Identifying Patients at High Risk for Venous Thromboembolism Requiring Treatment After Outpatient Surgery

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Objective: To identify independent predictors of 30-day venous thromboembolism (VTE) events requiring treatment after outpatient surgery.

Background: An increasing proportion of surgical procedures are performed in the outpatient setting. The incidence of VTE requiring treatment after outpatient surgery is unknown.

Methods: Prospective observational cohort study using the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database from 2005 to 2009. Adult patients who had outpatient surgery or surgery with subsequent 23-hour observation were included. The main outcome measure was 30-day VTE requiring treatment. Patients were randomly assigned to derivation (N = 173,501) or validation (N = 85,730) cohorts. Logistic regression examined independent risk factors for 30-day VTE. A weighted risk index was created and applied to the validation cohort. Stratified analyses examined 30-day VTE by risk level.

Results: Thirty-day incidence of VTE for the overall cohort was 0.15%. Independent risk factors included current pregnancy (adjusted odds ratio [OR] = 7.80, $P = 0.044$), active cancer (OR = 3.66, $P = 0.005$), age 41 to 59 years (OR = 1.72, $P = 0.008$), age 60 years or more (OR = 2.48, $P < 0.001$), body mass index 40 kg/m^2 or higher (OR = 1.81, $P = 0.015$), operative time 120 minutes or more (OR = 1.69, $P = 0.027$), arthroscopic surgery (OR = 5.16, $P < 0.001$), saphenofemoral junction surgery (OR = 13.20, $P < 0.001$), and venous surgery not involving the great saphenous vein (OR = 15.61, $P < 0.001$). The weighted risk index identified a 20-fold variation in 30-day VTE between low (0.06%) and highest risk (1.18%) patients.

Conclusions: Thirty-day VTE risk after outpatient surgery can be quantified using a weighted risk index. The risk index identifies a high-risk subgroup of patients with 30-day VTE rates of 1.18%.

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In the past decade, there has been a major shift from inpatient to outpatient surgery, with more than 60% of procedures now being performed on an outpatient basis.[1] Outpatient surgery, including general surgery, surgical oncology, spine surgery, plastic and reconstructive surgery, and orthopedic surgery, is now common among multiple surgical specialties.[2–11]

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Outpatient surgical management of many disorders has been shown to be safe. However, the outpatient surgical population has known risk factors for perioperative venous thromboembolism (VTE). These risk factors include advanced age, obesity, active cancer, abdominal insufflation, arthroscopy, and procedures involving extended operative times.[12–20]

Although VTE has received significant attention in the inpatient surgical population, it has historically been considered a rare event among outpatient surgical patients. However, existing data focused on VTE after outpatient surgery are limited to retrospective single- or 2-center studies with small sample sizes. The retrospective and self-reporting methodology of these studies results in reported VTE rates of 0.001% to 0.043% that likely underestimate the true event rate.[5,9,21]

The outpatient surgery population is a prescreened group expected to achieve excellent postoperative outcomes. Historically, medical personnel preferentially selected young, healthy individuals to undergo surgery in this setting. As the outpatient setting continues to increase its proportion of all procedures,[1] a large volume of healthy individuals in the VTE denominator may mask a distinct, higher risk group of patients within the overall outpatient surgery population. Despite an increase in the prevalence of VTE risk factors such as advanced age and obesity, survey data continue to demonstrate that only 50% of institutions have existing protocols for day-case VTE prophylaxis. Among institutions with protocols, compliance has been shown to be poor.[22]

Using a prospectively collected national 30-day outcomes surgery registry, we sought to establish the definitive VTE incidence after outpatient surgery. We hypothesized that VTE rates were higher than previously reported using retrospective and self-reporting techniques. Next, we sought to identify independent risk factors for 30-day VTE events among outpatient surgery patients and to create and validate a novel risk index. We hypothesized that high-risk patients would exhibit event rates warranting further investigation into outpatient surgery VTE prophylaxis.

METHODS

The American College of Surgeons' National Surgical Quality Improvement Program Participant Use File (ACS-NSQIP PUF) database is a de-identified, publicly available Health Insurance Portability Accountability Act-compliant data set. We obtained institutional review board approval and exemption before undertaking this project. Because no care interventions were mandated and no protected health information was available, signed patient consent was waived.

