



Published in final edited form as:

*Dis Colon Rectum*. 2014 April ; 57(4): 497–505. doi:10.1097/DCR.000000000000054.

## Infection and Venous Thromboembolism in Patients Undergoing Colorectal Surgery: What Is the Relationship?

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### Abstract

**BACKGROUND**—There is evidence demonstrating an association between infection and venous thromboembolism. We recently identified this association in the postoperative setting; however, the temporal relationship between infection and venous thromboembolism is not well defined

**OBJECTIVE**—We sought to determine the temporal relationship between venous thromboembolism and postoperative infectious complications in patients undergoing colorectal surgery.

**DESIGN, SETTING, AND PATIENTS**—A retrospective cohort analysis was performed using data for patients undergoing colorectal surgery in the National Surgical Quality Improvement Project 2010 database.

**MAIN OUTCOME MEASURES**—The primary outcome measures were the rate and timing of venous thromboembolism and postoperative infection among patients undergoing colorectal surgery during 30 postoperative days.

**RESULTS**—Of 39,831 patients who underwent colorectal surgery, the overall rate of venous thromboembolism was 2.4% (n = 948); 729 (1.8%) patients were diagnosed with deep vein thrombosis, and 307 (0.77%) patients were diagnosed with pulmonary embolism. Eighty-eight (0.22%) patients were reported as developing both deep vein thrombosis and pulmonary embolism. Following colorectal surgery, the development of a urinary tract infection, pneumonia, organ space surgical site infection, or deep surgical site infection was associated with a significantly increased risk for venous thromboembolism. The majority (52%–85%) of venous

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**Financial Disclosure:** None reported.

thromboembolisms in this population occurred the same day or a median of 3.5 to 8 days following the diagnosis of infection. The approximate relative risk for developing any venous thromboembolism increased each day following the development of each type of infection (range, 0.40%–1.0%) in comparison with patients not developing an infection.

**LIMITATIONS**—We are unable to account for differences in data collection, prophylaxis, and venous thromboembolism surveillance between hospitals in the database. Additionally, there is limited patient follow-up.

**CONCLUSIONS**—These findings of a temporal association between infection and venous thromboembolism suggest a potential early indicator for using certain postoperative infectious complications as clinical warning signs that a patient is more likely to develop venous thromboembolism. Further studies into best practices for prevention are warranted.

### Keywords

Colorectal surgery; Venous thromboembolism; Surgical site infection; Surgical outcome; National Surgical Quality Improvement Project

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Various risk factors for venous thromboembolism (VTE) have been identified.<sup>1–6</sup> These risk factors have been used to develop guidelines and tools to improve clinical decision making for delivery of risk-appropriate prophylaxis against VTE and, consequently, improve patient outcomes.<sup>7–10</sup> Despite these quality improvement efforts, some payers have recently classified VTE as a “never event,” creating a financial disincentive by withholding reimbursement for treatment of such events in certain settings.<sup>11,12</sup> Many argue that VTE compensation restrictions should be based on a preventable harm model—that only VTE events occurring without appropriate prophylaxis are preventable.<sup>13</sup> Based on this model, we recently evaluated our institutional data for preventable harm from VTE and found that only 8% of VTEs occurring among patients undergoing colorectal surgery<sup>14</sup> and 9% of VTEs occurring among surgical patients overall<sup>15</sup> were preventable. Interestingly, in this study, we also found that infectious complications were significantly associated with VTE events.<sup>14</sup>

There is only a small body of literature exploring the relationship between infection and VTE in postsurgical populations.<sup>5,16–20</sup> Much of this literature attributes the association to the release of cytokines associated with infection leading to an inflammatory state that results in an increased propensity toward VTE.<sup>1,2,4</sup> In our previous study, we identified a significant relationship between infectious complications and VTE in which patients with a surgical site infection (SSI), urinary tract infection (UTI), or pneumonia were 4-fold more likely to have a VTE. This finding was independent of VTE prophylaxis strategy, because risk-appropriate VTE prophylaxis was ordered for 92% of patients when their thrombotic event occurred.<sup>14</sup> In this study, we sought to verify these findings by using a larger national data sample and to determine whether there is a temporal relationship between infection and VTE. It is critical to determine the causal pathway between infection and VTE. Does infection precede VTE, suggesting that infection causes or raises the risk for VTE? Or does infection follow VTE, implying the opposite effect? Establishing this relationship could lead

to improved guidelines for the prevention, detection, and management of these life-threatening postoperative complications.

