Thrombotic Risk Assessment: A Hybrid Approach

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Abbreviations and Acronyms

ACCP, American College of Chest Physicians; BMI, body mass index; DVT, deep vein thrombosis; HIT, heparin-induced thrombocytopenia; IMPROVE, International Medical Prophylaxis Registry on Venous Thromboembolism; LMWH, low molecular weight heparin; MEDENOX, prophylaxis in MEDical patients with ENOXaparin; PE, pulmonary embolism; PTS, postthrombotic syndrome; THR, total hip replacement; THRIFT, Thromboembolic Risk Factors; TKR, total knee replacement; RAM, risk assessment model; UFH, unfractionated heparin; VTE, venous thromboembolism.

INTRODUCTION

Venous thromboembolism (VTE) is one of the most common, yet highly preventable, causes of in-hospital death. In response to this problem, the implementation of an appropriate, targeted thromboprophylaxis strategy has been described as the most important single factor for improving patient safety (1). Both medical and surgical patients are at risk of VTE. It has been calculated that without prophylaxis, the incidence of hospital-acquired deep vein thrombosis (DVT) is approximately 10% to 40% among medical patients and general surgery patients, and 40% to 60% following major orthopedic surgery (2). In patients subjected to autopsy, approximately 10% of all deaths in the hospital are attributed to pulmonary embolism (PE) (3), with most patients who suffer a fatal embolus dying within the initial 30-minute period. This small window for effective treatment, combined with its frequently asymptomatic nature, explains the high fatality rate associated with this condition (4). VTE is also responsible for a significant number of long-term health problems: Prandoni et al. have shown that 30% of patients with symptomatic DVT will suffer recurrent VTE in the 8 years following an event (5), while almost a third of patients who suffer a DVT will go on to develop long-term venous insufficiency complications in the lower leg, also known as 'postthrombotic syndrome' (PTS). This condition may result in chronic leg swelling, discomfort, dermatitis, and leg ulcers, which can reduce the patient's quality of life and have an economic impact frequently overlooked in DVT cost assessment (6).

Clinically proven methods of prophylaxis have been shown to prevent a significant proportion of clinically significant VTEs. Yet despite the publication of regularly updated consensus guidelines (2,7-10), VTE prophylaxis is still under- or inappropriately prescribed in a high proportion of patients, leaving them at significant risk of serious complication due to PE or DVT (11,12).

Effective VTE risk assessment is therefore critical in targeting and optimizing prophylaxis, and for the subsequent improvement in patient outcomes. There is an urgent need for a clear, easy-to-use risk assessment model based on information in the patient's medical history and clinical examination. Although there has been, and continues to be, a great deal of clinical research into VTE, it is unlikely that there will ever be sufficient high-quality clinical evidence to guide decisions on prophylaxis in every group of patients— medical and surgical. With each patient representing a unique clinical situation with their own combination of risk factors, it can be difficult to determine the level of VTE risk, and the appropriate intensity of thromboprophylaxis. This review considers the reasons contributing to underuse of prophylaxis, and discusses a 'hybrid approach' combining risk assessment scoring with the application of current treatment guidelines. The results of an audit from the author's hospital and a real-world case study are also detailed to illustrate key issues.

POOR ADHERENCE TO PROPHYLAXIS GUIDELINES

Consensus groups such as the American College of Chest Physicians (ACCP) and the THRIFT Consensus Group regularly publish guidelines on the prevention and treatment of VTE in both surgical and nonsurgical patients (2,7-10). While the recommendations from these groups are based on clinical evidence from trials and meta-analyses that are stratified clearly according to patient risk, VTE prophylaxis is still suboptimal in many patients (11-17), and the rates of total and proximal DVT remain high.

US surveys of prophylaxis use indicate that the percentage of surgical patients receiving prophylaxis ranges from 38% to 94% depending on the type of procedure (11,15,18,19). One particular study documenting adherence to the 1995 ACCP guidelines in surgical patients found that 25% of patients undergoing high-risk major abdominal surgery did not receive any form of VTE prophylaxis (11). Furthermore, in a retrospective analysis by

Arnold et al. looking at cases of VTE in a US cohort of surgical and medical patients, it was found that one out of six VTE events could have been prevented if physicians had followed the ACCP guidelines (12). Inadequate prophylaxis was most often due to the fact that no prophylactic measures were prescribed.

