Prevention of deep vein thrombosis and pulmonary embolism

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Abstract

Venous thromboembolism is a major cause of perioperative morbidity and mortality. Immobilized medical patients are also at risk. Long-term sequelae represent a significant chronic health burden. Hospitalized patients should be assessed for their risk of thromboembolism and bleeding at regular intervals. Risk stratification using recommended models can be used to guide the choice of thromboprophylaxis. Both mechanical and pharmacological interventions reduce the incidence of venous thromboembolism. Extended prophylaxis is now recommended following high-risk orthopaedic and cancer surgeries and a number of newer oral antithrombotic agents are now available for this. Anaesthesia should be tailored to minimize the risk of venous stasis and maximize early postoperative mobilization.

Keywords Bleeding risk; pulmonary embolism; risk scoring; thromboprophylaxis; venous thromboembolism deep vein thrombosis

Royal College of Anaesthetists CPD Matrix: 1A02, 1E05, 2A03

Learning objectives

After reading this article, you will be able to:

- describe the aetiology, incidence and implications of venous thromboembolism
- risk stratify patients for venous thromboembolism and bleeding
- explain the benefits and limitations of the various methods of thromboprophylaxis
- formulate a thromboprophylaxis management plan for various clinical scenarios

In 1859 Rudolph Virchow coined the terms thrombosis and embolism and went on to describe the essential factors of stasis, vessel wall damage and hypercoagulability. To this day, these factors are considered the cornerstones to identifying risk and in the prevention of venous thromboembolism (VTE). Deep vein thrombosis (DVT) can occur in deep veins of the limbs as well as in central veins. The consequences may be immediate and life threatening if emboli enter the pulmonary circulation causing pulmonary embolus (PE), or more rarely the systemic circulation via a shunt causing cerebrovascular or other vital organ compromise. Chronic sequelae, termed 'post thrombotic syndrome' (PTS), include chronic pain, venous insufficiency, skin changes and ulceration. The risk of PTS at 10 years is approximately 30%.[1]

Incidence and consequences

In the United States the first-time incidence of VTE exceeds 100 per 100,000 population. The 30-day mortality for patients diagnosed with DVT is around 6% and for those developing PE it is approximately 12%. About one-third will develop a recurrence within 10 years. It accounts for approximately 25,000 deaths annually in England, which represents around 10% of all hospital deaths.[2] The financial cost of VTE in Australia for 2008 was estimated at $1.72 billion (0.15% of GDP).[1]

VTE remains a major cause of morbidity and mortality in hospitalized patients, even in the developed world. Data from research and clinical audits suggest that the available preventive options are under-utilized and inconsistently applied. Prevention of VTE has been the focus of recommendations from both the United Kingdom National Institute of Health and Care Excellence (NICE) (Guidelines on Venous Thromboembolism 2010[2]) and the American College of Chest Physicians (ACCP) Antithrombotic Guidelines (9th edition (AT9) 2012[3]). European Society of Anesthesiology (ESA) guidelines on perioperative venous thromboembolism prophylaxis were also published in 2018[4].

VTE can be clinically silent and as a result is difficult to diagnose accurately. The ACCP guidelines suggest assessing the probability of suspected disease using the Wells criteria for DVT, or the Wells and Geneva criteria for PE *before* ordering investigations. Those classified low to moderate risk have a D-dimer assay and if this is positive undergo imaging. Patients with a high pretest probability proceed directly to imaging, without requiring D-dimer assay. The recommended imaging for DVT is compression duplex ultrasound, while for PE it is CT-pulmonary angiography or ventilation perfusion scanning.

Prevention of VTE

Prevention of VTE requires us to both identify which patients are at risk and choose an appropriate method of prophylaxis. Before pharmacological prophylaxis is instituted, the risk of VTE must be weighed against the risk and consequences of any increased bleeding in relation to both the patient and the procedure. The UK NICE guidelines recommend assessing a patients' risk of bleeding and VTE within 24 hours of hospital admission and whenever the clinical situation changes.[2]

Identifying the 'at-risk' patient

All immobilized patients are at risk, both medical and surgical. The Padua score (Table 1) is a risk prediction tool widely used in acute medical patients. In the perioperative setting, the risk of VTE is determined by both patient risk factors and risks from the surgical procedure itself. The ACCP uses the Caprini score (Table 2) to risk stratify surgical patients. NICE surveillance

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Padua prediction score: for hospitalized medical patients

Risk factor	Points
Active cancer	3
Previous VTE (exception of superficial vein thrombosis)	3
Reduced mobility (at least 3 days)	3
Diagnosed thrombophilia	3
Recent trauma and/or surgery (<1 month)	2
Age (>70 years)	1
Heart and/or respiratory failure	1
Acute myocardial infarction or ischaemic stroke	1
Acute infection and/or rheumatological disorder	1
Obesity (BMI>30kg/m2)	1
Ongoing hormonal treatment	1

Patients at high risk if score >4

Table 1

updates suggest that all of these risk assessment tools, despite having good predictive value in some patient groups, need more robust validation. As a result, no national tool for risk assessment is currently recommended by NICE and this has been highlighted as a focus for the next edition of the guideline.