## MATERIALS AND METHODS

### Data Acquisition

The American College of Surgeons (ACS) National Surgical Quality Improvement Project (NSQIP) collects surgical outcomes data from participating hospitals around the United States. Data collected by NSQIP includes demographic characteristics, comorbid conditions, laboratory values, operation characteristics, postoperative outcomes, mortality, and hospital readmission. Clinical reviewers collect the information prospectively and follow patients for 30 days postoperation by using patient records and phone interviews. Further details regarding NSQIP are available at their Web site.<sup>21</sup> All patients undergoing colorectal surgery in the 2010 NSQIP Participant User File were identified by the use of relevant Current Procedural Terminology codes (44005–44799, 45000–45387, not 44180 (laparoscopic lysis of adhesions)). Inflammatory bowel disease status and colorectal cancer status were determined by the use of the International Classification of Diseases, Ninth Revision, Clinical Modification codes for those conditions that were primarily associated with the procedure diagnosis code.

### Outcomes and Variables

Development of VTE within 30 postoperative days was identified as the primary outcome. The secondary outcome was the number of days between developing infection and VTE. This outcome was determined as the number of days between the first infectious complication and diagnosis of VTE. The main variables of interest for this study were postoperative infectious complications that included superficial incisional SSI, deep SSI, organ space SSI, wound dehiscence, UTI, and pneumonia. Definitions for these variables are available in the NSQIP 2010 user guide.<sup>21</sup> Potential confounding and biologically associated variables were identified for inclusion in the analysis. Demographic variables were sex and age. Patient characteristics included BMI, disseminated cancer, current smoking status, IBD (Crohn's disease, ulcerative colitis), emergent status of the operation, and operative time.

Length of hospital stay was included in the descriptive analysis but eliminated from multivariable analysis because of the potentially confounding relationship between instances of VTE causing increased length of stay and length of stay being associated with increased risk of VTE. Similarly, return to the operating room for an additional procedure was included in the descriptive analysis but not in the multivariable regression because we were unable to determine whether there was a temporal relationship between return to the operating room and developing an infectious complication. The descriptive analysis also includes whether the patient had colorectal cancer. This is a known risk factor for VTE; however, there is crossover between patients with colorectal cancer and disseminated cancer. We decided to use disseminated cancer in the multivariable analysis because there was a significant difference in patients with disseminated cancer and VTE. Operative time was included as a binary variable (<180 minutes vs ≥180 minutes). Operative time has been used as a proxy for operative complexity, so we chose 180 because it was the 75th percentile

and enabled comparison of the most complex cases. Evidence of sepsis, either preoperatively or postoperatively, was not included in any of our analyses because there is variability in identified and reported patients in NSQIP as having sepsis. Finally, NSQIP does not provide data on whether patients received prophylaxis. Although we considered this a significant variable to include in our analyses, we were unable to do so for lack of data.

### Statistical Analysis

Descriptive statistics comparing the VTE vs non-VTE populations were performed. Missing data were dropped from the analysis because they accounted for only 5.5% of the total data ( $n = 2318$  of 42,149 cases) and resulted in dropping only 4.6% ( $n = 35$  of 764) of deep vein thromboses (DVTs) and 3.8% ( $n = 12$  of 319) of pulmonary embolisms (PEs). A category for BMI >40, corresponding to morbid obesity, was generated to account for the potential impact of outlying BMI data points and to determine whether extreme obesity was associated with VTE.

Logistic regression models, controlling for the aforementioned patient characteristics and postoperative infectious complications, were applied to evaluate the association between VTE with postoperative infectious complications. Similarly, the regression analyses were performed to examine the relationships with DVT and PE individually. These regression models examine the association between the odds of developing VTE and postoperative infections and are not intended to take the temporal relationship between the VTE and infection into account.

