Venous Thromboembolism: Prophylaxis in Medical Patients and Approach to Acute Treatment

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Table of Contents

Introduction ........................................ 2
VTE Prophylaxis .................................. 3
Treatment of Acute VTE. ...................... 7
Summary ........................................... 12
Key Points ......................................... 12
References ....................................... 12

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Robert C. Pendleton, MD, and Andrew Freeman, MD

INTRODUCTION

Venous thromboembolism (VTE), encompassing both deep vein thrombosis (DVT) and pulmonary embolism (PE), is a common disease that carries a substantial risk of morbidity and mortality and is associated with high health care costs, making it a national health priority in the United States. VTE is the third most common cardiovascular condition, following myocardial infarction and stroke, with an incidence of 3:1000 patient-years and nearly 2:100 patient-years in patients older than 85 years. It is estimated that VTE leads to 700,000 hospitalizations and causes in excess of 100,000 deaths annually. Even in patients who survive an acute thromboembolic event, long-term morbidity is substantial as 20% to 50% of patients develop post-thrombotic syndrome following symptomatic DVT, and 4% of acute PE survivors develop chronic thromboembolic pulmonary hypertension.

Importantly, over half of VTE events occur in association with transient periods of increased risk, specifically surgery or acute illness leading to hospitalization. In the absence of thromboprophylaxis, the incidence of objectively confirmed, hospital-acquired DVT is approximately 10% to 40% among medical and general surgery patients and as high as 40% to 60% after major orthopedic surgery. Further, autopsy studies suggest that approximately 10% of hospital deaths are due to PE. Of hospitalized patients, medical patients are of particular importance. Though the risk is often more commonly recognized in surgical patients, over 50% of medical inpatients are at significant risk for VTE, and 50% to 75% of cases of VTE in hospitalized patients occur on the medical service. Furthermore, approximately 75% of in-hospital fatal PE occurs in these medical patients.

VTE prophylaxis with either low-dose unfractionated heparin (LDUH) or a low-molecular-weight heparin (LMWH) reduces the incidence of DVT in hospitalized medical patients by 70% compared with no prophylaxis, and does not result in a clinically significant increase in bleeding. Both the American College of Chest Physicians (ACCP) and the International Union of Angiology (IUA) have provided specific consensus guideline recommendations regarding at-risk medical patients who...
should receive VTE prophylaxis. Yet, despite these longstanding and specific evidence-based consensus guidelines, VTE prophylaxis in medical patients remains grossly underutilized. Studies have shown rates of appropriate prophylaxis consistently around 40% in medical patients; half of at-risk patients with inappropriate prophylaxis received no prophylaxis at all. As such, an improvement in the systematic implementation of effective thromboprophylaxis in these at-risk patients has the potential to reduce the burden of VTE and to save lives.

In the United States, VTE-related performance measures and quality improvement initiatives to improve on the prevention of VTE in hospitalized patients have been implemented. Organizations including the National Quality Forum, the Office of the Surgeon General, and the Joint Commission all call attention to the high prevalence and risk of VTE and advocate for the use of appropriate thromboprophylaxis. In 2008, the Agency for Healthcare Research and Quality recognized VTE as the most common preventable cause of hospital death and cited thromboprophylaxis against VTE as the “number one patient safety practice.”

**VTE PROPHYLAXIS**

**CASE PRESENTATION**

A 68-year-old obese woman with chronic systolic heart failure (ejection fraction of 35%) and a spontaneous DVT 4 years ago presents to the hospital with decreased mobility over the past 10 days related to increased leg swelling, shortness of breath, orthopnea, and weakness. Her medications include a β blocker, loop diuretic, and angiotensin receptor blocker. On exam she has a blood pressure of 120/84 mm Hg, heart rate of 88 bpm, and room air oxygen saturation of 88%. She has inspiratory rales in both lung bases, an S₃ gallop, and symmetric bilateral pitting edema. Her chest radiograph reveals bilateral vascular congestion and pleural effusions. She is admitted for treatment of decompensated heart failure.