Surprisingly, a tendency has been reported for prophylaxis to be administered less frequently with increasing risk level (20). Why this occurs is unknown, although it may reflect physician concerns that the risk of complications due to anticoagulant therapy may be greater in very high-risk patients.

SUBOPTIMAL PROPHYLAXIS IN ACTION

The extent of the prophylaxis problem was highlighted in a recent study by the author's group (14). Carried out to test the performance of current VTE risk assessment, the primary objective was to determine the percentage of a surgical patient population falling into one of three risk categories (moderate, high, and highest risk; Table 1). The study also sought to identify whether patients were receiving appropriate prophylaxis based on their risk level, and to compare the degree of compliance with prophylaxis guidelines with that found and reported for the same hospital in 1991. A total of 157 patients undergoing neurosurgery, cardiovascular surgery, general, gynecological, or orthopedic surgery (other than arthroplasty) were included in the study. Each patient had a detailed preoperative VTE risk assessment, and the type and duration of prophylaxis prescribed to each patient was recorded and compared with their individual risk score. In-hospital outcomes for all patients were carefully monitored, and patients were followed up by telephone after a month.

The study found that 19% (30 out of 157) of patients were not prescribed any prophylactic measures despite the existence of several risk factors. This was even more surprising considering that the majority of patients were in the highest risk category, and

therefore at greatest need of prophylaxis. Clinically overt VTE appeared in 2 out of 73 (2.7%) patients in the highest risk category, both of whom had not received appropriate prophylaxis, while a total 57% of patients were shown to have received inadequate prophylaxis according to the ACCP guidelines (2). Comparison of these results with our previous thromboprophylaxis audit performed in 1991 (Table 1) indicates no improvement in compliance with treatment guidelines; indeed, in the group at highest risk of VTE, only 30% of patients received appropriate prophylaxis in 2002 compared with 70% in the same category in 1991.

UNDERUSE OF PROPHYLAXIS – WHY IS THERE A PROBLEM?

Misconception of risk

Although the serious implications to health are now well accepted—both in the short and long term—a large part of the problem can be attributed to the clinically silent nature of VTE. For surgical patients there is a low incidence of clinically apparent VTE in the perioperative period, thus it is rare for an individual surgeon to witness an acute PE or major DVT event in one of their patients. Studies have shown that a significant proportion of symptomatic thromboembolic complications occur after discharge from hospital (21-23), with a survey of California orthopedic surgeons finding that 76% of VTE events were diagnosed following discharge from hospital after total hip replacement (THR), and 48% after total knee replacement (TKR) (24). The current trend toward shorter hospital stays serves to accentuate this problem, whereby the need for and benefits of thromboprophylaxis can be difficult to appreciate for a physician who rarely sees the problem. Extended prophylaxis has value in preventing not only sudden death but also all of the other complications of VTE responsible for significant morbidity and mortality.

Although the majority of trials in VTE have studied surgical patients, medical patients are also at significant risk of thrombotic disease (2). Fewer than a third of patients who suffer a fatal PE have recently undergone surgery (25), and as many as 1 in 20 hospitalized patients with multiple clinical conditions go on to develop PE (26). The average overall incidence of DVT in medical patients is 10% to 20% (2), but this rises in certain patient groups. For example, stroke is associated with a 20% to 50% risk of VTE complications without prophylaxis (2), while VTE is thought to occur in 20% to 40% of patients with an acute myocardial infarction (27). Cancer is also a well-known thrombotic risk factor due to the hypercoagulable state induced by the malignancy, with treatments for the disease, such as surgery and chemotherapy, only serving to further compound the risk (2,28). Despite current guidelines stating that medical patients can be at significant risk of VTE and should receive thromboprophylaxis, a survey from the International Medical Prophylaxis Registry on Venous Thromboembolism (IMPROVE) of acutely ill medical patients recently revealed that fewer than 40% of patients enrolled in the registry received prophylaxis (13).

Safety concerns

Another factor underlying the suboptimal use of pharmacological prophylaxis is overestimation of the bleeding risk associated with anticoagulant prophylaxis. For example, a survey of orthopedic surgeons in the United Kingdom found that almost half (48%) had discontinued the use of low molecular weight heparin (LMWH) for TKR or THR due to concern over bleeding complications (29). However, numerous randomized, placebo-controlled, double-blind trials and further meta-analyses of prophylaxis with LMWH and unfractionated heparin (UFH) during major surgery have demonstrated that both types of heparin prophylaxis are extremely effective in preventing VTE at the expense of no, or a very small, increase in the rate of major bleeding (30-35). Although LMWH and UFH are

associated with an increased risk of wound hematomas (30,33,34), major bleeding complications are extremely uncommon, and the consequences of VTE are potentially much more severe—thereby outweighing any justification for withholding heparin prophylaxis.