To evaluate the temporality between infectious complications and VTE, we categorized the infectious complications as occurring before, the same day as, or after VTE was diagnosed. Descriptive analysis was used to examine which infectious complications occurred more frequently in each group. Generalized linear models were used to determine the absolute relative risk increase per day for developing VTE after development of an infectious complication when controlling for age, BMI, smoking status, IBD, disseminated cancer, and emergent status. A priori, a  $p$  level of <0.05 was set as our threshold for statistical significance. All statistical analyses were performed by using Microsoft Excel and Stata version 12.1 (Statacorp, College Station, TX). Institutional review board approval was obtained.

The ACS NSQIP and the hospitals participating in the ACS NSQIP are the source of the data used herein; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors.

## RESULTS

A total of 39,831 patients undergoing colorectal surgery with complete data collection were identified from the NSQIP 2010 Participant User File database. The overall rate of VTE was 2.4% ( $n = 948$ ) with 729 (1.8%) patients diagnosed with DVT only, 307 (0.77%) patients diagnosed with PE only, and 88 (0.22%) patients diagnosed with both DVT and PE (Table 1). The patients developing VTE were more likely to have disseminated cancer ( $p < 0.001$ )

and be emergent cases ( $p < 0.001$ ) (Table 1). Twenty percent of patients who did not develop VTE experienced at least 1 postoperative infection that we were examining, whereas 45% of patients who developed a VTE were also identified as having at least 1 postoperative infectious complication (Table 1). Postoperative infectious complications were more likely to develop among the VTE patients ( $p < 0.001$ ) (Table 1). Seventy (7.4%) patients who developed VTE died within 30 days postoperation. Of these, 19 developed PE and 57 were identified as having a DVT. At least 1 postoperative infection, including SSI, pneumonia, UTI, and wound dehiscence, was developed by 8122 (20.4%) patients. The incidence of SSI was 12.4% ( $n = 4949$ ). The most common SSI was superficial SSI, which accounted for infections in 2755 individuals (6.9%). Excluding superficial SSI, 5.5% ( $n = 2197$ ) of patients developed a SSI. One hundred twenty-three individuals developed both VTE and a SSI (0.31% of the total population). Rates of SSI were higher among patients with VTE than without (21.0% vs 12.2%,  $p < 0.001$ ) (Table 1). This finding persisted when superficial SSIs were eliminated from the analysis (13.0% vs 5.3 %,  $p < 0.001$ ).

When controlling for patient characteristics and demographic factors, increased risk of developing VTE was associated with postoperative UTI, pneumonia, deep SSI, and organ space SSI (Table 2). With the exception of deep SSI, each of these postoperative infectious complications was associated with increased odds of developing both DVT and PE (Table 2). Development of any postoperative infectious complication was associated with 2.8 times the risk of VTE. Increased absolute daily risk for developing VTE, DVT, or PE was found for patients developing any postoperative infectious complication other than superficial SSI (Table 3). For example, patients with an organ space SSI were 2.2 times more likely to develop VTE. In those patients who developed an organ space SSI, there was a 0.74% daily increased risk of developing VTE throughout the 30-day postoperative period in comparison with patients who did not develop a postoperative organ space SSI.

Figure 1 examines the temporal relationship between postoperative infection and DVT. Among patients diagnosed with both DVT and a postoperative SSI, the infection was detected before or on the same day as DVT diagnosis for the majority of organ space SSI (69.6%), deep SSIs (85.0%), and episodes of wound dehiscence (79.1%) (Fig. 1A). Close to 20% of DVTs were diagnosed the same day as the postoperative infection (Fig. 1A). Deep vein thrombosis developed a median of 8 days (interquartile range (IQR), 2–11; mean, 7.6) after the infection. For deep SSI and wound dehiscence, DVT developed a median of 4 days (IQR, 1–15; mean, 7.7) and 7 days (IQR, 1–11; mean, 7.1) later (Fig. 1A). Twenty-eight percent of DVT patients developed the DVT after hospital discharge (Fig. 2).