**RISK FACTORS FOR VTE IN HOSPITALIZED MEDICAL PATIENTS**

In order to implement prevention efforts, practitioners must first recognize patients at risk for whom thromboprophylaxis would be beneficial. In general terms, hospitalization for an acute medical illness is associated with an eightfold increase in the relative risk of developing VTE and is the strongest epidemiologic risk factor associated with an index symptomatic DVT. More specifically, advancing age is a common risk factor for VTE, with the risk increasing exponentially after age 40 years. Additional specific risk factors for VTE include a prior history of VTE, active malignancy, neurologic disease with extremity paresis, congestive heart failure, bed rest, and the presence of central venous catheters. Common risk factors for VTE in hospitalized patients are summarized in Table 1. Importantly, many hospitalized medical patients have multiple risk factors.

**Systematic Risk Assessment**

Risk identification is an important first step in the systematic implementation of effective and appropriate thromboprophylaxis (Figure 1). In general terms, this can be approached via either individual patient risk assessment using a risk-assessment model (RAM) or with group-based risk assessment. Figure 2 illustrates one com-
Commonly employed RAM. While a number of RAMs have been developed as tools to assist in identifying medical and surgical patients at risk for VTE based on individual risk scoring, studies validating these various models are limited.21–23 Although RAMs for individual patients may become useful in identifying at-risk patients, the use of these schemes to intensify prophylactic regimens based on VTE risk has not yet been investigated.

In contrast to individual risk assessment, current international guidelines approach VTE risk assessment from a broader, group-based approach. For example, in acutely ill medical patients, the 2008 ACCP Guidelines on the Prevention of Venous Thromboembolism recommend thromboprophylaxis for patients admitted for congestive heart failure or severe respiratory disease; or those who have decreased mobility and one or more additional VTE risk factors, including active cancer, previous VTE, sepsis, acute neurologic disease, or inflammatory bowel disease.3

### Mechanical Prophylaxis

Although effective in some populations, no randomized clinical trials have evaluated mechanical methods of prophylaxis (including graduated compression stockings [GCS] or intermittent pneumatic compression [IPC]) in general medical patients. However, the ACCP guidelines give grade 1A recommendations for the optimal use of mechanical thromboprophylaxis (with either GCS or IPC) in medical patients with risk factors for VTE and contraindications to anticoagulant prophylaxis.3 Relative contraindications to pharmacologic, anticoagulant-based prophylaxis include active or recent gastrointestinal bleeding, hemorrhagic stroke, severe thrombocytopenia, or other hemostatic defects.

### Pharmacologic Prophylaxis

Prophylaxis modalities using LDUH, LMWH, or fondaparinux substantially reduce the risk of VTE.

### Table 1. Risk Factors for Venous Thromboembolism in Hospitalized Patients

<table>
<thead>
<tr>
<th>Risk Factor</th>
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<tr>
<td>Personal or family history of venous thromboembolism</td>
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<tr>
<td>Malignancy with or without chemotherapy</td>
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<tr>
<td>Immobility/bed rest</td>
</tr>
<tr>
<td>Obesity</td>
</tr>
<tr>
<td>Hypercoagulability—Inherited or acquired</td>
</tr>
<tr>
<td>Estrogen hormones (oral contraceptive pill, hormone replacement therapy, pregnancy)</td>
</tr>
<tr>
<td>Inflammatory illness—inflammatory bowel disease, infection, rheumatologic</td>
</tr>
<tr>
<td>Advanced age</td>
</tr>
<tr>
<td>Surgery</td>
</tr>
<tr>
<td>Spinal cord injury</td>
</tr>
<tr>
<td>Major trauma and/or extremity fracture</td>
</tr>
<tr>
<td>Heart or respiratory failure</td>
</tr>
<tr>
<td>Stroke</td>
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<tr>
<td>Central venous catheter</td>
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</table>
in medical patients. The ACCP guidelines give grade IA recommendations to each of these pharmacologic agents for the prevention of VTE in at-risk medical patients. In a meta-analysis of 9 randomized trials including nearly 20,000 medical patients, anticoagulant thromboprophylaxis reduced fatal PE by 64%, symptomatic PE by 58%, and symptomatic DVT by 53% without increasing major bleeding compared with no prophylaxis.

