Reducing Postoperative Venous Thromboembolism Complications with a Standardized Risk-Stratified Prophylaxis Protocol and Mobilization Program

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BACKGROUND: Data revealed that our urban, academic, safety net medical center was a high outlier for postoperative venous thromboembolism (VTE). Our goal was to implement and determine the efficacy of a standardized intervention for reducing postoperative VTE complications.

STUDY DESIGN: We developed a strategy to decrease VTE complications, based on standardized electronic physician orders that specify early postoperative mobilization and mandatory VTE risk stratification for every patient, using the "Caprini" grading system. The derived scores dictate the nature and duration of VTE prophylaxis, including on an outpatient basis. Electronic reminders about appropriate VTE prophylaxis are automatically generated before and after operations, and on discharge. Both mechanical (pneumatic compression boots) and pharmacologic prophylaxis (unfractionated or low molecular weight heparin) are used, as indicated by risk level. We conducted a before-and-after trial, comparing National Surgical Quality Improvement Program (NSQIP) VTE outcomes (deep vein thromboses and pulmonary emboli) before and after implementing the standardized risk-stratified protocol combined with a postoperative mobilization program. Measured outcomes included NSQIP-reported raw and risk-adjusted VTE outcomes during 2 years before and after implementing the VTE prevention program.

RESULTS: The incidence of deep venous thromboses decreased by 84%, from 1.9% to 0.3% ($p < 0.01$), with implementation of VTE prevention efforts; the pulmonary emboli incidence fell by 55%, from 1.1% to 0.5% ($p < 0.01$). Risk-adjusted VTE outcomes steadily declined from an odds ratio of 3.41 to 0.94 ($p < 0.05$).

CONCLUSIONS: A patient care program, emphasizing early postoperative mobilization along with mandatory VTE risk stratification and commensurate electronic prophylaxis recommendations, significantly reduced the likelihood of VTE complications among our patients. (J Am Coll Surg 2014;218:1095−1104. © 2014 by the American College of Surgeons)

Postoperative venous thromboembolism (VTE) events, which include deep venous thromboses (DVT) and pulmonary emboli (PE), are a leading cause of morbidity and mortality. In the United States, the estimated annual incidence of VTE is 117 per 100,000.[1] Among patients who undergo abdominal operations, symptomatic VTE occurs in 0.4% to 3.1%.[2] Pulmonary emboli may cause sudden death and may independently reduce survival for up to 3 months after diagnosis.[3] Those who live may develop pulmonary hypertension. Deep venous thromboses result in venous hypertension, which can lead to debilitating swelling and chronic pain.[4] One study estimated the attributable cost of a VTE complication to be $18,310.[5] Interestingly, in some series, the majority of VTE events in surgery patients occur after discharge from the hospital.[2]

Surgery patients are at particular risk for VTE because major operations induce an inflammatory response and a hypercoagulable state, and necessarily create an endothelial vascular insult. Furthermore, the tendency for patients to limit mobilization due to postoperative pain may predispose to venous stasis.[6] Other commonly encountered risk factors include older age, cancer, trauma, obesity,

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Abbreviations and Acronyms
DVT = deep venous thrombosis
O/E = observed to expected ratio
OR = odds ratio
PE = pulmonary embolism
VTE = venous thromboembolism

sepsis, and inherited coagulopathies. The concept of a risk stratification score, calculated by assigning weighted numerical values to VTE risk factors, has been championed by Joseph Caprini and others.[7,8] The Caprini system recognizes that numerous factors confer differing degrees of hazards, and it assigns relative values to those attributes to derive an estimate of VTE likelihood. The Caprini score has been shown to accurately predict the chances of a VTE in surgical patients and has guided prophylaxis decisions.

Comprehensive prophylaxis recommendations have been proposed by the American College of Chest Physicians. These include strong endorsement of low dose unfractionated heparin, low molecular weight heparin, or fondaparinux as chemoprevention, in addition to intermittent compression boots and mobilization if possible, for all patients undergoing major operations.[9] To achieve maximum benefit, certain high risk patients may require extended VTE prophylaxis, including after discharge.[10,11] Unfortunately, there is evidence that prophylaxis measures are often underused, with at-risk patients receiving inappropriate or no prophylaxis.[12,13] A large multinational study revealed that only 59% of surgical patients received evidence-based VTE prophylaxis.[14]

National Surgical Quality Improvement Program (NSQIP) data revealed that our medical center, the largest safety-net medical center in New England and an academic, urban hospital, was a high outlier for VTE. Boston Medical Center (BMC) is a merged entity of the former Boston University Hospital and Boston City Hospital, with 509 licensed beds. More than half of its patients have an annual income below $20,420. About one-quarter of the patients do not speak English, and racial and ethnic minorities constitute 70% of all patients. Recognizing an opportunity for improvement, we sought to create a standardized VTE prevention program and to demonstrate its efficacy.

METHODS

Development of a standardized venous thromboembolism prevention program

A VTE prevention team met to consider strategies to reduce VTE complications. After reviewing the relevant literature, the consensus was to use the Caprini risk stratification method for all general surgery and vascular surgery patients at our institution. Among the several available VTE prophylaxis programs, we selected the Caprini system because it is adaptable to individual patients' risk factors, less likely to underestimate the hazards of VTE, and is well validated. We developed a scoring system and integrated it into the electronic inpatient medical record (Sunrise Acute Care, Allscripts). The system uses a check-box format so that each risk factor is explicitly listed and may be selected with a simple click (Fig. 1). The risk score is automatically calculated based on the selected factors, and the patient is placed into 1 of 5 risk categories (lowest, low, moderate, high, or highest risk). Our electronic order system is customized to require that a Caprini score be calculated for every patient at the time of operation and/or admission within general surgery and vascular surgery standardized order sets. If the surgery team does not calculate the Caprini score and act on the electronic recommendations, the orders cannot be completed. Therefore, we made an effort to ensure that each patient would be scored according to the Caprini model.

In addition, we created standardized VTE prophylaxis regimens and linked them to the Caprini risk categories. The prophylaxis regimens provide the recommended mechanical and pharmacologic prophylaxis along with a suggested duration (Table 1), which is automatically displayed. The duration of chemoprophylaxis may require extended regimens continued on an outpatient basis. For example, patients whose Caprini scores place them in the high risk category (scores 5 to 8) are advised to receive 7 to 10 days of chemoprophylaxis; those in the highest risk category (scores $\geq$ 9) are advised to receive a 30-day course of chemoprophylaxis, both of which typically require outpatient treatment. The electronic order system is designed to require that all patients receive standardized prophylaxis regimens. When the discharge orders are recorded, the recommended VTE prophylaxis is automatically displayed for patients who require an extended course.

Our electronic order system requires selection of a prophylaxis regimen. Nevertheless, a surgeon may still decline VTE prophylaxis, when it is contrary to his or her judgment, by choosing the "opt out" selection in the order sets. This prompts an automatic drop-down menu that indicates reasons for not prescribing VTE chemoprophylaxis. The selections include active bleeding, risk of hemorrhage outweighing risk of VTE, surgeon preference, heparin allergy or contraindication, or other reason (supported by an explanation in the medical record). As a result, the order set even documents the reason