Trends between infectious complications and subsequent development of PE were less dramatic (Fig. 1). For patients with PE, the majority of events were detected the same day or following SSI for organ space SSI (62.8%), deep SSI (54.5%), and wound dehiscence (56.3%) (Fig. 1B). Of these patients, 8 with organ space SSI, 3 with deep SSI, and 2 with wound dehiscence were diagnosed the same day as the patient's PE. The median number of days between the SSI and PE when infection developed before or on the same day as PE was 5.5 days (IQR, 0–11; mean, 6.7) for organ space SSI, 0.5 days (IQR, 0–11; mean, 8.0) for deep SSI, and 12 days (IQR, 3–16; mean, 10.7) for wound dehiscence (Fig. 1B). Forty-one

percent of the PE patients developed the PE after hospital discharge (Fig. 3). In patients with an SSI, this rate was 42%.

## DISCUSSION

We previously demonstrated, using data from a single institution, that patients undergoing colorectal surgery who develop VTE are more likely to concurrently develop SSIs in the postoperative period than are non-VTE patients.<sup>14</sup> Our finding of increased risk for VTE among patients undergoing colorectal surgery with an SSI is confirmed in the current nationwide sample. This finding was most evident in patients with an organ space SSI (OR, 2.2;  $p < 0.001$ ). Development of postoperative organ space SSI preceded DVT by a median of 8 days and PE by 5.5 days. Furthermore, there was a significant increase in daily risk for developing VTE following a postoperative infectious complication. These findings indicate that postoperative infections could represent an important clinical warning sign that a patient is more likely to develop VTE.

The 3 primary theories for explaining increased rates of VTE among patients with acute infections, as reviewed by Alikhan and Spyropoulos,<sup>1</sup> are immobilization of the patient, activation of the inflammatory response, and direct effects of the inflammatory response on the lungs and heart resulting in hemostasis. This theory that an inflammatory response might be the causal factor in developing VTE has been supported over the years by numerous studies.<sup>2,20,22,23</sup> A variety of chemokines and proinflammatory factors including Factor VIII, C-reactive protein, tissue factor, fibrinogen, and interleukin-8 have been investigated with varying results.<sup>1,2,4,20,22,23</sup> The role of Factor VIII as an acute phase response protein and risk factor for VTE has been identified in multiple studies.<sup>4,20,23–26</sup>

Patients undergoing colorectal surgery are at increased risk for postoperative infection for numerous reasons. Colorectal surgery wounds are frequently classified as clean-contaminated because of the spillage of GI tract fluids. Although colorectal procedures are being performed more frequently with the use of minimally invasive techniques, open procedures remain common and are associated with an increased risk of both infection and VTE.<sup>19,27,28</sup> Although our results did not entirely corroborate this, much of the literature suggests that the proinflammatory state of IBD is prothrombotic.<sup>17,18,29,30</sup> Although infection has previously been identified as a risk factor for VTE in medical patients,<sup>31,32</sup> there is a paucity of data available on the temporal relationship between VTE and infection in surgical patients. What information is available indicates that infection frequently precedes VTE; however, the quantification of this finding had not been explored.<sup>5,19</sup> It is important to note that, when interpreting our findings, we are unable to determine causality. Rather, what we present here demonstrates that there is an association between developing certain postoperative infectious complications and subsequent VTE. Whether this association is causal requires future prospective, controlled trials with large numbers of patients.

Our finding of a less clear temporal relationship between PE and infectious complications was unexpected considering the relationship demonstrated with DVT and the documented prothrombotic state that infectious complications create in the body.<sup>20,22,23</sup> A stronger



statistical relationship for DVT than PE may be expected, because DVT precedes PE and is more common than PE. Further, this could reflect patients who develop DVT related to the placement of a central venous catheter for management of infection.

It is interesting to note that a significant proportion of VTE was diagnosed on the same day as infection. This may be related to asymptomatic VTE being diagnosed at the time of workup for infection such as by CT scan, a classic example of surveillance bias.<sup>33</sup> In our institutional study, we found that 33% of the PEs were identified by CT the same day as infection was reported in the patient.<sup>14</sup> In this current study, we found that between 10% and 30% of PEs were identified the same day as an infection, varying based on the type of infection. This begs the question of what role surveillance bias plays in which patients are identified and treated for VTE. Additionally, which of these VTEs would have become clinically significant is unknown. A major implication related to the surveillance bias stemming from this study is the consideration of increased screening for VTE once a postoperative infection is identified.