The ACS-NSQIP methodology has previously been described in detail.[23,24] A systematic sampling method is employed. All operations performed under general, spinal, or epidural anesthesia are eligible for NSQIP inclusion. Operations are divided into 8-day cycles. At each NSQIP site, the first 40 operations performed within each 8-day cycle are included in the database. To ensure heterogeneity, cases with high volume and low risk (such as breast lumpectomy

or inguinal hernia repair) are capped at 5 cases per cycle. At present, there are more than 250 medical centers that contribute data to ACS-NSQIP PUF.

At each ACS-NSQIP site, a trained clinical nurse is assigned for data review and collection. Each reviewer completes in-depth training on data collection methods. Periodic site reviews are performed to examine interrater reliability. Reliability has been shown to be excellent, with less than 1.5% variable disagreement during formal annual audits.[23] Sites with interrater reliability rates less than 95% are excluded from the ACS-NSQIP PUF. Patient demographic and comorbidity data are collected prospectively. On postoperative day 30, the clinical nurse obtains outcome data through medical record review and examination of institutional death and complications conferences. In addition, individual patient follow-up is conducted via letter or telephone to identify complications diagnosed and/or treated at other institutions. Patients with incomplete 30-day outcome data are not included in the database.

ACS-NSQIP PUF Variables Analyzed

All adult patients whose surgery was listed as outpatient and who had a length of stay equal to zero days were included for analysis in the ACS-NSQIP PUF between 2005 and 2009. This included patients who either had same-day surgery or a 23-hour observation after surgery.

Outcome Variables

Our primary outcome was a composite VTE variable, including patients with deep vein thrombosis (DVT) and/or pulmonary embolism (PE). Our secondary outcome was time to DVT or PE. DVT is considered to be a new thrombus within the venous system that is confirmed using an objective imaging method (eg, duplex ultrasound or computed tomographic scan). Patients must be treated with anticoagulation, inferior vena cava (IVC) filter placement, or IVC ligation. *PE* is defined as an obstructing thrombus within the pulmonary arterial system. PE requires confirmation using an objective imaging method (eg, computed tomography scan or arteriogram). Complete definitions of DVT and PE are provided in the Appendix (Supplemental Digital Content, available at http://links.lww.com/SLA/A240).

Patient Variables

Basic demographic data were analyzed including age, sex, and body mass index (BMI). Patient comorbidities included the following: congestive heart failure, chronic obstructive pulmonary disease, peripheral vascular disease, diabetes requiring medication (insulin or oral therapy), renal failure requiring dialysis, current smoking, current pregnancy, and prior operation within 30 days. Intraoperative variables of interest included type of anesthesia (general vs nongeneral), operative time, and primary Current Procedural Terminology (CPT) coding for the procedure. The primary CPT codes were used to define surgical variables including venous surgery at the saphenofemoral junction, venous surgery that did not involve the great saphenous vein (GSV) (eg, procedures that involved the short saphenous vein, perforator veins, or varicose veins), arthroscopic surgery of major joints (shoulder, elbow, hip, knee), and laparoscopic abdominal surgery. Independent study variables are defined in the Appendix.

Statistical Analysis

Statistical analysis was performed using the SPSS version 19 statistical package (IBM, Armonk, NY). All patients meeting our inclusion criteria were randomly allocated to a derivation (67%) and validation (33%) cohort. Descriptive statistics on the incidence of DVT, PE, and VTE were generated. To determine independent predictors and risk scoring of VTE, a nonparsimonious logistic regression model was developed in the derivation cohort. We used the validation cohort to determine risk index validity. Descriptive statistics were performed on all categorical data elements to look for associations with VTE using either Pearson χ^2 or Fisher exact tests where appropriate. For ease of usability in creating a risk index, the continuous data elements age, BMI, and operative time were transformed into categorical data. Age was categorized into less than 40, 40 to 59, and 60 or more years. BMI was categorized into lower than 25, 25 to 39, and 40 kg/m^2 or higher. Operative time was categorized into less than 60, 60 to 119, and 120 or more minutes.