LMWH is at least as safe and effective as UFH (31,34,36,37). LMWH has been associated with a lower risk of major bleeding complications; one particular study of patients undergoing abdominal surgery reported a 23% reduction in the frequency of major bleeding events in patients who received LMWH compared with UFH, although this difference was not significant. The study also observed significantly fewer severe bleeds and wound hematomas (30). LMWH exhibits minimal binding with plasma proteins, endothelial cells, and platelet factor IV, providing a more predictable clinical response than UFH as well as reducing the likelihood of causing heparin-induced thrombocytopenia (HIT) (38,39). With an incidence of 1% to 5%, immune HIT is an uncommon but serious complication of heparin therapy, and is often cited as a reason for caution in prescribing heparin prophylaxis. Of 665 patients who received prophylaxis with either UFH or LMWH during elective THR, 18 patients developed HIT, and the majority of these patients were in the UFH group (4.8% versus 0.6%; $p < 0.001$) (39).

While the benefits of LMWH thromboprophylaxis have been shown in numerous studies, suboptimal use may arise from additional safety concerns combined with a misconception of risk. Clinical issues remain unanswered and may contribute to physician hesitation to pharmacologic prophylaxis, for example, optimal dosing and the need for monitoring in patients with severe obesity or renal insufficiency (37).

Lack of awareness of the problem

Physicians frequently cite informal, retrospective surveys of their own clinical service or personal experience to explain why they believe the rate of VTE is low (40). There also appears to be poor awareness of the diverse range of clinical signs and symptoms that can be attributed to thrombosis and the fact that these relatively minor symptoms can be extremely common (Table 2). Many physicians fail to realize that what they are seeing may be an indicator of an otherwise silent thrombotic event requiring further investigation, which can therefore be attributed to a lack of prophylaxis.

Cost of suboptimal prophylaxis

Pharmacological prophylaxis undoubtedly incurs a significant cost, both in terms of the drugs themselves and, with UFH and oral anticoagulants, an increase in nursing time and laboratory monitoring. However, the economic consequences of withholding prophylaxis are often overlooked. In addition to the short-term costs of delayed hospital discharge due to an acute VTE event or patient readmission for DVT, failure to prevent VTE increases the risk of long-term morbidity due to PTS and recurrent thrombosis. Patients with symptomatic DVT have a high risk of recurrent VTE that persists for at least 8 years, and which may increase with comorbidities such as cancer (5). Estimates based on a recent cost-of-illness study conducted by our group suggest that in the United States, the annual per-patient cost of severe PTS is $3,816 in the first year and $1,677 thereafter, while the cost of DVT and PE complications were estimated at $3,798 and $6,604, respectively (41). Therefore, prevention of DVT can have an enormous impact on both the patient's quality of life and the long-term cost of care.

Mechanical methods of prophylaxis provide a cheaper alternative to pharmacological methods taken on a direct cost-per-patient basis, but this must be balanced with issues of

safety and efficacy. Mechanical devices, such as intermittent pneumatic compression (IPC) and graduated compression stockings (GCS), do not increase the risk of bleeding and can offer important protection in some groups of patients for whom anticoagulant therapy is contraindicated or is impractical due to their clinical status (eg, trauma patients). One early study comparing five methods of thromboprophylaxis found that antistasis modalities performed well compared to the drug modalities (UFH, dextran, and aspirin), with the lowest incidence of DVT events reported in the IPC group (42). A subsequent study evaluating the effectiveness of combining a pharmacologic drug with an antistasis modality reduced the incidence of DVT to just 1.5% in a group of 328 surgical patients (43). The value of combination therapy has been further highlighted in the more recent APOLLO trial, which compared the use of IPC plus fondaparinux with IPC alone in 1300 high-risk abdominal surgery patients in North America (44). IPC was chosen on the basis of a survey that found approximately half of clinicians in the United States use this modality for the prevention of thrombosis in general surgery patients. IPC showed 5% incidence of DVT by venography— and is therefore itself an effective modality. A 1.7% incidence was reported for IPC plus fondaparinux. A benefit is also suggested when mechanical methods are combined with LMWH (2). In a review of trials comparing the use of GCS alone or in combination with LMWH in high-risk surgical patients (general and orthopedic), combination therapy was found to be more effective than pharmacological methods alone (45).