What are some relevant clinical implications of our findings? Given its association with VTE, postoperative infections could be used to identify patients who warrant surveillance or more intensive VTE prophylaxis (combined pharmacomechanical prophylaxis). The use of duplex scanning or other newer methods such as D-dimer may be considered beneficial in this patient population as an inpatient or outpatient surveillance method. Because as many as one-third of VTEs occur after discharge,<sup>9,18</sup> postoperative infections could be used along with other risk factors to identify patients who should be prescribed postdischarge extended-duration VTE prophylaxis.<sup>18,34,35</sup> Iannuzzi et al<sup>36</sup> recently published a prediction model using nonorthopedic surgical cases that stratifies patients into low (<0.5%), medium (0.5%–1%), and high risk (1%–2%) for developing postdischarge VTE. The use of such prediction tools will likely play a large role in the identification of patients who would most benefit from increased surveillance in the future. Our study demonstrates that perhaps infectious complications could also be a risk factor included in such prediction tools. Further studies validating the use of prediction tools for the identification of patients who will most benefit from surveillance or extended prophylaxis are necessary.

Although this study included nearly 40,000 patients from a variety of medical institutions across the country, which reduces selection bias, it also leads to potential confounding factors from the various institutions. Although VTE prophylaxis guidelines are available,<sup>7,37</sup> varying levels of compliance have been reported across institutions that influence which patients develop VTE.<sup>37–39</sup> We evaluated our own compliance before exploring a relationship between VTE and postoperative infection and found our compliance to be 92% among patients with VTE<sup>14</sup>; however, this rate is probably different at other institutions. NSQIP does not currently provide VTE prophylaxis data for all patients, so we are unable to account for prophylaxis in our analysis. Some argue that this is a valuable process measure to include in future versions.<sup>15</sup> Many patients, as demonstrated in Table 1, required a second procedure. Although these patients might be at increased risk of developing VTE, we were unable to assess temporality with postoperative infections, and thus were not able to include this variable in our analysis.

Despite uniform training from ACS-NSQIP officers, the follow-up and degree of reporting from different institutions can be variable, leaving the validity of the data reliant on those who are recording and reporting it. However, because of the large number of patients included in this database, we do not expect this limitation to significantly influence our results. Furthermore, the findings from this study are supported by our earlier study that also demonstrated a significant association between infectious complications and VTE. Finally, a related limitation is the limited follow-up recorded through NSQIP. Although the NSQIP model has been validated for collecting postoperative complications out to 30 days, the risk of developing DVT and PE may remain high beyond this 30-day period.<sup>40</sup> With regard to variables, we were unable to examine if there was a relationship between placement of a central venous catheter and subsequent DVT because these data are unavailable from NSQIP.

Venous thromboembolism and SSI are known complications of colorectal surgery procedures. We identified a temporal association between organ space SSI and deep SSI with subsequent VTE development in the postsurgical population with daily increased risk of VTE development of 0.74% and 0.40%. Further research examining this relationship prospectively will guide the development of future prophylaxis guidelines and improve patient safety in the postsurgical setting.

