for VTE. Nonsignificant (*p* > 0.05) variables were removed from the multivariate model by using the likelihood ratio test to verify that they did not contribute significantly to the predictive model. Discrimination and calibration of the final predictive model were assessed by examining the receiver operator area under the curve and the Hosmer-Lemeshow goodness-of-fit tests. Probability values of <0.05 were considered significant. All analysis was performed with STATA Release 12 (STATA Corp, College Station, TX).

RESULTS

Rate of Thromboembolic Complications

Within ACS NSQIP 2006 to 2010, we identified 10,431 IBD patients (5001 with UC and 5430 with CD) who underwent surgery during the study period. In these patients, within 30 days, 242 VTE developed in 224 patients (178 patients with isolated DVT or thrombophlebitis, 46 with isolated PE, and 18 patients with both DVT and PE). The diagnosis of DVT and PE each occurred on average 10.8 days after surgery.

Baseline Characteristics

Patients with IBD who had VTE were, on average, 3 years older than those without DVT, but they had similar gender and BMI. VTE occurred with a higher frequency in patients with UC than in those with CD (3.3% vs 1.4%, *p* < 0.001). Other baseline patient characteristics are summarized in Table 1. Those with VTE were more likely to have hypertension, reduced preoperative functional status, chronic steroid use, bleeding disorder, recent transfusion, anemia, and malnutrition (all significant, *p* < 0.05). Anemia was defined as a hematocrit <37%, which was the median hematocrit value in our dataset. Malnutrition was defined as >10% loss in body weight over the previous 6 months or albumin <3.5 g/dL.

In terms of operative characteristics (summarized in Table 2), emergency surgery and prolonged anesthesia time were significantly associated with the occurrence of postoperative

VTE ($p < 0.01$). Emergency surgeries include any case in which the surgeon and anesthesiologist report the case as emergent and that occurs no later than 12 hours after the patient has been admitted to the hospital or after the onset of related preoperative symptomatology. Anesthesia time (in minutes) was converted to a categorical variable, with a prolonged anesthesia time defined as any time greater than the median anesthesia time of 231 minutes. Table 2 also demonstrates the association between several postoperative characteristics and the occurrence of VTE. For example, patients with thromboembolism had longer length of stay (18.8 vs 8.9 days, $p < 0.001$) and a higher risk of death at 30 days (4% vs 0.9%, <0.001) relative to those patients without VTE. Furthermore, as shown in Figure 1, patients experiencing VTE were significantly more likely to have a variety of concomitant postoperative complications, such as myocardial infarction, renal failure, pneumonia, and infection (including superficial surgical site infection, urinary tract infection, and sepsis).

Predictors of VTE

On stepwise multivariate analysis (Table 3), we identified 8 potentially modifiable perioperative variables independently associated with the development of VTE. The single most predictive variable was bleeding disorder (OR 2.74, 95% CI 1.8–4.3), followed by chronic preoperative steroid use (OR 2.17, 95% CI 1.7–2.8), and partially dependent functional status (OR 1.98, 95% CI 1.2–3.2). Our model demonstrated good discrimination, with a receiver operator area under the curve of 0.73, and excellent calibration with the goodness-of-fit p value of 0.16.

DISCUSSION

As in other recent studies,¹¹ we observed an elevated risk of VTE in a large national sample of patients with IBD who had undergone colorectal procedures. This effect was particularly strong in those with chronic UC. Furthermore, we identified several potentially modifiable risk factors associated with the development of VTE including chronic steroid use, low hematocrit, and prolonged anesthesia time. Last, we found that IBD patients who developed VTE have worse postoperative outcomes including significantly longer length of stay, more complications, and a higher rate of death.

Despite wide recognition in the medical literature that IBD patients are at increased risk for VTE, specific guidelines for preventative measures in this patient population do not exist. In the next several paragraphs we will review strategies specific to this population as suggested by our findings.

Preoperative Steroid Use

Steroid therapy has been regarded as a prothrombotic factor in patients undergoing colorectal surgery, in general, and in IBD patients, in particular.^{4,12,13} The results of our study support this notion with nearly 60% of VTEs occurring in patients on chronic steroids. It is arguable that it is not the specific use of chronic steroids that increases VTE risk in IBD patients, but rather that chronic steroid use is a surrogate marker for things such as aggressive disease activity, and therefore a more robust proinflammatory/prothrombotic state, or bed rest and relative immobility due to pain or disease activity (eg, abdominal pain or 20 diarrheal stools per day may prohibit a patient from having an active lifestyle). Regardless, chronic and high-dose steroid use may lead to several specific VTE prevention strategies, including aggressive weaning of steroids preoperatively (not always possible because of disease activity), consideration of altering the magnitude of the operation (eg, performing 3-stage instead of 2-stage IPAA),¹⁴ and awareness that IBD patients on steroids are at even greater risk of VTE.