Overall, however, mechanical means of prophylaxis have been less extensively studied than pharmacological methods, and are generally considered less efficacious than anticoagulants for the prevention of DVT. While there is evidence supporting the efficacy of mechanical devices in low-risk patients (2), they do not provide adequate prophylaxis in those at high-risk. The most recent ACCP guidelines recommend combination therapy for high-risk patients with multiple risk factors, and that, in general, mechanical prophylaxis be

used primarily in patients who are at high risk of bleeding or as an adjunct to anticoagulant-based prophylaxis (2).

The biggest problem: lack of clear data?

There are established international guidelines based on level-1 evidence that estimate the incidence of VTE in various populations, and then assess in as scientific a way as possible the efficacy and safety of prophylactic methods based on sound prospective randomized trials. However, only a small subset of what is done in medicine has been tested in appropriate, well-designed studies. Appropriate trials for every clinical situation have not been, and probably never will be, carried out for every situation.

When clinical data are either lacking or insufficient to guide treatment, the physician has to use clinical reasoning to identify the approach that best fits the patient and the pathology involved. It can be frustrating to see patients not being given effective prophylaxis simply because there are 'no data available'. Such individuals may be at very high risk of a thrombotic event, but there is no clear treatment path because their clinical situations have yet to be subjected to randomized prospective trials. So how do we ensure such patients are treated appropriately?

MATCHING RISK WITH PROPHYLACTIC STRATEGY

Routine screening of patients for symptomatic DVT is logistically difficult, and both clinically and economically inefficient (2). Equally, reliance on clinical surveillance to identify early symptoms or signs of DVT is inadequate to prevent clinically important VTE events: the first manifestation of VTE may be a fatal PE.

Thrombotic risk assessment allows patients to be stratified according to their overall VTE risk and thromboprophylaxis to be tailored appropriately, but it is a complex task that

must take into account both *exposing* risk factors relating to the clinical situation (eg, duration/type/site of surgery, type of anesthesia, concomitant illness, presence of infection, etc.), and *predisposing* factors unique to the individual patient (eg, age, thrombophilic abnormalities, history/family history of DVT, etc.). Many patients have more than one VTE risk factor and are considered to be at increased risk due to their cumulative effect (46-48) (although interestingly, a recent paper from the MEDENOX study reported an insignificant relationship between the number of VTE events and the number of risk factors) (49). Risk assessment models (RAMs) have been developed with the intention of simplifying and standardizing the scoring of VTE risk, and to allow optimization of prophylactic strategies. Unfortunately, there has been a history of poor compliance with RAMs, with a common complaint from physicians being that they are overly complicated and logistically difficult to implement in their own clinical setting. Many early VTE risk-scoring systems also relied upon diagnostic information not readily available from clinical examination (eg, laboratory values such as euglobulin lysis levels), which has led to reluctance among many doctors to implement such systems.

A simple, clinically validated, easy-to-use RAM based on factors in the patient's medical history and clinical examination is needed, and has the potential to be widely adopted. The model should be used to stratify patients according to risk and the treatment strategy applied in conjunction with academic guidelines where available, ie, the 'hybrid approach' to risk assessment.

A RAM developed by our team and implemented in our hospital overcomes the complexities and practical constraints associated with previous models (Table 3) (50). The model includes clear lists of risk factors with a simple accompanying scoring system, which allows patients to be assigned to one of the four VTE risk categories identified in the ACCP guidelines (low, moderate, high, very high), and an appropriate prophylaxis regimen to be

recommended (Table 4). Coupled with a thorough patient history and physical, this RAM can

help assess the relative risk for VTE based on individual risk factors. The following case

study highlights the value of a simple RAM in determining the prophylactic action required

for a patient whose risk of VTE is not easily categorized according to current guidelines.

CASE STUDY [set in text box]

Patient history

A 65-year-old man with a body mass index (BMI) > 30 kg/m^2, who received irradiation treatment for prostate cancer 5 years earlier, was found to have a 2 cm^3 carcinoma of the cecum during routine colonoscopy. The patient had been suffering from inflammatory bowel disease (IBD) for many years. He was taking a statin for elevated cholesterol levels, had mild hypertension with treatment, and was on a baby aspirin daily. The patient underwent a laproscopically-assisted colon resection, which lasted 2 hours 30 min. The patient did well postoperatively and was discharged 6 days later. The path report confirmed the presence of an early cancer without signs of metastasis.