**Low-dose unfractionated heparin.** Heparin is the most common anticoagulant prescribed for prophylaxis in the United States. While several studies have shown a significant reduction in objectively confirmed asymptomatic distal DVT with LDUH compared with no prophylaxis, no significant reduction in mortality has been demonstrated.

The optimal dosing regimen for LDUH in thromboprophylaxis is uncertain. In practice, routinely used regimens are 5000 IU twice daily and 5000 IU 3 times daily. While a number of clinical trials have examined LDUH compared to both placebo and LMWH in medical patients, there have been no head-to-head trials directly comparing twice-daily or 3-times-daily LDUH dosing regimens. In a meta-analysis indirectly assessing prophylaxis with either twice-daily or 3-times-daily LDUH, there was no difference in overall rate of VTE between the 2 groups, although 3-times-daily heparin showed a trend towards a decrease in PE and in proximal DVT and PE. However, twice-daily heparin was associated with lower rates of major bleeding events. Although controversial, the IUA guidelines specifically recommend LDUH at a dose of 5000 IU 3 times daily in medical patients.

**Low-molecular-weight heparins.** LMWHs such as dalteparin and enoxaparin have proven efficacy
in preventing VTE events in medical patients, are at least as effective as LDUH, and have similar or improved safety profiles. In a large randomized trial, as compared to placebo, the LMWH enoxaparin (40 mg once daily) group had lower rates of DVT (14.9% versus 5.5%) without an increase in major bleeding. Similarly, the efficacy of dalteparin (5000 IU daily) was compared with placebo in over 3700 acutely ill medical patients at risk for VTE. Dalteparin reduced the risk of the composite endpoint of symptomatic VTE, sudden death, or proximal DVT to 2.8%, compared with 5% in the placebo group, without a significant difference in severe bleeding complications. Although no data clearly demonstrate a reduction in overall mortality with LMWHs, their use for thromboprophylaxis does reduce both nonfatal and fatal VTE.

**Fondaparinux.** The ACCP guidelines on VTE prevention also recommend the use of the pentasaccharide activated factor X inhibitor, fondaparinux, as an alternative prophylactic regimen in acutely ill medical patients. Though it is not approved by the U.S. Food and Drug Administration (FDA) for this indication, the inclusion in the ACCP guideline is derived from a randomized clinical trial in older medical patients wherein a relative risk reduction in VTE events of 46.7% was demonstrated in patients given fondaparinux 2.5 mg versus placebo (5.6% versus 10.5%) with no difference in major bleeding.

**Comparative efficacy of Heparin versus LMWH**

Studies with direct comparisons of LDUH 3 times daily to LMWH for VTE prophylaxis in acutely ill medical patients show a similar efficacy in preventing VTE. While some meta-analyses suggest either a trend or a small, but significant, reduced risk for DVT when using LMWH, the dosing of LDUH in these grouped analyses remains inconsistent. In patients with acute ischemic stroke, however, LMWHs have been observed to reduce the risk of VTE when compared to LDUH.

**Comparative safety of Heparin versus LMWH**

In surgical populations, LMWHs have a better safety profile when compared with LDUH both in severe bleeding complications and wound hematomas. However, safety outcomes from other comparative trials of LDUH and LMWH show no difference between bleeding risk or total thrombocytopenia. Heparin-induced-thrombocytopenia (HIT) is an uncommon but potentially devastating complication of heparin exposure. Although less common in medical patients as compared to other patient groups, HIT occurrence does appear to be greater in medical patients when thromboprophylaxis with LDUH is used compared with LMWH. A large retrospective analysis reported the incidence of HIT to be 0.51% in medical patients receiving heparin, compared with 0.084% using LMWHs.

