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Approaching Venous Thrombosis in General Surgery Patients

Gulcin Hepgul[1], Fatih Yanar[2] and Meltem Küçükyılmaz[1]
[1]*Bagcilar, Training and Research Hospital, General Surgery Clinic*
[2]*Bakirkoy Dr Sadi Konuk Training and Research Hospital, General Surgery Clinic*
Turkey

1. Introduction

Venous thromboembolism (VTE) manifesting as deep vein thrombosis(DVT) or pulmonary embolism (PE), is one of the most common complications of hospitalization and is associated with short and long-term morbidity, mortality and resource expenditure. Routine use of thromboprophylaxis reduces adverse patient outcomes while at the same time decreasing overall costs. Almost all hospitalized patients have at least one associated risk factor for VTE, and approximately 40% have three or more risk factors **(Table 1)**(1).

Surgery
Trauma (major trauma or lower-extremity injury)
Immobility, lower-extremity paresis
Cancer (active or occult)
Cancer therapy (hormonal, chemotherapy, angiogenesis inhibitors, radiotherapy)
Venous compression (tumor, hematoma, arterial abnormality)
Previous VTE
Increasing age
Pregnancy and the postpartum period
Estrogen -containing oral contraceptives or hormone replacement therapy
Selective estrogen receptor modulators
Erythropoiesis-stimulating agents
Acute medical illness
Inflammatory bowel disease
Nephrotic syndrome
Myeloproliferative disorder
Paroxysmal nocturnal hemoglobinuria
Obesity
Central venous catheterization
Inherited or acquired thrombophilia

Table 1. Risk Factors for VTE

Without thromboprophylaxis, the incidence of objectively confirmed, hospital-acquired DVT is approximately 10 to 40% among medical or general surgical patients and 40 to 60% following major orthopedic surgery **(Table 2)**(1-2).

Patient Group	**DVT Prevalence, %**
Medical patients	10-20
General, surgery	15-40
Major gynecologic surgery	15-40
Major Urologic surgery	15-40
Neurosurgery	15-40
Stroke	20-50
Flip or knee arthroplasty, HFS	40-60
Major trauma	60-80
SCI	60-80
Critical care patients	10-80

* Rates based on objective diagnostic: screening for asymptomatic DVT in patients not receiving thromboprophylaxis.

Table 2. Approximate Risk of DVT in Hospitalized Patients

Several hundred clinical trials of thromboprophylaxis, conducted over the past 50 years, have shown that the use of prophylaxis reduces the rates of deep vein thrombosis (DVT), proximal DVT, pulmonary embolism (PE), and fatal PE by more than 60% in a broad spectrum of hospitalized patients with a very low risk of adverse effects. Although effective strategies for the prevention of venous thromboembolism (VTE) are widely available and existence of several guidelines for individual risk assessments to determine thrombosis risk and prophylaxis, a significant number of patients still develop VTE because appropriate thromboprophylaxis is not correctly prescribed. Adapting evidence-based practice guidelines into existing local policies and protocols has been shown to significantly increase the proportion of at-risk patients receiving appropriate thromboprophylaxis.

The American College of Chest Physicians (ACCP) sponsor and publish what are generally considered to be the most comprehensive and most commonly utilized of these guidelines(3). A summary of the 2008 ACCP Guidelines on the Prevention of VTE is presented in **Table 3**, (4).

The type and duration of surgery clearly influence the risk of DVT. Numerous efforts have been made to identify the patients most at risk for DVT and PE. The studies of this problem categorize risk levels as low, medium, high, and very high.

Patients at *low risk* are under 40 years of age contemplating minor surgery and with no associated risk factors. The incidence of DVT is less than 2%, proximal DVT 0.4%, PE at 0.2%, and fatal PE 0.02%. This group requires no special prophylaxis other than early ambulation.