Collinearity and Pearson correlations were evaluated for all variables (Table 1) entered into the model for the derivation cohort. All variables were entered into the nonparsimonious logistic regression model to determine independent predictors of VTE. Because age, BMI, and operative time were categorized, the lowest category was considered the reference variable in the model. Any variable with a $P < 0.05$ was considered an independent predictor of VTE. The predictive value of the derivation model was assessed using a receiver operating characteristic curve area under the curve (ROC AUC). The adjusted odds ratio was evaluated as a measure of effect size for each independent predictor.

An unweighted and an weighted risk indices were calculated for each patient in the derivation cohort. The unweighted risk index assigned one point for each independent predictor as identified in the logistic regression model. To create the weighted risk index, the β coefficient for each independent predictor was divided by the smallest β coefficient of the independent predictors. This value was multiplied by 2 and rounded to the nearest integer, in a manner previously described by others.[25] The unweighted and weighted risk indices were each treated as a continuous independent variable.

The discriminating capacity of unweighted and weighted risk scores for VTE were compared using ROC AUC and stratified analysis. The weighted risk score was subsequently applied to the validation cohort. A stratified analysis examining 30-day VTE incidence by risk score was performed in the validation cohort. These results were compared to stratified analysis performed in the derivation cohort.

RESULTS

Using ACS-NSQIP 2005–2009 data, a total of 259,231 patients had length of stay equal to zero days and an "In-/Out-patient Status" variable value of "outpatient." Of these, 173,501 patients were randomly assigned to the derivation cohort. Among derivation cohort patients, the incidence of DVT was 0.12% (209 patients) and PE was 0.038% (66 patients). The incidence of VTE, defined as patients with DVT and/or PE, was 0.15% (254 patients). Among patients with VTE, 8.2% (21 patients) had both DVT and PE. A description of primary procedure type is provided in Table 2.

Collinearity diagnostics did not demonstrate any condition index above 30. Therefore all variables in Table 1 were entered into the nonparsimonious logistic regression model with the development of VTE as the dependent dichotomous variable. In the derivation cohort, the logistic model included 89.4% (n = 155,151) patients with complete data and demonstrated the following as independent predictors ($P < 0.05$) of VTE: arthroscopic surgery, current pregnancy, active cancer, non-GSV venous surgery, saphenofemoral junction surgery, age 40 to 59 years, age 60 years or more, BMI 40 kg/m^2 or higher, and operative time 120 minutes or more (Table 3). The Omnibus Tests of Model Coefficients demonstrated a χ^2 of 300.774, degrees of freedom of 21 and $P < 0.001$. The Hosmer and Lemeshow test demonstrated a χ^2 of 4.334, degrees of freedom of 8 and $P = 0.826$. The ROC AUC was 0.77 $\pm$ 0.02 (ROC AUC $\pm$ standard error). The median time-to-event for VTE was postoperative day 8 (interquartile range postoperative day 5–13).

TABLE 1. Comparison of Independent Variables Between Patients Who Did or Did Not Have VTE Events