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**Figure 2. Venous thromboembolism (VTE) risk assessment model to stratify levels of VTE risk: high risk = 8+ points, intermediate risk = 2–7 points, low risk 0–1 points. (Adapted from Bahl V, Hu M, Hene PK, et al. A validation study of a retrospective venous thromboembolism risk scoring method. Ann Surg 2010; 251:344.)**

| 5 points each of: | Joint replacement surgery, hip/pelvic/leg fracture, stroke, multiple trauma, acute spinal cord injury |
| 3 points each of: | Age >75, history of VTE, family history of thrombosis, heparin-induced thrombocytopenia, known thrombophilia |
| 2 points each of: | Age 60–74, cancer, major surgery, laparoscopic or arthroscopic surgery, central venous catheter, bed rest >72 hr, immobilizing cast |
| 1 point each of: | Age 41–60, minor surgery, inflammatory bowel disease, edema, body mass index >25, sepsis, serious lung disease, medical patient on bed rest, heart failure, myocardial infarction, varicose veins, hormonal therapy, pregnant/postpartum |

5 points each of:
- Joint replacement surgery, hip/pelvic/leg fracture, stroke, multiple trauma, acute spinal cord injury

3 points each of:
- Age >75, history of VTE, family history of thrombosis, heparin-induced thrombocytopenia, known thrombophilia

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- Age 60–74, cancer, major surgery, laparoscopic or arthroscopic surgery, central venous catheter, bed rest >72 hr, immobilizing cast

1 point each of:
- Age 41–60, minor surgery, inflammatory bowel disease, edema, body mass index >25, sepsis, serious lung disease, medical patient on bed rest, heart failure, myocardial infarction, varicose veins, hormonal therapy, pregnant/postpartum
Following the 2008 ACCP Guidelines on the Treatment and Prevention of HIT, medical patients receiving LDUH for prophylaxis should have platelet counts monitored every 2 to 3 days from day 4 to 14 (or until heparin is stopped).³³

**DURATION OF PROPHYLAXIS**

The recommended duration of thromboprophylaxis for certain patient groups, such as joint replacement surgery and major abdominal oncologic surgery, is well defined.³ For other patient groups, the necessary duration of effective thromboprophylaxis is less certain. It is important to consider that while the length of hospitalization for most acutely ill medical patients at risk for VTE is approximately 3 to 8 days, most studies evaluating the efficacy of anticoagulant prophylaxis in this population provided treatment for 6 to 14 days.²⁴–²⁶ While there is ample evidence that the absolute risk for VTE in both medical and surgical patients persists beyond discharge, the optimal duration of therapy in medical patients has not been elucidated. For now, the ACCP recommends that clinicians follow the manufacturer-suggested dosing guidelines for each of the anticoagulant agents (grade 1C).³ Table 2 summarizes key practice guideline–based recommendations for prophylaxis in medical patients.

**CASE CONTINUED**

The patient receives a LMWH for prevention of VTE in addition to diuretic therapy. After 6 days in the hospital, she is discharged to home where she resumes her prior activities until 6 weeks later, when she returns to the hospital with the sudden onset of left-sided pleuritic chest pain and shortness of breath. On examination she is tachypneic and hypoxic. Her blood pressure is 110/76 mm Hg. She has a left-sided pleural rub and asymmetric, right greater than left, leg edema. A computed tomography (CT) pulmonary angiogram reveals segmental PE in the left lung and resolution of the previously noted vascular congestion and effusions.

**TREATMENT OF ACUTE VTE**

Despite optimal prevention efforts, VTE will still occur. It is estimated that as many as 25% of patients with acute PE die suddenly before hospital admission.³⁵ Of those who survive to seek medical help, timely diagnosis, risk stratification, and implementation of early effective therapy may improve outcomes.

For a majority of patients with VTE, treatment is straightforward (Figure 3) and includes the prompt initiation of a full-dose, rapidly acting, anticoagulant (eg, heparin or LMWH) and simultaneous initiation of long-term warfarin therapy (ie, vitamin K antagonist [VKA]). Discontinuation of the heparin or LMWH can occur after at least

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**Table 2. Summary Points for Venous Thromboembolism Prevention in Medical Patients**

All hospitalized patients should be assessed for VTE risk at admission.

Chemical prophylaxis with heparin, LMWH, or fondaparinux is recommended (dalteparin 5000 IU daily, enoxaparin 40 mg daily, fondaparinux 2.5 mg daily, or heparin 5000 IU 2 or 3 times daily).

If bleeding or other complications preclude chemical prophylaxis, then the optimal use of mechanical devices should be implemented.