There are no specific data based on prospective randomized trials on VTE risk and prophylaxis in a group of individuals with this exact combination of risk factors. That is not to say there are no relevant data because it is known that age > 60 years, BMI > 30 kg/m^2, inflammatory bowel disease, a history of cancer, and abdominal surgery for colon cancer are all risk factors for the patient developing a VTE (2). What form of prophylaxis should this patient receive given his risk factor profile?

Treatment

The patient received 5000 U of heparin preoperatively and during the operation. He was protected with pneumatic compression devices and elastic stockings to reduce stasis of blood in the legs during and immediately following the procedure. In addition, a prophylactic LMWH was administered once daily for a month starting 24 hours postoperatively. No complications were reported during a 90-day follow-up period.

This approach may be considered extreme, and is only endorsed at the present time by a minority of physicians in the United States and worldwide.

So what is the clinical basis of this treatment strategy?

LINKING THERAPY AND RISK

Based on clinical research to date, a patient undergoing a surgical procedure with more than five risk factors has a 40% to 80% chance of developing a VTE, and this is associated with a 0.2% to 5% rate of fatality from a PE (2). According to the RAM shown in Table 3, the patient described in the case study presented with five VTE risk factors (age, cancer, obesity, abdominal surgery, and IBD), which clearly placed him in the highest risk category (Table 4). Based on clinical trial data in abdominal surgery cancer patients, one month of daily LMWH injections was chosen. Although there may be concerns about the expense, or the risk of bleeding or other adverse event, this is a small concern compared to the ≤ 5% risk of a fatal event in this patient group (5 factors—table 4). Few passengers would board a plane knowing there to be up to a 5% risk of a fatal crash, which begs the question as to why an individual would choose not to use effective prophylaxis when there are no clinical data contraindicating such an approach.

Furthermore, often overlooked in this equation is the impact of postoperative thrombosis. While postoperative DVT can occur asymptomatically in the lower limbs, if part of a clot breaks off, it may embolize to the right atrium. Right-to-left shunt may then occur through a patent foramen ovale that temporarily opens due to atrial dilation in response to the thrombus. Known as a 'paradoxical embolism', this allows the clot to pass into the systemic circulation, whereupon it may lodge in the brain and lead to nonhemorrhagic stroke. In such cases, not only is there a 50% chance of residual damage, including paralysis due to stroke, but 20% of patients may die (51). Is this a risk worth taking in postoperative patients simply because they may be perceived to be at low risk?

Finally, these patients will probably not be fully ambulatory while hospitalized and during the first week post-discharge.

Accumulating evidence yet absence of guidelines

In situations for which specific data are not available, a conservative approach should

be followed and physicians must use reason where level-1 evidence is lacking. For example,

in terms of our case study patient, no clear guidelines exist to guide management. Yet looking

at the literature, we see a strong case for prolonged prophylaxis. Two studies using the

LMWHs dalteparin (52) and enoxaparin (53) have shown that prolonging LMWH

prophylaxis for a further 3 weeks is effective in preventing DVT after major abdominal

surgery in patients with cancer with no increase in bleeding complications. Meta-analysis of

these two studies confirmed that prolonging LMWH for a further 3 weeks following

discharge significantly reduces the risk of late occurring VTE by 62% (54). An increased

dose of the LMWH dalteparin from 2500 IU to 5000 IU once daily for 7 days significantly

reduced the incidence of VTE in cancer patients, with no increase in bleeding complications,

a result of particular significance given that cancer patients are at increased risk for bleeding

(55). Long-term LMWH (dalteparin 200 IU/kg for 6 months) has also been shown to be more

effective than an oral anticoagulant in reducing recurrent VTE in cancer patients with no

increased risk for bleeding (56), while further studies suggest benefits of LMWH for

improved cancer survival (57,58). This improved survival is thought to be associated with the

anti-angiogenic properties of LMWH that inhibit tumor progression (59).