Patients at *moderate risk* are those aged 40–50 who are undergoing major surgery, have no associated risk factors, and expect a prompt recovery. The frequency of DVT is 10%–20% proximal DVT, 2%–4%, clinical PE 1%–2%, and fatal PE 0%– 1.4%. This group will benefit from prophylactic treatment with LMWH, or LDUH and ES.

Patient groups	Recommended thromboprophylaxis options*	Optimal duration of prophylaxis
Low VTE Risk: •Medical - fully mobile, brief admission, no additional risk factors • Surgical - procedure < 30 minutes, patient mobile, no additional risk factors	No prophylaxis Early and frequent ambulation	Not applicable.
Moderate VTE Risk: •Acute medical illness •Major general surgery •Major gynecologic surgery " Major urologic surgery •Thoracic surgery •Bariatric surgery	Low-molecular-weight heparin Low-dose heparin Fondaparinux Combinations of a mechanical method and an anticoagulant	Continue until discharge for the majority of patients. Selected patients may benefit from post-discharge prophylaxis.
High VTE Risk: •Hip or knee arthroplasty •Hip fracture surgery	Low-molecular-weight heparin Fondaparinux Rivaroxaban or dabigatran Warfarin (target INR 2-3)	Minimum of 10 days and up to 35 days.
High VTE Risk: •Major trauma, (including spinal cord injury)	Low-molecular-weight heparin Combinations of a mechanical method and an anticoagulant	Continue until discharge for the majority of patients. Prophylaxis should be continued for the inpatient rehabilitation period.
High bleeding risk	Mechanical method of prophylaxis (GCS, PCD, VFP) Consider anticoagulant prophylaxis when bleeding risk decreases	Duration appropriate for the specific patient risk group.

GCS indicates graduated compression stocking; PCD, pneumatic compression device, VFP, venous foot pump.

Table 3. Risk stratification, recommended thromboprophylaxis and optimal duration of prophylaxis by patient group.

The *high-risk* group are patients over 60, candidates for major surgery, with associated risk factors. The prevalence of DVT is 20%–40%; proximal DVT 4%–8%, clinical PE 2%–4% and fatal PE 0.4%–1%. Higher doses of LMWH or LDUH should be used, together with 1 PC devices and ES.

In the *very-high-risk* group of patients with major trauma (multiorgan, spinal, pelvic, long bone fractures), intermittent compression devices and ES should be started as early as possible, and LMWH or LDUH initiated as soon as it is safe. In cases of major trauma, with absolute contraindications for anticoagulants, the prophylactic indication of an inferior vena cava (IVC) filter should be considered, especially in cases with duplex ultrasonography demonstration of DVT.

2. Mechanical methods of thromboprophylaxis and the role of combined thromboprophylaxis modalities

Early and frequent mobilizitation of hospitalized patients at risk for VTE is an important part of patient care. However, many patients cannot be fully ambulatory early after surgery. Furthermore, the majority of hospital-associated, symptomatic thromboembolic events occur after patients have started to ambulate, and mobilization alone does not provide adequate thromboprophylaxis for hospital patients. Specific mechanical methods of thromboprophylaxis, which include graduated compression stockings (GCS), intermittent pneumatic compression (IPC) devices, and the venous foot pump (VFP), increase venous outflow and/or reduce stasis within the leg veins. Use of mechanical thromboprophylaxis is the preferred option for patients at high risk for bleeding. If the high bleeding risk is temporary, consideration should be given to starting pharmacologic thromboprophylaxis once this risk has decreased. Mechanical thromboprophylaxis may also be considered in combination with anticoagulant thromboprophylaxis to improve efficacy in patient groups for which this additive effect has been demonstrated(3,5,6). However, since they are not associated with bleeding, and some methods have demonstrated efficacy as DVT prevention in clinical trials, the use of mechanical prophylaxis in combination with pharmacological prophylaxis may be helpful in certain situations. For example, in major trauma patients who have a high risk of bleeding at presentation (as after head injury), we use mechanical prophylaxis initially followed by anticoagulant prophylaxis with LMWH when safe (5,6). This strategy could be adopted in any postoperative situation in which the initial risk of bleeding is high.