When heparin is used, platelet counts should be assessed every 2 to 3 days to monitor for heparin-induced thrombocytopenia.

For patients with renal impairment, heparin or reduced-dose LMWH is recommended.

LMWH = low-molecular-weight heparin; VTE = venous thromboembolism.

Information derived from references 3, 13, 34, and 37.
5 days, assuming that the warfarin is therapeutic.\textsuperscript{13,36,37} Yet, acute VTE treatment continues to evolve and areas of advancement include issues related to optimal location of initial care delivery.
and risk stratification of patients with PE and the use of advanced therapies such as thrombolysis and catheter-based interventions. Additionally, novel oral anticoagulants may become management options in the future.

INITIAL PARENTERAL ANTICOAGULATION

Due to the delayed onset of action of oral warfarin, the initial use of a rapid-acting parenteral anticoagulant (eg, heparin or LMWH) is necessary. In a key clinical trial, Brandjes and colleagues randomized 120 patients with proximal DVT to continuous intravenous heparin plus VKA or VKA alone. The study was stopped early because symptomatic recurrent VTE events occurred in 12 of 60 patients (20%) in the VKA group versus only 4 of 60 patients (6.7%) in the heparin plus VKA group ($P = 0.058$). In comparative trials, a shorter duration of parenteral anticoagulant (approximately 5 days) has been shown to be as effective as a longer course of a parenteral anticoagulant (approximately 10–14 days). For most patients with acute VTE, these studies provide the basis for current recommendations to institute a parenteral anticoagulant and warfarin simultaneously and to continue the parenteral anticoagulant for at least 5 days, after which it can be discontinued if warfarin is therapeutic.

When used for the treatment of VTE, heparin can be administered as a continuous intravenous infusion or subcutaneously as either an adjusted-dose or fixed-dose regimen. Heparin has limitations due to a rapid clearance phase through nonspecific binding to plasma proteins, relatively low and variable bioavailability, and a short elimination half-life, all of which leads to the general need for laboratory monitoring (eg, the activated partial thromboplastin time) and subsequent dose adjustment. Due to these inherent limitations with heparin, LMWHs have emerged as a preferred initial therapy for many patients. The LMWHs are manufactured through the chemical or enzymatic depolymerization of unfractionated heparin, leading to smaller and more uniform molecular weight and less negative ionic charge. These chemical differences are associated with less nonspecific protein binding, more predictable anticoagulant response, and a longer elimination half-life, which allows for once- or twice-daily subcutaneous administration without the need for routine laboratory monitoring.

Primarily because of dose predictability and ease of use, the introduction of LMWH therapy as a treatment option for VTE has improved patient management. In initial clinical trials, LMWH therapy was demonstrated to be at least as safe and effective as adjusted-dose intravenous heparin in patients with proximal vein thrombosis. Subsequently, numerous other comparative trials have been performed, and in a meta-analysis Dolovich and colleagues demonstrated the LMWHs to be comparable to heparin for the initial treatment of VTE with regards to recurrence (relative risk [RR], 0.85 [95% confidence interval {CI}, 0.65–1.12]), major bleeding (RR, 0.63 [95% CI, 0.37–1.05]), and total mortality (RR, 0.76 [95% CI, 0.59–0.98]). Similarly, in a subsequent meta-analysis of 2110 patients who presented with acute symptomatic PE, LMWHs were at least as effective (odds ratio [OR] for recurrence, 0.68 [95% CI, 0.42–1.09]) and safe (OR for major bleeding, 0.67 [95% CI, 0.36–1.27]) as heparin. In the setting of cancer, the LMWHs may be clearly superior to heparin with reduced risk of subsequent mortality. Because of their ease of administration and efficacy and safety profile, the LMWHs are the preferred initial anticoagulant as recommended by current practice guidelines.
The initial treatment of VTE used to be confined to the inpatient setting; however, 2 clinical trials demonstrated that outpatient LMWH treatment for patients with acute DVT is safe and effective.\textsuperscript{48,49} Further, in properly selected patients, the outpatient management of DVT can lead to a substantial reduction in health care costs.\textsuperscript{50} Assuming an appropriate care-delivery system is in place, outpatient DVT treatment has become appropriate for a majority of DVT patients, except perhaps those with massive iliofemoral DVT, a high bleeding risk, or substantial comorbid illness that otherwise necessitates hospitalization.\textsuperscript{51}