The importance of weighting risk factors

Without accounting for all risk factors, inadequate prophylaxis may result. While the

aim is to develop a practicable RAM that overcomes the hindering complexities of its

predecessors, this must not be at the expense of oversimplification. For instance, in its

categorization of risk groups, the current ACCP guidelines lists patients >60 years

undergoing surgery as a high-risk group, with IPC as an acceptable sole means of prophylaxis

(2). Is this misleading when we note the increased incidence of VTE in cancer patients (up to 6 times higher than in individuals without a malignancy [60]) and see that LMWH or UFH are presented as the mainstays of prophylaxis in this group? By assigning 6 points to such a patient (2 each for surgery, cancer, and age >60 years) as suggested in our RAM, the patient would clearly be placed in the highest risk group, underlining the importance of weighting the factors. In this case, the IBD and obesity reinforce placing this patient in the highest risk group. Another key element was studied by Borow and Goldson (42) where incidence of venographic DVT was found to be related to surgery duration (20% at 1–2 h, 46.7% at 2–3 h, 62.5% >3 h). In this same study, age was also stratified (40–60, 61–70, 61–70, >71 years), with the incidence of DVT more than 60% for those above 71 years, compared to only 20% for those aged 40–60. This weighting is also employed in our RAM and further validates the weighted scoring system. We are currently in the process of implementing the RAM in the electronic record and adding a reminder to encourage prophylaxis. The aim is to build upon the positive results shown with the electronic alert developed by Kucher et al. (a 41% reduced risk of VTE at 90 days) (61) by combining it with a stratified approach to prophylaxis methods using weighted risk factors.

SUMMARY

High-quality clinical data are unlikely to be available to guide thromboprophylactic decisions in all clinical situations, particularly for medical patients in whom VTE has been less extensively studied. Thorough and up-to-date clinical guidelines are available and provide the foundation for treatment regimens; however, with new trial data constantly emerging, there will always be some disparity between the guidelines and clinical practice.

Despite the availability of effective methods of prophylaxis, both surgical and nonsurgical patients continue to be placed at risk of VTE and its potentially fatal complications, such as PE or stroke, due to the underuse of thromboprophylaxis. Prophylaxis is also being prescribed inappropriately, with patients at highest risk often receiving ineffective treatment due to misconceptions of VTE risk and concerns about the safety of anticoagulant therapy.

Where firm recommendations are available, the physician should treat according to the evidence, but where evidence is lacking, the physician should assess each patient based on their medical and clinical status and use a risk factor model to help stratify patients according to risk. Using this 'hybrid approach', which combines guidelines with intelligent clinical practice, more patients should receive appropriate prophylactic treatment tailored to their individual risk.

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Table 1. Adherence With ACCP Consensus Guidelines: An Audit of Hospital Practice.

	Moderate risk (2 risk factors)	High risk (3–4 risk factors)	Highest risk (5 or more risk factors)
Total (2002)	9/157 (6%)	43/157 (27%)	105/157 (67%)
Prophylaxis guidelines followed	7/9 (78%)	28/43 (65%)	32/105 (30%)
Prophylaxis guidelines not followed	2/9 (22%)	15/43 (35%)	73/105 (70%)
	Low (0–1 risk factors)	Moderate (2–4 risk factors)	High risk (more than 4 risk factors)
Total (1991)	185/538 (34%)	261/538 (49%)	92/538 (17%)
Prophylaxis guidelines followed	18/185 (10%)	110/261 (42%)	70/92 (76%)
Prophylaxis guidelines not followed	167/185 (90%)	151/261 (58%)	22/92 (24%)

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Table 2. Clinical Signs, Symptoms, or Events That May Be Associated With Venous

Thromboembolism in Clinical Practice.

- Leg pain
- Leg swelling
- Chest pain
- Shortness of breath
- Transient orthostatic hypotension
- Decreased level of consciousness presumed to be narcotic excess
- Fainting spell
- Hypoxia
- Follow-up of patient for re-admission or death 90 days postoperatively
- Sudden death
- Death without autopsy
- Postoperative stroke due to patent foramen ovale
- Suspected myocardial infarction
- Failure to thrive, sinking spell or "the dwindles"
- Postthrombotic syndrome during physical examination of the legs (standing) 5 years postoperatively
- Postoperative pneumonia

Table 3. Example of a Practical, Easy-to-Use VTE Risk Assessment Model.