	No DVT/PE (N = 173,247)	Yes DVT/PE (N = 254)	Odds Ratio (95% Confidence Interval)
Male sex	72,221 (43%)	106 (41%)	0.9 (0.7–1.2)
Age, yrs			
<40	41,489 (24%)	33 (13%)	Reference
40–59	76,472 (44%)	119 (47%)	2.0 (1.3–2.9)
≥60	55,286 (32%)	102 (40%)	2.3 (1.6–3.4)
BMI, kg/m^2			
<25	51,685 (30%)	64 (25%)	Reference
25–39	105,728 (61%)	162 (64%)	1.2 (0.9–1.7)
≥40	12,616 (7.3%)	26 (10%)	1.7 (1.1–2.6)
Current smoker	32,831 (19%)	39 (15%)	0.8 (0.6–1.1)
Pregnancy	241 (0.1%)	1 (0.4%)	2.8 (0.4–20.1)
Active cancer	1455 (0.8%)	5 (2.0%)	2.4 (1.0–5.8)
Congestive heart failure	201 (0.1%)	1 (0.4%)	3.4 (0.5–24.4)
Chronic obstructive pulmonary disease	3492 (2.0%)	9 (3.5%)	1.8 (0.9–3.5)
Diabetes	15,063 (8.7%)	18 (7.1%)	0.8 (0.5–1.3)
Peripheral vascular disease	1360 (0.8%)	2 (0.8%)	1.0 (0.2–4.0)
Preoperative dialysis	2473 (1.4%)	3 (1.2%)	0.8 (0.2–2.6)
Prior operation within 30 days	2295 (1.4%)	5 (2.1%)	1.5 (0.6–3.5)
General anesthesia	136,899 (79%)	206 (81%)	1.1 (0.8–1.6)
Arthroscopy procedure	6899 (4.0%)	30 (12%)	3.2 (2.2–4.7)
Abdominal laparoscopic procedure	37,134 (21%)	38 (15%)	0.6 (0.5–0.9)
Saphenofemoral junction procedure	5575 (3.2%)	59 (23%)	9.1 (6.6–12.2)
Non-GSV venous surgery	2584 (1.5%)	30 (12%)	8.8 (6.0–13.0)
Operative time, min			
<60	109,113 (63%)	135 (53%)	Reference
60–119	53,017 (31%)	95 (38%)	1.4 (1.1–1.9)
≥120	8717 (5.0%)	23 (9.1%)	2.1 (1.4–3.3)

TABLE 2. Derivation cohort Categorized by Primary Procedure Type

CPT Range of Primary Procedure	Type of Operation by Organ System or Area of Body	Total Patients (N = 173,501), n (% of Total Population)	Patients With DVT/PE (N = 254), n (% Incidence Within CPT Group)
10000–19999	Integument	37,389 (22)	16 (0.04)
20000–29999	Musculoskeletal	15,824 (9.1)	40 (0.25)
30000–33999	Respiratory and cardiovascular	177 (0.1)	0 (0)
34000–37799	Arteries and veins	11,097 (6.4)	94 (0.85)
38000–39999	Hemic and lymphatic system, mediastinum, and diaphragm	1640 (0.9)	8 (0.49)
40000–43499 and 69500–69650	Head and neck, esophagus	2529 (1.5)	0 (0)
43500–43999	Foregut (stomach, including gastric bypass procedure)	2824 (1.6)	2 (0.07)
44000–46999	Hindgut (small bowel, large bowel, rectum, and anus)	8074 (4.7)	8 (0.10)
47000–48999	Liver, biliary system, and pancreas	23,436 (13)	20 (0.09)
49000–49490	Miscellaneous peritoneal procedures	1530 (0.9)	4 (0.26)
49491–49999	Herniorrhaphy	57,349 (33)	54 (0.09)
50000–53999	Urinary system	2147 (1.2)	1 (0.05)
54000–59999	Genital system (male or female)	3398 (2.0)	2 (0.06)
60000–60999	Endocrine	5161 (3.0)	5 (0.10)
61000–64999	Nervous system structures	926 (0.5)	0 (0)

The unweighted and weighted risk indices were based on the independent predictors. The unweighted risk index in the derivation cohort demonstrated a ROC AUC of 0.71 ± 0.02. The weighted risk index in the derivation cohort demonstrated a ROC AUC of 0.76 ± 0.02. The 95% confidence intervals between the unweighted and weighted risk indices in the derivation cohort did overlap, which indicates they were not statistically different. However, when compared to the unweighted index, the weighted risk index provided a clinically relevant improvement in risk discrimination between low, moderate, high, and highest risk patients. The weighted risk-index from the derivation model is shown in Figure 1 and was applied to the validation cohort.