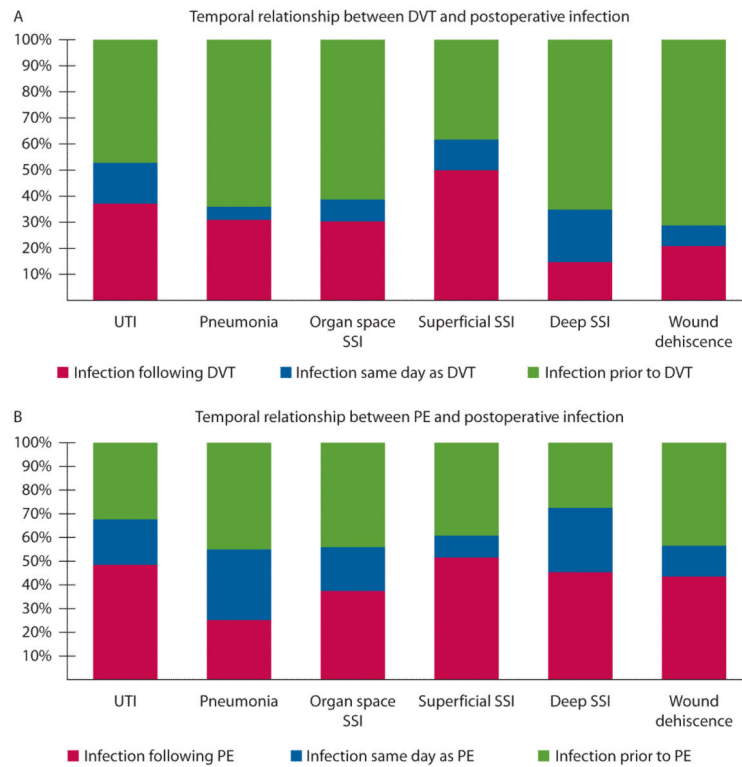
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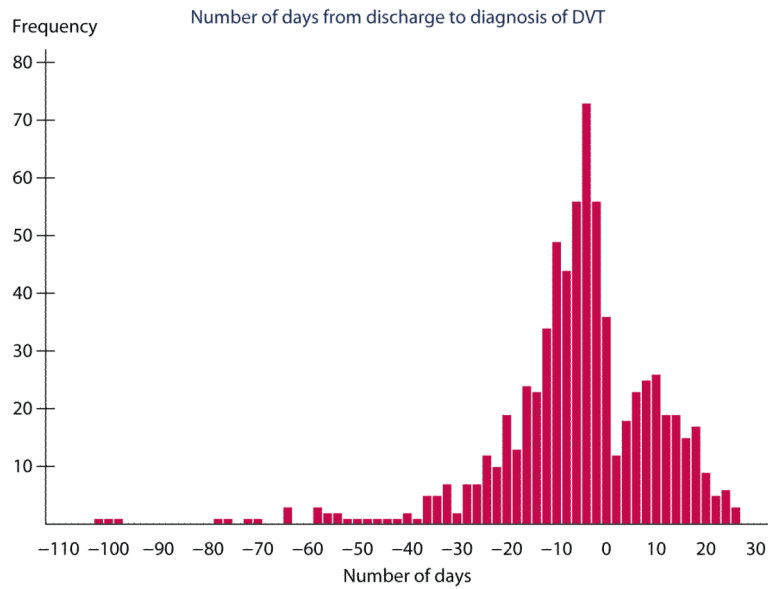


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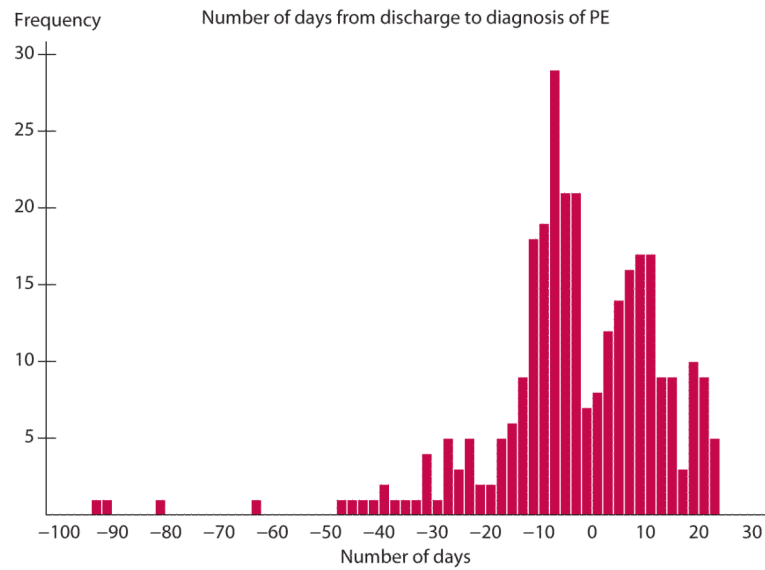
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**FIGURE 1.** Figures demonstrating the temporal relationship between identification of postoperative DVT (A) and PE (B) and postoperative infectious complications. These graphs examine the temporal relationship between infection and VTE by using the categories infection following VTE, infection the same day as VTE, and infection prior to VTE. Ten percent to 30% of patients developing PE had a postoperative infection identified the same day. DVT = deep vein thrombosis; PE = pulmonary embolism; UTI = urinary tract infection; SSI = surgical site infection; VTE, venous thromboembolic event.