**RISK STRATIFICATION OF THE PATIENT WITH PULMONARY EMBOLISM**

Unlike patients with acute DVT, patients with acute PE represent a very heterogeneous risk-group with 3-month mortality rates ranging from 1\% to 17\%.\textsuperscript{52,53} As such, rapid clinical risk stratification of patients with PE has been proposed to facilitate more appropriate care by identifying patients at very high risk of adverse outcomes who may benefit from more aggressive treatment (eg, thrombolysis) and admission to a high level of care such as an intensive care setting.\textsuperscript{37} Risk stratification can be performed with the use of structured clinical severity risk assessment scores such as the Pulmonary Embolism Severity Index (PESI) and Geneva risk score, cardiac biomarkers such as troponin and B-type natriuretic peptide, and imaging results such as right ventricular enlargement on CT pulmonary angiogram or right ventricular dysfunction on echocardiogram. Each has been demonstrated to have prognostic value in patients with acute PE.\textsuperscript{54–58} Although useful to identify patients at an increased risk of short-term mortality, these same risk stratification tools, in theory, may also allow for the identification of low-risk patients who could be considered for outpatient treatment.\textsuperscript{36}

**CASE CONTINUED**

Therapeutic subcutaneous LMWH is promptly initiated in the patient. A serum troponin is normal. An echocardiogram reveals left ventricular systolic dysfunction with an ejection fraction of 40\%; there is no evidence of right ventricular enlargement or dysfunction.

**OUTPATIENT TREATMENT IN LOW-RISK PULMONARY EMBOLISM PATIENTS**

Two recent systematic reviews suggest outpatient treatment of low-risk PE to be safe.\textsuperscript{59,60} However, this conclusion is based on inclusion of small cohort studies with little comparative data. In fact, a recent small randomized clinical trial was stopped early due to an unexpectedly high short-term mortality rate (2.8\% [95\% CI, 0.8\%–9.6\%]) in presumed low-risk PE patients randomized to outpatient therapy.\textsuperscript{61} Yet, in clinical practice, outpatient PE management is becoming more commonplace, with 13\% of PE patients being discharged after a 1- to 2-day hospitalization and an additional 30\% discharged within 3 to 4 days.\textsuperscript{62} Of concern is that postdischarge mortality has been demonstrated to be higher in patients with PE who had a length of stay of 4 days or less (OR, 1.55 [95\% CI, 1.21–2.00]) compared to those with a longer hospitalization.\textsuperscript{63} If providers choose to manage patients with an acute PE as outpatients, careful risk assessment should be performed and an adequate system of monitoring should be in place. Without randomized clinical trials, however, the safety of this approach remains controversial.

**ROLE OF ADVANCED THERAPIES**

Advanced therapies for VTE management include vena-cava filters, thrombolysis, and cath-
Vena cava filters are image-guided, percutaneously placed metallic catchment devices designed to interrupt the vena cava and prevent thrombus embolization. Placement of these devices has recognized risks, including thrombus embolization despite their presence, filter migration or fracture, vena cava thrombosis, insertion site hematoma or thrombosis, extravascular penetration, and (rarely) death. In long-term follow-up (average 8 years), the presence of a vena cava filter in addition to anticoagulation compared to anticoagulation alone led to lower risk of subsequent PE (symptomatic and asymptomatic) (hazard ratio [HR], 0.36 [95% CI, 0.17–0.79]), but increased risk of DVT (HR 1.52 [95% CI, 1.02–2.27]) without a difference in mortality (HR, 0.97 [95% CI, 0.74–1.29]).

Because of these potential risks and the uncertain benefit, vena cava filter placement should be limited to accepted indications (Table 3). Placement of vena cava filters for other indications (eg, primary prevention in high-risk patients, life-threatening pulmonary embolism, and large free-floating thrombus) remains controversial.