Anemia

About one-third of patients with IBD experience anemia, most often caused by a combination of the anemia of chronic disease and iron deficiency.¹⁵ These forms of anemia are often accompanied by thrombocytosis, which can contribute to VTE. The relative importance of chronic iron deficiency and resultant thrombocytosis may be underestimated. A recent study demonstrated that iron therapy in patients with IBD-associated anemia normalizes thrombocytosis, thus decreasing the risk of thrombosis.¹⁵ In our VTE subgroup, 62% of patients had a preoperative hematocrit <37%, whereas only 2% had recently received a transfusion. This suggests that more aggressive correction of anemia preoperatively, ideally with iron and nutritional supplementation, may be indicated in this population. An alternative explanation is that providers are withholding VTE prophylaxis because of a patient's anemic state. Unfortunately, we do not have access to data that would allow us to investigate this possibility, but it remains an important consideration and we would caution against withholding VTE prophylaxis strictly because of anemia, given our results.

Anesthesia Time

Our regression model suggested that prolonged anesthesia time, but not prolonged operative time, may influence VTE rates. Multiple proposed mechanisms include longer femoral venous stasis, more endothelial trauma, additional bleeding and hypovolemia, and deoxygenation of venous blood.¹⁶ Studies have shown that the duration of surgery affects the incidence of postoperative thromboembolism, regardless of the type of anesthesia.^{16,17} On the other hand, it has also been found that operative time was not associated with increased VTE risk.¹² The results of our study seem to support the finding that prolonged anesthesia time contributes to postoperative VTE risk. This finding is particularly true in patients with UC. Subgroup analyses revealed that UC patients undergoing surgery were more likely to undergo lengthier surgeries in comparison with patients with CD (mean operative time, 211 vs 158 minutes, $p < 0.001$). However, in patients with CD, the incidence of VTE remains highest in those undergoing prolonged anesthesia (55.8% if anesthesia time >231 minutes vs 36.9%, $p = 0.001$). It follows that anesthesia adjuncts, such as additional venous access, should be placed before induction and that operating room efficiency should not be underestimated.

Prevention

Because VTE is often clinically silent and may be rapidly fatal, prophylaxis is mandatory. Clinical practice guidelines now recommend pharmacological prophylaxis for hospitalized IBD patients.¹⁸ However, there is no consensus for a standardized agent or approach to anticoagulation, and guidelines detailing variation in method or duration of prophylaxis among subtypes of patients (eg, UC vs CD, inpatient vs outpatient, active disease vs inactive phase), surgical procedures, or length of hospitalization do not exist. The current American College of Chest Physician guidelines recommend pharmacological VTE prophylaxis with low-molecular-weight heparin (LMWH) or unfractionated heparin (UFH) for inpatients with multiple risk factors for thrombotic complications and for those undergoing moderate- to major-risk surgical procedures, such as those in our cohort.¹⁸

Two notable studies have compared the efficacy and safety of short-term thromboprophylaxis with LMWH enoxaparin vs UFH in patients undergoing colorectal surgery. The first, the Canadian Colorectal DVT Prophylaxis Trial,¹⁹ a multicenter, randomized, double-blind study, found that daily enoxaparin (40 mg SC daily) was as effective as UFH (5000 units SC every 8 hours) in preventing postoperative VTE, with a rate of 2.8% with either agent. Despite these results, at the time of this trial, UFH was less expensive and thus remained the preferred agent for prophylaxis. These findings were

echoed by a second multicenter, randomized, double-blind trial, the ENOXACAN study,²⁰ which compared the efficacy of enoxaparin vs UFH at the same doses as the Canadian Trial, but in 1115 patients undergoing elective curative surgery for abdominal or pelvic cancer.²⁰ Of the ENOXA-CAN population, 660 were patients undergoing colorectal surgery, for whom enoxaparin was found to be at least as effective as UFH for VTE prophylaxis (with similar rates of 16.6% vs 18.8%).