**FIGURE 2.** This chart demonstrates the number of days between the diagnosis of DVT and discharge. Negative numbers represent DVT diagnosis that occurred before hospital discharge, whereas positive numbers represent DVT diagnosis postdischarge. Twenty-eight percent of patients were diagnosed with DVT postdischarge. The number of days between diagnosis and discharge was not calculated for 24 patients with missing data. DVT = deep vein thrombosis



**FIGURE 3.** This chart demonstrates the number of days between diagnosis of PE and discharge. Negative numbers represent PE diagnosis that occurred before hospital discharge, whereas positive numbers represent PE diagnosis postdischarge. Forty-one percent of patients were diagnosed with PE postdischarge. The number of days between diagnosis and discharge was not calculated for 8 patients with missing data. PE = pulmonary embolism.

TABLE 1

Baseline characteristics of the study populations

	VTE (n = 948)	No VTE (n = 38,883)	p <sup>a</sup>
Sex (female)	495 (52)	20,635 (53)	0.603
Age, y (SD)	65 (15)	61 (16)	<0.001
BMI category (kg/m <sup>2</sup> )			0.001
Normal weight (BMI <25)	329 (35)	14,430 (37)	
Overweight (BMI 25–30)	265 (28)	12,239 (31)	
Obese (BMI 30–40)	283 (30)	10,021 (26)	
Morbid obesity (BMI >40)	71 (7)	2193 (6)	
Emergent status	359 (38%)	7755 (20)	<0.001
Median length of stay, d (IQR)	15 (9–25)	6 (4–11)	
Median days from admission to PE (IQR)	13 (7–21)	–	
Median days from admission to DVT (IQR)	13 (8–20)	–	
IBD			0.003
Ulcerative colitis	32 (3)	946 (2)	
Crohn's disease	14 (1)	1206 (3)	
Colorectal cancer	196 (20)	8898 (23)	0.067
Current smoker	151 (16)	7661 (20)	0.004
Disseminated cancer	82 (9)	1933 (5)	<0.001
Operative time, mean min (SD)	155 (100)	146 (93)	0.004
Return to operating room	207 (22)	2615 (6.7)	<0.001
Postoperative infectious complication	425 (45)	7697 (20)	<0.001
Postoperative SSI	199 (21)	4750 (12)	<0.001
Postoperative UTI	86 (9)	1321 (3)	<0.001
Postoperative pneumonia	117 (12)	1265 (3)	<0.001
Postoperative wound dehiscence	36 (4)	623 (2)	<0.001

Values are n (%) except where otherwise noted. Percentages are rounded to the nearest whole number so percentages may not add to 100%.

VTE = venous thromboembolism; IQR = interquartile range; SSI = surgical site infection; UTI = urinary tract infection; DVT = deep vein thrombosis; PE = pulmonary embolism.

<sup>a</sup> $\chi^2$  for categorical, *t* test for continuous.



TABLE 2

Relationship between postoperative infectious complications and the risk of VTE, DVT, and PE