3. VTE in cancer patients

The association of cancer with thrombosis has been known for more than 100 years. Since the beginning it was regarded as a 2-way association, first cancer increases the risk of thrombosis(as first observed by Armand Trousseau in 1865), and secondy clotting activation increases the progression of cancer(as postulated by Billroth in 1878). Patients with cancer have at least a sixfold-increased risk of VTE compared to those without cancer and active cancer accounts for almost 20% of all new VTE events occurring in the community. Furthermore, VTE is one of the most common and costly complications seen in cancer patients. Although the association between cancer and thrombosis has been known for years, there is now an increasing recognition among cancer providers of the impact of thrombotic complications on patients with cancer (7,8). Several factors have contributed to this heightened awareness. Firstly, cancer-associated VTE is increasingly prevalent. In a recent analysis of more than 1 million hospitalized patients with cancer, the rate of VTE increased by 28% from 1995 to 2003 ($P < .0001$)(9). Secondly, the consequences of VTE are better understood. Thrombosis is the second-leading cause of death in patients with cancer

and is associated with worsened mortality (10-12). In addition, patients with cancer who suffer VTE have an increased risk of recurrent VTE, bleeding complications, morbidity, and utilization of health care resources(13,14). Finally, newer anticancer agents particularly antiangiogenic drugs, appear to be more thrombogenic than conventional chemotherapy (15,16). Selected cancer patients with established VTE will need extended treatment to prevent its recurrence. In addition, a number of new cancer therapies have been associated with a further increase in the risk of VTE, warranting primary prophylaxis. Given the high mortality rate for VTE in cancer patients, it is imperative to ensure that all health-care professionals become familiar with and utilize the latest guidelines and tools for timely and evidence-based risk assessment, prevention, and treatment of VTE(17,18).

A hypercoagulable state or low-grade DIC is common in patients with cancer. The results of laboratory tests indicate that a process of fibrin formation and removal is ongoing during the development of malignancy. Reported rates of venous thromboembolism (VTE) in patients with cancer range from 4% to 31%(19,23). Cancer alone elevates the risk of thrombosis 4-fold; chemotherapy increases the risk 6.5-fold(24,25). Patients who undergo cancer surgery have a higher risk of postoperative VTE than those who have surgery for a nonmalignant disease (26). VTE is the second leading cause of death in cancer patients, and the presence of VTE in patients with cancer has been reported to increase the likelihood of death by 2- to 8-fold (27-32).

Results of the FRONTLINE (Fundamental Research in Oncology and Thrombosis) survey underscored the need for development of clinical guidelines focusing on VTE in cancer patients: surgeons and medical oncologists reported that they used VTE prophylaxis in only about 50% and 5% of their patients, respectively(33). Two sets of guidelines devoted specifically to oncology patients are available to help guide clinicians: recommendations by the American Society of Clinical Oncology (ASCO) and by the National Comprehensive Cancer Network (NCCN) (34-35). Both sets of recommendations direct that all adults hospitalized with cancer receive prophylactic anticoagulation therapy in the absence of contraindications. However, a recent review of more than 70,000 hospitalized patients with cancer in whom an indication for thromboprophylaxis had been identified showed that the rate of appropriate prophylaxis was only 27%(36).

Alcalay et al. was found VTE as a significant predictor of death within 1 year of colorectal cancer diagnosis, among the patients with local or regional stage disease, but not among the patients with metastatic disease(37).