Following these 2 trials, the ENOXACAN-II study,²¹ which extended VTE chemoprophylaxis to 4 weeks, demonstrated a significant reduction in VTE for up to 3 months after surgery among patients in the treatment arm in comparison with the placebo group (12% vs 4.8%). These findings highlight the need for additional research, such as a cost-effectiveness analyses if not multicenter randomized trials, to investigate the potential benefit of prolonged prophylaxis in our high-risk population.

Limitations

Our study has several important limitations. First, because of the retrospective nature of our analysis, we are only able to assess association, and not causation, between the identified preoperative risk factors and thrombotic complications. Second, VTE prophylaxis measures, such as prophylactic anticoagulation, sequential compression device use, or inferior vena cava filter placement, are not recorded in ACS NSQIP and may vary across institutions and individual surgeons. However, we did confirm that there was no significant difference in the incidence of VTE among this cohort of patients following the implementation of Surgical Care Improvement Project VTE Guidelines in 2007, indicating that it is statistically sound to combine all study years, and to assume that any changes in prophylaxis resulting from Surgical Care Improvement Project recommendations did not impact our results. Third, the ACS NSQIP database does not record data to indicate how many patients underwent testing for VTE, nor whether or not those VTEs recorded were found by screening examination or were the result of diagnostic workup because of the symptoms of DVT or PE. However, previous work has shown that rates of VTE in the NSQIP most closely mirror rates among symptomatic populations.²² Fourth, details pertaining to duration and dosing of steroid therapy for patients classified as taking chronic steroids are not available in ACS NSQIP, nor are other measures to indicate potential disease severity. Last, anatomic features of DVTs (upper vs lower extremity) or the presence of indwelling catheters, remain unknown, which may confound these results. Despite these limitations, our results demonstrate important associations that may be used to develop prospective cohort studies designed to validate risk of VTE in patients with IBD who are undergoing surgery.

CONCLUSIONS

Patients with IBD are at increased risk for postoperative VTE and associated worse postoperative outcomes. These patients often bring a disease-induced hypercoagulable state to the operating table, exacerbated by features such as chronic steroid use, malnutrition, and a suboptimal hematocrit level. Intraoperatively and postoperatively, additional risks accumulate, ranging from prolonged anesthesia time to lengthy pelvic procedures to immobility. Actions to potentially reduce the incidence of VTE in this at-risk population include correcting preoperative coagulopathy and/or anemia, improving nutritional status, reducing steroid use, operating early to avoid emergency surgery, and limiting anesthesia time. Additional study of these potentially modifiable risk factors is warranted to assess intervention strategies, and decision analysis is needed to determine whether prolonged postdischarge chemoprophylaxis with UFH or LMWH is a cost-effective strategy in this at-risk patient population.