Postoperative infection	VTE adjusted OR <sup>a</sup> (95% CI)	DVT adjusted OR (95% CI)	PE adjusted OR (95% CI)
Sex (female)	0.93 (0.81–1.06)	0.89 (0.76–1.03)	0.94 (0.75–1.18)
Age	1.02 (1.01–1.02)	1.02 (1.01–1.02)	1.02 (1.01–1.02)
BMI category (kg/m <sup>2</sup> )			
Normal weight (BMI <25)	Reference	Reference	Reference
Overweight (BMI 25–30)	0.99 (0.84–1.17)	0.95 (0.79–1.15)	1.24 (0.92–1.69)
Obese (BMI 30–40)	1.35 (1.14–1.59)	1.24 (1.02–1.49)	1.84 (1.37–2.47)
Morbid obesity (BMI >40)	1.48 (1.13–1.93)	1.17 (0.84–1.62)	2.71 (1.79–4.10)
Smoker	0.84 (0.70–1.01)	0.78 (0.63–0.97)	0.97 (0.72–1.32)
IBD			
Ulcerative colitis	1.99 (1.37–2.90)	2.34 (1.99–2.74)	1.33 (0.61–2.88)
Crohn's disease	0.85 (0.50–1.46)	1.28 (1.08–1.51)	0.76 (0.28–2.07)
Disseminated cancer	1.74 (1.38–2.20)	1.57 (1.19–2.07)	2.14 (1.47–3.12)
Emergent status	2.23 (1.94–2.57)	2.34 (1.99–2.74)	1.83 (1.43–2.36)
Intraoperative time >180 min	1.26 (1.09–1.47)	1.28 (1.08–1.51)	1.15 (0.89–1.50)
UTI	1.99 (1.57–2.53)	2.01 (1.54–2.63)	2.01 (1.36–2.97)
Pneumonia	2.55 (2.06–3.17)	2.36 (1.85–3.02)	2.81 (1.98–3.98)
Superficial SSI	1.17 (0.93–1.47)	1.10 (0.84–1.44)	1.37 (0.95–1.98)
Deep SSI	1.49 (1.00–2.23)	1.48 (0.93–2.35)	1.74 (0.93–3.26)
Organ space SSI	2.24 (1.79–2.81)	2.03 (1.56–2.65)	2.98 (2.12–4.20)
Wound dehiscence	1.36 (0.95–1.95)	1.20 (0.78–1.85)	1.61 (0.94–2.75)

VTE = venous thromboembolism; DVT = deep vein thrombosis; PE = pulmonary embolism; UTI = urinary tract infection; SSI = surgical site infection.

<sup>a</sup>Odds ratios are for multiple logistic regression models and are adjusted for all variables in the chart.

TABLE 3

Absolute risk of developing VTE following postoperative infectious complication

Postoperative infection	VTE increasing risk/day <sup>a</sup>	DVT increasing risk/day	PE increasing risk/day
UTI <sup>b</sup>	+0.71 (0.58–0.84)	+0.74 (0.60–0.88)	+0.85 (0.63–1.06)
Pneumonia <sup>c</sup>	+1.00 (0.89–1.12)	+0.88 (0.75–1.02)	+1.39 (1.20–1.59)
Superficial SSI <sup>d</sup>	+0.10 (–0.07–0.27)	+0.08 (–0.12–0.28)	+1.38 (–0.14–0.42)
Deep SSI <sup>e</sup>	+0.40 (0.17–0.64)	+0.43 (0.16–0.70)	+0.58 (0.25–0.92)
Organ space SSI <sup>f</sup>	+0.74 (0.62–0.87)	+0.66 (0.51–0.81)	+1.22 (1.05–1.39)
Wound dehiscence <sup>g</sup>	+0.41 (0.19–0.63)	+0.29 (0.02–0.57)	+0.58 (0.25–0.91)

Values shown are % (95% CI).

VTE = venous thromboembolism; DVT = deep vein thrombosis; PE = pulmonary embolism; UTI = urinary tract infection; SSI = surgical site infection.

<sup>a</sup>Increasing risk of developing VTE following infectious complications was determined by using generalized linear models. The risk is adjusted for sex, age, BMI, smoking status, IBD status, disseminated cancer, emergent status, and operative time.

<sup>b</sup>Number of patients with UTI and DVT, 66; UTI and PE, 33.

<sup>c</sup>Number of patients with pneumonia and DVT, 86; pneumonia and PE, 44.

<sup>d</sup>Number of patients with superficial SSI and DVT, 61; superficial SSI and PE, 33.

<sup>e</sup>Number of patients with deep SSI and DVT, 20; deep SSI and PE, 11.

<sup>f</sup>Number of patients with organ space SSI and DVT, 69; organ space SSI and PE, 43.

<sup>g</sup>Number of patients with wound dehiscence and DVT, 24; wound dehiscence and PE, 16.