A total of 85,730 patients had been randomly assigned to the validation cohort. The incidence of DVT was 0.10% (87 patients) and PE was 0.043% (37 patients). VTE incidence was 0.13% (112 patients). At each risk level, the observed incidence of VTE was

TABLE 3. Independent Predictors of VTE From Multivariable Logistic Regression Model

Risk Factor	Adjusted Odds Ratio (95% Confidence Interval)	*P*
Male gender	1.09 (0.83–1.42)	0.530
General anesthesia	1.38 (0.98–1.95)	0.062
Arthroscopic surgery	5.16 (3.33–7.99)	<0.001
Abdominal laparoscopy	1.32 (0.88–1.96)	0.177
Current pregnancy	7.80 (1.06–57.54)	0.044
Active cancer	3.66 (1.49–8.99)	0.005
Congestive heart failure	3.20 (0.425–24.06)	0.259
Chronic obstructive pulmonary disease	1.89 (0.95–3.77)	0.071
Diabetes requiring medication	0.69 (0.42–1.13)	0.143
Peripheral vascular disease	0.68 (0.17–2.78)	0.593
Current smoker	1.01 (0.71–1.43)	0.965
Renal failure on dialysis	1.42 (0.44–4.53)	0.560
Prior operation within 30 days	1.49 (0.61–3.65)	0.384
Saphenofemoral junction surgery	13.20 (9.31–18.73)	<0.001
Non-GSV venous surgery	15.61 (10.23–23.83)	<0.001
Age, yrs		
<40	Reference	—
41–60	1.72 (1.15–2.57)	0.008
≥60	2.48 (1.64–3.77)	<0.001
BMI, kg/m^2		
<25	Reference	—
25–39	1.15 (0.85–1.57)	0.358
≥40	1.81 (1.12–2.92)	0.015
Total operative time, min		
<60	Reference	—
60–119	1.21 (0.92–1.60)	0.175
≥120	1.69 (1.06–2.67)	0.027

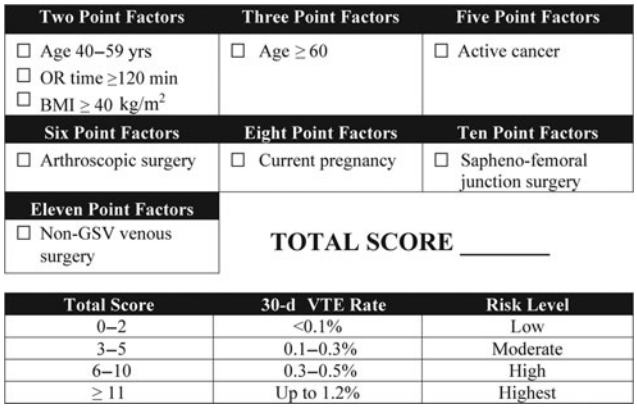

FIGURE 1. Weighted risk index for 30-day VTE events after outpatient surgery.

very similar between the derivation and validation sets (Fig. 2). The weighted risk index in the validation model demonstrated a ROC AUC of 0.78 ± 0.03, which is nearly identical to the weighted risk index in the derivation model.

Of 11,428 "highest risk" patients, 97% (11,106 patients) had either saphenofemoral junction surgery or non-GSV venous surgery. However, the majority of patients in the "highest risk" group also had multiple VTE risk factors: 8976 patients (78.5%) had 2 risk factors, 1727 (15.1%) had 3 risk factors, and 86 (0.8%) had 4 risk factors, which independently contributed to VTE risk. Only 644 (5.6%) "highest risk" patients had non-GSV venous surgery as an isolated

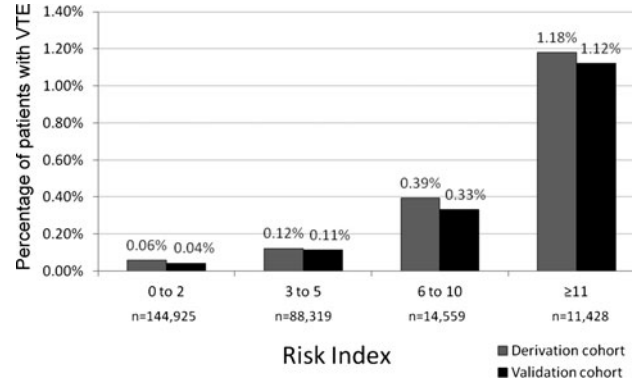

FIGURE 2. Observed rates of VTE stratified by weighted risk index.

risk factor. Using the weighted risk index, a total of 14,559 patients were classified as "high risk." Only 9.1% (1335 patients) of "high risk" patients had some form of venous procedure.