References

1. Dobesh PP, Wittkowsky AK, Stacy Z, et al. Key articles and guidelines for the prevention of venous thromboembolism. *Pharmacotherapy*. 2009; 29:410–458. [PubMed: 19323620]
2. Tinsley A, Naymagon S, Trindade AJ, Sachar DB, Sands BE, Ullman TA. A Survey of Current Practice of Venous Thromboembolism Prophylaxis in Hospitalized Inflammatory Bowel Disease Patients in the United States [published online ahead of print April 2, 2012]. *J Clin Gastroenterol*. 10.1097/MCG.0b013e31824c0dea
3. Bernstein CN, Nabalamba A. Hospitalization-based major comorbidity of inflammatory bowel disease in Canada. *Can J Gastroenterol*. 2007; 21:507–511. [PubMed: 17703250]
4. Danese S, Papa A, Saibeni S, Repici A, Malesci A, Vecchi M. Inflammation and coagulation in inflammatory bowel disease: the clot thickens. *Am J Gastroenterol*. 2007; 102:174–186. [PubMed: 17100967]
5. Bernstein CN, Blanchard JF, Houston DS, Wajda A. The incidence of deep venous thrombosis and pulmonary embolism among patients with inflammatory bowel disease: a population-based cohort study. *Thromb Haemost*. 2001; 85:430–434. [PubMed: 11307809]
6. Miehsler W, Reinisch W, Valic E, et al. Is inflammatory bowel disease an independent and disease specific risk factor for thromboembolism? *Gut*. 2004; 53:542–548. [PubMed: 15016749]
7. Murthy SK, Nguyen GC. Venous thromboembolism in inflammatory bowel disease: an epidemiological review. *Am J Gastroenterol*. 2011; 106:713–718. [PubMed: 21407182]
8. Nguyen GC, Sam J. Rising prevalence of venous thromboembolism and its impact on mortality among hospitalized inflammatory bowel disease patients. *Am J Gastroenterol*. 2008; 103:2272–2280. [PubMed: 18684186]
9. ACS NSQIP. [Accessed May 1, 2012] The American College of Surgeons, 2002–2012. Available at: <http://site.acsnsqip.org/>
10. De Martino RR, Goodney PP, Spangler EL, et al. Variation in thromboembolic complications among patients undergoing commonly performed cancer operations. *J Vasc Surg*. 2012; 55:1035–1040. e4. [PubMed: 22409858]
11. Merrill A, Millham F. Increased risk of postoperative deep vein thrombosis and pulmonary embolism in patients with inflammatory bowel disease: a study of National Surgical Quality Improvement Program patients. *Arch Surg*. 2012; 147:120–124. [PubMed: 22006853]
12. Fleming FJ, Kim MJ, Salloum RM, Young KC, Monson JR. How much do we need to worry about venous thromboembolism after hospital discharge? A study of colorectal surgery patients using the National Surgical Quality Improvement Program database. *Dis Colon Rectum*. 2010; 53:1355–1360. [PubMed: 20847615]
13. Ie K. Therapy insight: vascular complications in patients with inflammatory bowel disease. *Nat Clin Prac Gastroenterol Hepatol*. 2005; 2:266–272.
14. Holubar SD, Larson DW, Dozois EJ, Pattana-Arun J, Pemberton JH, Cima RR. Minimally invasive subtotal colectomy and ileal pouch-anal anastomosis for fulminant ulcerative colitis: a reasonable approach? *Dis Colon Rectum*. 2009; 52:187–192. [PubMed: 19279410]
15. Kulnigg-Dabsch S, Evstatiev R, Dejaco C, Gasche C. Effect of iron therapy on platelet counts in patients with inflammatory bowel disease-associated anemia. *PLoS One*. 2012; 7:e34520. [PubMed: 22506024]
16. Ture A, Usluer A, Eti Z, et al. The effect of anesthetic technique on postoperative venous thromboembolism in elderly patients undergoing total hip replacement. *Marmara Med J*. 2008; 21:146–151.
17. Jaffer AK, Barsoum WK, Krebs V, Hurbaneck JG, Morra N, Brotman DJ. Duration of anesthesia and venous thromboembolism after hip and knee arthroplasty. *Mayo Clin Proc*. 2005; 80:732–738. [PubMed: 15945526]
18. Geerts WH, Bergqvist D, Pineo GF, et al. American College of Chest Physicians. Prevention of venous thromboembolism: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th Edition). *Chest*. 2008; 133 (6 suppl):381S–453S. [PubMed: 18574271]
19. McLeod RS, Geerts WH, Sniderman KW, et al. Canadian Colorectal Surgery DVT Prophylaxis Trial investigators. Subcutaneous heparin versus low-molecular-weight heparin as

thromboprophylaxis in patients undergoing colorectal surgery: results of the Canadian colorectal DVT prophylaxis trial: a randomized, double-blind trial. *Ann Surg.* 2001; 233:438–444. [PubMed: 11224634]

20. Efficacy and safety of enoxaparin versus un-fractionated heparin for prevention of deep vein thrombosis in elective cancer surgery: a double blind randomized multi-centre trial with venographic assessment. ENOXACAN Study Group. *Br J Surg.* 1997; 84:1099–1103. [PubMed: 9278651]
21. Bergqvist D, Agnelli G, Cohen AT, et al. ENOXACAN II Investigators. Duration of prophylaxis against venous thromboembolism with enoxaparin after surgery for cancer. *N Engl J Med.* 2002; 346:975–980. [PubMed: 11919306]
22. De Martino, RR.; Corriere, M.; Beck, AW., et al. Improving the measurement of deep venous thrombosis in quality improvement registries. *Proceedings of the Society for Vascular Surgery Annual Meeting; Chicago, IL.* June 16–18, 2011;

FIGURE 1.

Postoperative (30-day) complications among patients who did (gray bars) or did not (black bars) experience a venous thrombotic event (VTE) after colorectal surgery for IBD * = all patients with missing mortality data were presumed to be alive at 30 days.