Thromboembolic events are a major cause of morbidity and mortality in patients undergoing surgery. Cancer patients requiring curative abdominal surgery are considered to be at a particularly high risk for VTE, and thromboprophylaxis is strongly recommended (38). Studies of Western populations have shown that DVT rates range from 15% to 30% for cancer patients not receiving thromboembolic prophylaxis, and a meta-analysis by Colditz et al. estimated fatal PE rates of 0.1%–0.8% (39,40). Colorectal surgery is associated with a specific high risk of postoperative thromboembolic complications relative to other general surgery (41-43). The incidences of DVT and PE in colorectal cancer surgery patients who do not receive thromboembolic prophylaxis are approximately 40% and 5%, respectively (42-43). Moreover, late VTE rates of 10%– 20% have been reported in patients who received LMWH thromboprophylaxis in the first postoperative week (44).

The randomized double-blind ENOXACAN II study, and the multicenter randomized Denmark/Norway study found that thromboprophylaxis for 4 weeks after abdominal or pelvic cancer surgery reduced the incidence of venographically demonstrated asymptomatic

thrombosis (45-46). In those studies, the rate of asymptomatic thrombosis was 5%–7% after prolonged prophylaxis. Although the majority of asymptomatic DVT is not clinically significant, there is an association between asymptomatic DVT and the subsequent development of symptomatic VTE (47). In most studies, the ratio of asymptomatic DVT to symptomatic VTE ranges from 5:1 to 10:1. If a ratio of 10:1 is applied, the incidence of symptomatic DVT is approximately 0.5%–0.7% after prolonged thromboprophylaxis (4 weeks), similar to that found in the present study (0.63%). It shows the comparable incidence with that of Western countries, although in the present study thromboprophylaxis was administered only to high-risk patients and the treatment was of much shorter duration (median 3 days) and at a lower dose than that reported in those other studies.
Venous thromboembolism is a common complication in cancer patients due to the hypercoagulable state induced by changes in the coagulation system (48). A prothrombotic state is present in many cancer patients as a result of an increase in procoagulants, such as tissue factor, cancer procoagulant, and factor VIIa, and hypercoaguability increases as the cancer progresses (49,50). Patients with metastatic cancers are at an increased risk of VTE. Several studies have shown a direct association between cancer stage and thrombosis risk. Recent studies showed that a higher initial cancer stage was a strong independent risk factor for developing VTE within the first year after diagnosis of cancer (51). In the Korean study, multivariate analysis showed metastatic colorectal cancer (stage IV) was found a predictor of VTE. Moreover, advanced colorectal cancer (stage III, IV) was also a predictor of VTE, and patients with advanced cancer were twice as likely to be diagnosed with VTE as patients with less-advanced cancer (52).

4. Anticoagulant use in renal insufficiency

Renal clearance is the primary mode of elimination for several anticoagulants, including LMWH, fondaparinux, and the new oral factor Xa and Ha inhibitors. Therefore, with reduced renal function, these drugs may accumulate and may increase the risk of bleeding, particularly in elderly patients and those at high risk for bleeding (53). The relationship between renal impairment and drug accumulation for the various LMWHs appears to be variable and may be related to the chain length distribution of the different LMWH preparations (54). Two recent studies in hospitalized patients, the majority of whom were critically ill and had creatinine clearances less than 30 mL/min, have shown no bioaccumulation of dalteparin 5000 U once daily based on serial anti-factor Xa levels (55,56). Therefore, we do not reduce the prophylaxis dose of dalteparin in patients with renal insufficiency. In patients receiving intermittent hemodialy-sis, we suggest that the LMWH be administered after the dialysis session. With enoxaparin thromboprophylaxis, we suggest that 30 mg once daily be used. We also suggest that fondaparinux, rivaroxaban and dabigatran be avoided unless future evidence demonstrates that these agents can be used safely in patients with severe renal insufficiency.