DISCUSSION

Using a multicenter, prospective observational surgical outcomes database of more than 200,000 procedures, we have demonstrated that the 30-day incidence of VTE requiring therapy after outpatient surgery is 0.15% overall and 1.18% among "highest risk" patients. In a logistic regression model, multiple independent predictors of VTE were identified (Table 3). The weighted risk index (Fig. 1) explained 78% of the variability in VTE in a distinct validation cohort and allowed discrimination between low- and high-risk patients. Patients categorized as "highest risk" using our risk index were at almost 20-fold increased risk for 30-day VTE events when compared to those categorized as "low risk" (1.18% vs 0.06%, Fig. 2). Although this novel risk index explains a large proportion of the variability in 30-day VTE risk and is the first risk index targeted toward outpatient surgery patients, it is not a definitive risk prediction tool. Important predictor variables such as personal or family history of VTE, use of hormone replacement therapy, and inflammatory bowel disease, among others, are not tracked as independent variables in ACS-NSQIP. Incorporation of these recognized risk factors into the presented risk index is an important next step for further research.

The scope of ambulatory surgery continues to expand, driven both by economics and patient convenience. Recent systematic reviews confirm that patients previously considered to be at high risk can safely undergo outpatient operative procedures. These patients include those with morbid obesity, obstructive sleep apnea, coronary artery disease, diabetes, and advanced age.[26,27] Current ambulatory surgery risk scoring systems have been focused on composite outcomes such as unanticipated hospital admission, ability to be discharged from the postanesthesia care unit, and mortality.[28–31]

Fleisher et al[32] have used a representative sample from 5 years of Medicare data (1994–1999) to examine hospital readmission after outpatient surgery. Subsequently, Fleisher et al used Agency for Healthcare Research and Quality data to create and validate a weighted risk assessment model to predict hospital readmission after outpatient surgery.[33] These studies identified (among others) advanced age, operative time more than 120 minutes, and malignancy as predictors of hospital readmission. Interestingly, these 3 factors were also significantly associated with postoperative VTE in our analysis of the ACS-NSQIP PUF data.

VTE has been identified as a major patient safety and quality of care issue by policymakers and payers.[34–38] The US Surgeon

General's 2008 Call to Action promoted development of evidence-based guidelines for VTE risk assessment and prophylaxis.[34,35] The Surgical Care Improvement Project, a national partnership whose goal is to improve the quality of surgical care through reduction in postoperative complications, has identified VTE prevention and VTE prophylaxis as indicators of quality care.[39] These efforts have been focused on the inpatient surgical population and identifying appropriate VTE chemoprophylaxis guidelines.

Our data are the first to demonstrate that even in the prescreened ambulatory setting, VTE requiring therapy afflicts 1 in every 84 highest risk patients. Although the vast majority (97%) of these "highest risk" patients had some form of venous procedure, a similar proportion of patients (94%), had risk factors others than the surgical procedure, which contributed to their elevated risk level. This underscores the importance of a weighted risk-stratification model as opposed to a risk assessment based on procedure type alone. Among the 14,559 "high risk" patients, fewer than 10% had a venous procedure performed, yet 1 of every 250 patients (0.39%) experienced VTE requiring treatment. These data are in stark contrast to provider and patient expectations that outpatient surgery is a low-risk event. As an increasing proportion of procedures are transitioned to the outpatient setting, policymakers, providers, and researchers must focus attention on developing VTE mechanical prophylaxis and chemoprophylaxis guidelines for this unique patient population with challenging follow-up logistics. Currently, fewer than 50% of outpatient centers have guidelines and even fewer adhere to them.[22]

Our data provide internists, proceduralists, and anesthesiologists with a method to estimate a proportion of patient's VTE risk during the preoperative optimization, intraoperative, and follow-up period. In addition, the risk index may improve the informed consent process by providing clear, data-driven information to patients.[40,41] However, those who use these data to estimate VTE risk must understand its inherent limitations as discussed later. When estimating perioperative VTE risk, providers must take into account the independent risk factors identified by our study and plausible risk factors that we were unable to evaluate, including personal or family history of VTE, known thrombophilia, use of hormone replacement therapy or oral contraceptive pills, and inflammatory bowel disease, among others.