**Table 3. Suggested Indications for Vena Cava Filter Placement**

<table>
<thead>
<tr>
<th>Indication</th>
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<tr>
<td>Acute proximal deep venous thrombus or pulmonary embolism and anticoagulation contraindicated (eg, bleeding risk)</td>
</tr>
<tr>
<td>Acute/recent venous thromboembolism with active bleeding excluding ongoing anticoagulation therapy</td>
</tr>
<tr>
<td>Thrombus extension and/or recurrence despite optimal anticoagulant therapy</td>
</tr>
<tr>
<td>Chronic thromboembolic pulmonary hypertension</td>
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</table>

Thrombolytic agents include streptokinase, urokinase, alteplase, reteplase, and tenecteplase. Although effective at achieving clot dissolution, all thrombolytic agents can increase the risk of major bleeding. The use of thrombolysis is recommended for patients with acute massive PE who are hypotensive and in shock. However, the role of lytic therapy for patients with submassive PE (ie, those with a normal blood pressure but who have markers of increased mortality such as elevated cardiac biomarkers or right ventricular dysfunction on imaging) remains controversial. In a meta-analysis of patients with submassive PE, lytic therapy in addition to heparin (versus heparin alone) was associated with nonsignificant trends towards lower rates of recurrence and death but greater bleeding complications. Until additional data is available, current recommendations are to restrict thrombolysis to selected patients with PE.

Due to a high risk of post-thrombotic syndrome (PTS) in patients with proximal DVT, there has been interest in interventional approaches at the time of diagnosis which may lower this risk. In a national DVT registry, catheter-based interventions reduced PTS and improved quality of life, but these outcomes were offset by increased major bleeding events. More recently, the TORPEDO trial (n = 183) demonstrated lower rates of recurrent DVT (2.3% versus 14.8%) and PTS (3.4% versus 22%) without an increased risk of bleeding in patients who received anticoagulation with or without catheter-directed pharmacomechanical therapy, respectively. Until there are confirmatory results, the use of catheter-based interventions should be individualized and should be primarily limited to those with massive iliofemoral DVT.

**CASE CONCLUSION**

The patient is continued on LMWH, and this is discontinued after 5 days when her INR on warfarin is therapeutic. Because the patient...
has a normal blood pressure and has no evidence of right heart dysfunction, she does not receive advanced therapy such as thrombolysis. After 6 days in the hospital, she is safely discharged to home with ongoing outpatient follow-up and warfarin management.

**SUMMARY**

VTE is a common and morbid condition that frequently complicates surgery and hospitalization for acute medical illness. Effective preventive strategies include the routine and systematic assessment of VTE risk at the time of hospital admission and the implementation of effective prophylaxis (eg, heparin or LMWH) in those at risk. When VTE occurs, timely diagnosis and implementation of an effective parenteral anticoagulant (eg, heparin or LMWH) for at least 5 days with appropriate overlap to therapeutic warfarin therapy is standard treatment for most. Although many patients with DVT can be treated as outpatients, the outpatient management of PE remains controversial. Because of a heterogeneous risk of short-term mortality, patients with PE should have a rapid risk stratification to identify those (eg, those who are hypotensive and in shock) who may benefit from aggressive therapy such as thrombolysis. For others with VTE, the use of advanced therapies should be individualized to highly selected patients who may benefit most.

**KEY POINTS**

- VTE, encompassing both DVT and PE, is a common, costly, and potentially fatal condition wherein a majority of events occur in relation to hospitalization or surgery.
- Of hospitalized patients, medical patients account for a significant proportion of the VTE burden and more medical patients die of fatal PE.
- Current regulatory standards are that all patients admitted to the hospital should have VTE prophylaxis ordered or documentation justifying its absence. In medical patients, pharmacologic prophylaxis (eg, heparin or LMWH) is preferred in those patients without contraindications.
- Initial treatment of established VTE includes a parenteral anticoagulant (LMWH preferred to heparin for most) continued for a minimum of 5 days of overlap in transition to therapeutic long-term warfarin therapy.
- The role of advanced therapies such as vena cava filters and thrombolysis should be individualized; their use should not be a routine part of managing the patient with VTE.

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