Thrombosis risk factor assessment

Patient's name: _____ Age: _____ Gender: _____ Weight: _____

Each factor represents 1 point:

- ❑ Age 41 to 60 years
- ❑ Minor surgery planned
- ❑ History of prior major surgery (< 1 month)
- ❑ Varicose veins
- ❑ History of inflammatory bowel disease
- ❑ Swollen legs (current)
- ❑ Obesity (BMI > 25 kg/m^2)
- ❑ Acute myocardial infarction
- ❑ Congestive heart failure (< 1 month)
- ❑ Sepsis (< 1 month)
- ❑ Serious lung disease including pneumonia (< 1 month)
- ❑ Abnormal pulmonary function (chronic obstructive pulmonary disease)
- ❑ Medical patient currently on bed rest
- ❑ Other risk factors (specify)

Each factor represents 2 points:

- ❑ Age 60 to 74 years
- ❑ Arthroscopic surgery
- ❑ Malignancy (present or previous)
- ❑ Major surgery (> 45 minutes)
- ❑ Laparoscopic surgery (> 45 minutes)
- ❑ Patient confined to bed (> 72 hours)
- ❑ Immobilizing plaster cast (< 1 month)
- ❑ Central venous access catheter

Each factor represents 3 points:

- ❑ Age > 75 years
- ❑ History of DVT/PE

- **Family history of thrombosis***
- Positive Factor V Leiden
- Positive prothrombin 20210A
- Elevated serum homocysteine
- Positive lupus anticoagulant
- Elevated anticardiolipin antibodies
- Heparin-induced thrombocytopenia
- Other congenital or acquired thrombophilia

If yes, enter type: _____

*Most frequently missed risk factor

Each factor represents 5 points:
- Elective major lower extremity arthroplasty
- Hip, pelvis, or leg fracture (< 1 month)
- Stroke (< 1 month)
- Multiple trauma (< 1 month)
- Acute spinal cord injury (paralysis) (< 1 month)

For women only (each factor represents 1 point):
- Oral contraceptives or hormone-replacement therapy
- Pregnancy or postpartum (< 1 month)
- History of unexplained stillborn infant, recurrent abortion ($\geq$ 3), premature birth with toxemia or growth-restricted infant

TOTAL RISK FACTOR SCORE _____

Prophylaxis safety considerations: Check box if answer is 'YES'

Anticoagulants: Factors associated with increased bleeding

- ❑ Is patient experiencing any active bleeding?
- ❑ Does patient have (or has had history of) heparin-induced thrombocytopenia?
- ❑ Is patient's platelet count < 100,000/mm^3?
- ❑ Is patient taking oral anticoagulants, platelet inhibitors (eg, non-steroidal anti-inflammatory drugs, clopidogrel)
- ❑ Is patient's creatinine clearance abnormal? If yes, please indicate value

If any of the above boxes are checked, the patient may not be a candidate for anticoagulant therapy and should consider alternative prophylactic measures.

Intermittent pneumatic compression

- ❑ Does patient have severe peripheral arterial disease?
- ❑ Does patient have congestive heart failure?
- ❑ Does patient have an acute superficial/deep vein thrombosis?

If any of the above boxes are checked, the patient may not be a candidate for intermittent compression therapy and should consider alternative prophylactic measures.

Table 4. Prophylaxis Decision-Making Tool (Based on VTE Risk Scores).

Total VTE risk score	Incidence of DVT (%)	Risk level	Recommended prophylactic regimen	Risk of fatal PE without prophylaxis (%)
0–1	< 10	Low	No specific measures; early ambulation	< 0.01
2	10–20	Moderate	LWMH (≤ 3400 U once daily) or LDUH, (5000 U bid) or GCS* or IPC	0.1–0.4
3–4	20–40	High	LMWH (> 3400 U daily), LDUH (5000 U tid) or oral anticoagulant alone *or* in combination with GCS or IPC	0.4–1.0
≥ 5	40–80	Highest	LMWH (> 3400 U daily) or LDUH (5000 U tid) or oral anticoagulant alone *or* in combination with GCS or IPC	0.2–5

*Combining GCS with other prophylactic methods (LDUH, LMWH, or IPC) may give better protection.

The total risk score guides the physician to the most appropriate prophylactic treatment; risk categories correspond to the ACCP guidelines (2).

bid, twice daily; DVT, deep-vein thrombosis; GCS, graduated compression stockings; IPC, intermittent pneumatic compression; LDUH, low-dose unfractionated heparin; LMWH, low molecular weight heparin; PE, pulmonary embolism; tid, three times daily; VTE, venous thromboembolism.

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