Prior research has attempted to quantify VTE risk using weighted, point-based risk models. Variations of the widely used Caprini risk assessment model have been validated in a variety of patients and surgery types.[42–48] However, no VTE risk model has either been developed or validated specifically for the outpatient surgery population. Using our risk index, the highest risk outpatients had observed 30-day VTE rates of 1.18%. Interestingly, this rate is approximately twice as high as low-risk inpatients who underwent general, vascular, urologic, or plastic and reconstructive surgery (0.61%–0.70%) and similar to the observed VTE rate among the overall inpatient population (1.44%).[42,46]

Limitations

Our results have several limitations, many of which are secondary to inherent limitations of the ACS-NSQIP database. ACS-NSQIP does not track personal or family history of VTE or known thrombophilia as independent variables, although these are recognized contributors to VTE risk.[12,13,16,34,35,38] Absence of these variables may account for the 22% of the variability in VTE events not explained by our risk index. In addition, ACS-NSQIP has no data on administration of VTE prophylaxis. There is no recorded data on use of mechanical prophylaxis, such as elastic compression stockings or sequential compression devices, and/or use of chemoprophylaxis, such as unfractionated heparin or low-molecular weight heparin. Thus, we cannot provide a data-driven discussion of VTE prevention after day-case surgery. Prevention of VTE after outpatient surgery is an important topic for future research.

Our current risk model is not definitive as it could not include many recognized risk factors for VTE. This may explain the 22% of variability in 30-day VTE, which was not explained in our model. Inclusion of well-recognized risk factors and prophylaxis measures like personal or family history of VTE, known thrombophilia, and use of mechanical or chemoprophylaxis as independent variables in future versions of ACS-NSQIP will augment the results presented here and allow a more robust, comprehensive risk stratification tool to be created. In addition, we have reported on the importance of active cancer as an independent risk factor. Surgery for breast cancer is often performed in the outpatient setting. Thus, confounding may be present for our active cancer variable as the NSQIP does not contain data on use of tamoxifen, which is a recognized risk factor for VTE.[49] Inclusion of both active cancer and tamoxifen use in future regression models could control for this potential confounding factor. Our model identifies current pregnancy as an independent risk factor for VTE after outpatient surgery. The presumed mechanism of this risk is increased estrogen levels. Oral contraceptive pills or hormone replacement therapy are additional source of exogenous estrogen. Unfortunately, these could not be included as risk factors in our risk index. Use of oral contraceptive pills or hormone replacement therapy are not tracked as independent variables by ACS-NSQIP.

The ACS-NSQIP database contains 30-day outcomes based on both medical record review and mandatory phone or letter contact. Thus, the reported DVT and PE rates are likely to represent the vast majority of VTE events within 30 days. However, previous studies demonstrate that VTE risk remains elevated for at least 60 to 90 days after surgery.[46,50] Events that occur after postoperative day 30 are not recorded in the ACS-NSQIP database. Thus, our reported rates of DVT and PE likely underestimate the true incidence of postoperative VTE.

Finally, VTE events in ACS-NSQIP most likely represent symptomatic VTE because screening duplex ultrasound is not routinely used in the outpatient setting. One notable exception is GSV ablation procedures, in which routine postoperative duplex is performed to assess endovenous closure level.[51,52] We controlled for this potential confounder by creating a separate saphenofemoral junction surgery variable, which was used as an independent variable in our logistic regression model. Rates of postsurgical, asymptomatic VTE have been shown to be high in other patient populations.[53–57]

CONCLUSIONS

We present a weighted risk index to assist clinicians in understanding factors that contribute to 30-day VTE risk in the outpatient surgery population. The risk index provides excellent discrimination between high- and low-risk patients. We have observed that "highest risk" patients undergoing outpatient surgery have an almost 20-fold increase in risk of VTE requiring therapy and demonstrate a VTE burden similar to the inpatient surgical population. Further research is necessary to (1) create a comprehensive VTE risk model for outpatient surgery patients by combining our risk index with other recognized VTE risk factors and (2) examine the risks, benefits, and cost of mechanical and chemoprophylaxis for patients at high risk for VTE after outpatient surgery.

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