Box 1 lists factors associated with an increased risk of perioperative bleeding which should be considered when planning VTE prophylaxis. Major bleeding is defined by NICE to be an episode resulting in a decrease in haemoglobin concentration of 2 g/dl or more, transfusion of two or more units of blood, bleeding into a retroperitoneal, intracranial or intraocular site, a serious or life-threatening clinical event or one that requires surgical or medical intervention.

VTE prophylaxis

Prevention of VTE can include one or both of mechanical or pharmacological measures. Early mobilization following surgery is paramount and any intervention that facilitates this will help reduce perioperative DVT and PE. Adequate analgesia, preventing and treating postoperative nausea and vomiting, adequate hydration, minimizing the motor block associated with using regional anaesthesia and good nursing care are all fundamental.

Risk factors for bleeding

- Active bleeding
- Acquired bleeding disorders (such as liver failure)
- Untreated inherited bleeding disorders
- Concurrent use of anticoagulants known to increase the risk of bleeding
- Thrombocytopenia (platelet count <75x10^9/litre
- Uncontrolled hypertension (>230/120)
- Acute stroke
- Lumbar puncture, spinal or epidural anaesthesia within the previous 4 hours
- Lumbar puncture, spinal or epidural anaesthesia expected within the next 12 hours

Box 1

Mechanical prophylaxis

Graduated compression stockings (GCS) act as an external layer of muscle, compressing the veins with decreasing circumferential pressure from the ankle to the thigh (8–18 mmHg), so aiding the propulsion of blood from distended veins towards the right atrium. Contraindications include severe peripheral vascular disease (ankle:brachial pressure index <0.8), following lower limb revascularization, significant peripheral neuropathy, acute severe congestive cardiac failure, weeping dermatoses or cutaneous sepsis. An inappropriately fitted GCS may prevent forward flow, worsening stasis. Thigh-length stockings have not been shown to further reduce risk compared with knee length stockings.[5]

Intermittent pneumatic compression devices (IPCs) also perform their function by preventing pooling and stasis of blood in the venous system of the legs. The mechanism is by intermittent inflation of a bladder that produces external pressure on the veins, improving the forward flow of blood. They are also thought to increase fibrinolytic activity. There are many devices available which differ in respect of their site of compression (thigh/calf or foot pumps), location of air bladders, pattern of the pressure cycles, compression profiles, cycle length, ratio of inflation/deflation time and cycling mode. The NICE 4-year surveillance update 2014[6] included results from the CLOTS 3 trial which showed the use of IPC in acute stroke patients was an effective method of VTE prophylaxis. While IPCs are certainly effective in preventing VTE, they are more effective when combined with pharmacological prophylaxis. They should be used for at least 18 hours a day when prescribed. The recent ESA guidelines suggest the use of IPC over GCS. While patients at very high risk of VTE (Caprini score) should have mechanical and pharmacological measures, the ESA recommend against the routine use of mechanical prophylaxis in other risk groups (high) already receiving pharmacological measures.[4] This differs from the ACCP recommendations in Table 3, where high- and very-high-risk groups are treated similarly.

Pharmacological prophylaxis

Pharmacological prophylaxis is the mainstay of prevention and treatment of VTE. However, not all the newer agents have been studied in all patient groups or surgical procedures and variations in dose are required in different situations.

Antiplatelet agents: Aspirin is the only antiplatelet agent used for VTE prophylaxis but remains a controversial option.[7] The antithrombotic action of aspirin is due to inhibition of platelet function by acetylation of platelet cyclooxygenase (COX), resulting in irreversible inhibition of platelet-dependent thromboxane formation. Aspirin is a more potent inhibitor of the (constitutive) COX-1 than the (inducible) COX-2. The ACCP, in their previous guideline (AT8), advised against the use of aspirin in this context. Since then, newer evidence has led both the ACCP and the American Association of Orthopedic Surgeons to recommend the use of aspirin, in combination with mechanical

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