Caprini venous thromboembolism risk assessment permits selection for postdischarge prophylactic anticoagulation in patients with resectable lung cancer

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ABSTRACT

Objective: Postoperative venous thromboembolism (VTE) creates an 8-fold increase in mortality after lung resection. About one third of postoperative VTEs occur after discharge. The Caprini risk assessment model has been used by other specialties to calculate the risk of a VTE. Patients deemed high risk by the model are candidates for prophylactic anticoagulation after discharge, reducing the VTE risk by 60%. Our primary aims were to determine the frequency of VTE events and evaluate whether the Caprini model could risk-stratify patients.

Methods: Patients undergoing lung cancer resections during 2005 to 2013 were evaluated. Exclusion criteria were preoperative filter and therapeutic anticoagulation. A total of 232 patients were reviewed and Caprini scores calculated. Subjects were risk stratified into groups of low risk (0-4), moderate risk (5-8), and high risk (≥9). Occurrence of VTE events (deep vein thrombosis; pulmonary embolism) were identified by imaging.

Results: The 60-day VTE incidence was 5.2% (12 of 232); 33.3% occurred postdischarge (n = 4). Half (6 of 12) were pulmonary emboli, 1 of which caused a death, in an inpatient with a score of 16. The VTE incidence increased with Caprini score. Scores in the low, moderate, and high risk groups were associated with a VTE incidence of 0%, 1.7%, and 10.3%, respectively. With a high risk score cutoff of 9, the sensitivity, specificity, and accuracy are 83.3%, 60.5%, and 61.6%, respectively.

Conclusions: One third of VTE events occurred after discharge. Postoperative VTE incidence was correlated with increasing Caprini scores. Patients in the high risk group had an incidence of 10.3%. Elevated scores may warrant extended chemoprophylaxis for patients after discharge. (J Thorac Cardiovasc Surg 2016;151:37-44)

Risk category (score range)	Distribution of total cohort by risk category (n = 232)	# VTE patients (n = 12)	# no-VTE patients (n = 220)	VTE vs. no-VTE p-value	VTE incidence by risk category
Low (0−4)	16 (6.9%)	0 (0.0%)	16 (7.3%)	1.0	0.0%
Moderate (5−8)	119 (51.3%)	2 (16.7%)	117 (53.2%)	0.01	1.7%
High (9+)	97 (41.8%)	10 (83.3%)	87 (39.5%)	0.004	10.3%

Distribution of patients and overall venothromboembolism (VTE) incidence by risk category. Values are n (%), unless otherwise indicated. ''VTE patients'' had a VTE event; ''No-VTE patients'' did not have a VTE event.

Central Message

Postresection venothromboembolic events were correlated with high scores on a risk-assessment model for selecting extended prophylaxis.

Perspective

The risk of death from a postoperative VTE can reach 20% in some series of lung cancer patients. One third of the VTEs occur after discharge. Our study demonstrated the predictive ability of the Caprini risk-assessment model to allow risk stratification of patients after lung resection, for extended preventive anticoagulation after discharge in those at highest risk.

⊕ Supplemental material is available online.

Postoperative venous thromboembolism (VTE) after lung resection for cancer leads to a nearly 8-fold increase in mortality, higher than that reported after esophagectomy and major abdominal and pelvic operations.[1] Furthermore, as many as one third of postoperative VTE events occur after discharge, with risk persisting for >30 days.[2-8] As a result, new strategies are necessary to identify patients who are at increased risk for perioperative VTE and may benefit from extended prophylaxis with agents such as low molecular weight heparin.

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Abbreviations and Acronyms
CI = confidence interval
DVT = deep vein thrombosis
IQR = interquartile range
LOS = length of stay
OR = odds ratio
PE = pulmonary embolism
VTE = venous thromboembolism

Multicenter trials in abdominal and pelvic cancer surgery, and within general and orthopedic surgical populations, demonstrate that extended courses of chemoprophylaxis with these heparin products, such as enoxaparin sodium, for as long as 30 postoperative days, can reduce VTE rates by as much as 60% without an increase in adverse bleeding events.[3-5,9] Considering the costs, inconvenience, and potential side effects associated with prolonged prophylactic anticoagulation, the use of a VTE risk assessment tool might selectively apply this intervention to only those patients at high risk.