TABLE 1

Univariate associations between patient characteristics and the occurrence of postoperative VTEs

	No VTE (n = 10,431)	Yes VTE (n = 242)	p
Type of IBD, %			<0.001
Crohn's disease	98.6	1.4	
Ulcerative colitis	96.7	3.3	
Sex (% male)	50.9	51.0	0.97
Age, mean (SD)	42.9 (15.8)	45.9 (17.6)	0.004
Race, %			0.01^a
White	27.0	29.8	
Black	1.8	0.4	
Hispanic	0.8	2.5	
Other/missing	70.4	67.4	
BMI, mean (SD)	25.6 (6.1)	25.5 (5.6)	0.78
Diabetes mellitus, %	4.9	6.3	0.35
Smoking status, %			0.92
Never	64.8	66.0	
Past (>1 y)	14.2	14.0	
Current (<1 y)	21.0	20.0	
Functional status before surgery, %			<0.001
Independent	96.1	86.8	
Partially dependent	2.8	9.1	
Totally dependent	1.2	4.1	
Congestive heart failure, %	0.3	0.4	0.53 ^a
Coronary artery disease, %	2.0	2.5	0.64
Hypertension, %	18.2	24.8	0.009
Acute renal failure, %	0.3	0.8	0.14 ^a
Distant cancer, %	0.2	0.0	1.00 ^a
Preoperative wound infection/open wound, %	3.6	5.8	0.08
Chronic preoperative steroid use, %	36.4	59.5	<0.001
Bleeding disorder, %	3.0	11.2	<0.001
Transfusion, ^b %	0.7	2.1	0.03^a
Pregnant, %	0.1	0	1.00 ^a
Previous surgery within 30 days, %	1.5	1.8	0.57 ^a
Hematocrit <37 (%)	43.5	61.6	<0.001
Malnourished, ^c %	31.7	50.8	<0.001
Preop INR, mean (SD)	1.1 (0.3)	1.1 (0.3)	0.14
Preop PTT, mean (SD)	30.4 (7.7)	30.0 (8.2)	0.60
Preop PT, mean (SD)	13.1 (3.1)	13.4 (3.7)	0.26

VTE = venous thromboembolic event; INR = international normalized ratio; PTT = partial thromboplastin time; PT = prothrombin time; Preop = preoperative.

^aDenotes Fisher exact p value.

^bMore than 4 units packed red blood cells in 72 hours before surgery.

^cMore than 10% loss in body weight over the previous 6 months or albumin <3.5.

TABLE 2

Univariate associations between operative and postoperative characteristics and the occurrence of postoperative VTEs

	No VTE (n = 10,431)	Yes VTE (n = 242)	p
Type of surgery			0.110 ^a
Colon case (CPT 44000–44999), %	87.0	91.3	
Rectal case (CPT 45000–45999), %	11.3	8.3	
Anorectal case (CPT 46000–46999), %	1.7	0.4	
Anesthesia, %			0.65 ^a
General	99.4	100	
Other	0.6	0	
Anesthesia time, mean, in minutes (SD)	245.3 (114.2)	287.1 (115.3)	<0.001
Operative time, mean, in minutes (SD)	182.3 (103.0)	217.3 (105.9)	<0.001
Emergency surgery, %	6.2	13.2	<0.001
Length of stay, mean, in days (SD)	8.9 (9.1)	18.8 (16.7)	<0.001
Postoperative complication, % ^b	20.1	45.0	<0.001
Mortality within 30 days, %	0.9	4.1	<0.001

VTE = venous thromboembolic event; CPT = Current Procedural Terminology; UTI = urinary tract infection; MI = myocardial infarction.

^aDenotes Fisher exact *p* value.

^bA composite end point including superficial wound infection, bleeding requiring transfusion, pneumonia, renal failure, UTI, MI, sepsis, and death.

TABLE 3

Multivariate model for predicting VTEs following colorectal surgery for IBD

	OR	95%CI	p
Preoperative steroid use	2.17	1.7–2.8	<0.001
Bleeding disorder	2.74	1.8–4.3	<0.001
Malnourished	1.41	1.1–1.9	0.02
Partially dependent functional status	1.98	1.2–3.2	0.006
Hematocrit <37	1.50	1.1–2.0	0.007
Emergency case	1.83	1.2–2.8	0.004
Anesthesia time >231 min	1.96	1.5–2.6	<0.001
Postoperative wound infection	1.89	1.3–2.7	<0.001

Receiver operator area under the curve: 0.73. Goodness-of-fit: $p = 0.16$.

VTE = venous thromboembolic event.