The Caprini VTE risk assessment model is an individualized risk screening tool that has been evaluated in multiple specialties, including general, vascular, and plastic surgery, as well as gynecologic oncology.[6,10-13] The American College of Chest Physicians currently includes a modified Caprini model for VTE risk stratification among abdominal and pelvic cancer patients to identify candidates for prolonged prophylaxis although no guidelines have been developed for risk-based extended courses of chemoprophylaxis in thoracic surgery patients.[14]

The Caprini model is comprised of approximately 40 risk factors, including, but not limited to, duration of operation, personal or family history of VTE, body mass index ≥ 30 kg/m^2, and malignancy. A patient's risk factor score can be calculated throughout the hospitalization, but it is most important to determine it at the time of discharge. The total score is used to place individuals into 1 of 3 main risk categories: low (scores 0-4); moderate (5-8); and high (≥ 9). Although not yet widely adopted, a modified Caprini model is integrated into the electronic medical record at our institution, where the risk assessment protocol, in conjunction with early mobility measures, was shown to reduce postoperative VTE rates by as much as 80% for general and vascular surgical services.[11] With these services, moderate- and high-risk patients, respectively, are candidates for 10 and 30 days of total postoperative anticoagulant prophylaxis.

This risk assessment model has been implemented for our thoracic surgery patients only recently, and this article does not include patients managed per the model protocol. In this study, we sought to determine the 60-day incidence of postoperative VTE in patients who underwent lung cancer resection. In addition, we calculated the Caprini scores for these patients, to determine whether the model could identify patients at high VTE risk who might benefit from an extended course of prophylaxis.

METHODS

This retrospective study was approved by the Boston University Medical Center Institutional Review Board. Patients who underwent segmentectomy, lobectomy, or pneumonectomy for lung cancers within the Division of Thoracic Surgery were identified between June 2005 and June 2013 (n = 309). Pertinent cases were selected based on current procedural terminology codes for open and minimally invasive operations, and all cases were included that matched International Classification of Diseases (9th edition) codes for non–small cell lung cancers and small cell lung cancers.

All included patients had evidence documenting at least 60-day follow-up and had received routine postoperative, prophylactic, subcutaneous, unfractionated heparin 3 times daily, and/or intermittent pneumatic compression during the hospitalization. Low molecular weight heparin was not used as inpatient prophylaxis. Patients were excluded based on presence of any of the following criteria: lost to follow-up or missing records (n = 42); deceased due to non-VTE causes before 60 days after surgery (n = 7); multiple operations after the first (n = 5); preoperative inferior vena cava filter placement (n = 6); and hospital discharge on therapeutic anticoagulation for indications not related to postoperative VTE (n = 17). A total of 232 patient records were subsequently analyzed.

The definition used for a VTE event was any pulmonary embolism (PE) or deep vein thrombosis (DVT) identified via clinical imaging studies (ie, computed tomography pulmonary angiogram or duplex ultrasound) and treated with therapeutic anticoagulation or inferior vena cava filter. Caprini risk factors were recorded based on the modified scoring system used at Boston Medical Center,[11] and patients were stratified into 1 of 3 risk categories: low (scores 0-4), moderate (5-8), and high (≥ 9). The last 2 categories are currently linked to recommendations for prophylaxis extending beyond discharge. Risk factors were included up until the date of a VTE (for inpatient VTE cases) or until the date of discharge (for outpatient VTE and patients without VTE). The 60-day VTE incidence was determined based on the number of identified VTEs with respect to the total included cohort.

Statistical comparison of patient samples of those who had, versus did not have, VTE was accomplished using the 2-sample t test, the Fisher exact test, the Wilcoxon rank sum test, and χ^2 analysis, as appropriate. Logistic regression models were used to assess the relationship between raw Caprini scores or risk categories and the probability of postoperative VTE. The following potential confounders in these models were assessed: baseline cohort characteristics, fiscal year of procedure, adherence to inpatient prophylaxis (subcutaneous, unfractionated heparin, and pneumatic compression boots). Hospital length of stay (LOS) was assessed as a potential covariate, because LOS has been associated with increased risk of VTE and has been evaluated in other risk assessment model validation studies.[10] Significant confounders were included in adjusted logistic regressions. Regression models were assessed with C-statistics for test discrimination and the Hosmer-Lemeshow test for goodness of fit. Linear trends in odds ratios (ORs) were assessed using the Cochran-Mantel-Haenszel test.

Potential Caprini score thresholds were scrutinized for their predictive ability to isolate the high risk group as dichotomized variables with assessment of sensitivity, specificity, positive predictive value, negative predictive value, and C-statistics. This evaluation applied an ad hoc criterion for threshold selection (eg, matching to existing Caprini risk categories and maximization of C-statistic values), rather than an inferential one; thus, no adjustment for multiple testing was needed.