5. Concomitant use of regional anesthesia techniques and anticoagulant prophylaxis

Neuraxial blockade (spinal or epidural anesthesia and continuous epidural analgesia) results in a significant reduction in cardiopulmonary morbidity compared with general anesthesia and narcotic-based systemic analgesia, as well as better pain control and patient

satisfaction (57). However, concerns have been raised about a possible increased risk of epidural or spinal hematoma and spinal cord ischemia or paraplegia with use of concomitant anticoagulant prophylaxis (58,59).We believe that anticoagulant thromboprophylaxis with LMWH or LDH can safely be given along with neuraxial blockade with proper patient selection and timing of doses. Further details can be found in Section 1.5 of the 8th ACCP Prevention of VTE guidelines(3). In summary:

1. Neuraxial blockade should be avoided in patients with systemic bleeding disorders and if hemostasis is impaired by an anticoagulant. The spinal needle or epidural catheter should be inserted at a time when there is minimal or no anticoagulant effect present.
2. Anticoagulant prophylaxis should be delayed if a hemorrhagic aspirate ("bloody tap") is encountered during initial needle or catheter placement.
3. Removal of an epidural catheter should be done when the anticoagulant effect is at a minimum (usually just before the next scheduled injection) and anticoagulant prophylaxis should be delayed for at least 2 hours after spinal needle or epidural catheter removal.
4. In patients with an indwelling epidural catheter, we suggest that warfarin be avoided altogether or that the catheter be removed less than 48 hours after starting warfarin because of its unpredictable anticoagulant effect.
5. The safety of continuous epidural analgesia with concomitant administration of fondaparinux or one of the new oral anticoagulants is not known and this combination is best avoided at this time.
6. Patients with epidural catheters who are given anticoagulant thromboprophylaxis should be carefully monitored for symptoms and signs of spinal cord compression. If spinal hematoma is suspected, diagnostic imaging and surgical decompression should be performed rapidly to reduce the risk of permanent spinal cord damage.
7. Every hospital using neuraxial blockade along with anticoagulant prophylaxis should develop a written protocol.
8. For patients receiving deep peripheral nerve blocks along with anticoagulant prophylaxis, it is reasonable to use the same cautions described above.

6. Trauma

Deep venous thrombosis DVT and pulmonary embolism are among the most common preventable sources of mortality and morbidity in trauma patients treated in intensive care units. In various studies, DVT and PE have been demonstrated to range from 6%to 40% and from2%to 22%, respectively, in patients with serious spinal/head trauma (5, 6, 60-62). Knudson et al. and Geerts et al. reported that in trauma patients other than the ones with head trauma LMWH was better than unfractionated heparin for DVT prophylaxis (61,62). Vanek, with a metaanalysis, showed that intermittent pneumatic compression (IPC) decreased the relative risk of DVT by 62%, 47%, and 48% compared to placebo, high-pressure stockings, and LMWH, respectively (63). Norwood et al. reported that enoxaparin for DVT prophylaxis in patients with acute brain injury having an Abbreviated Injury Score of > 3 did not increase the morbidity (64). Early use of LMWH for DVT prophylaxis in the presence of intraabdominal solid organ injury (liver, spleen, kidney) may also be safe (6, 61). A properly placed and managed intermittent pneumatic compression device could provide thromboprophylaxis of comparable efficacy to that of LMWH, in patients with moderate and severe injury (65).

7. Laparoscopic surgery

The expanding use of laparoscopy last 3 decades has profoundly changed surgical diagnosis and therapy. However there is still some controversy over the best practice for prevention of deep vein thrombosis (DVT) during laparoscopic surgery. There is considerable uncertainty related to the thromboembolic risk after laparoscopic procedures, and the use of thromboprophylaxis is controversial. Surgical trauma is generally less with laparoscopic than with open abdominal surgery, but activation of the coagulation system is similar to or only slightly less with laparoscopic procedures. Laparoscopic operations may be associated with longer surgical times than comparable open procedures. Both pneumoperitoneum and the reverse Trendelenburg position reduce venous return from the legs, creating venous stasis. Patients undergoing laparoscopic procedures may have shorter hospital stays, but they may not mobilize more rapidly at home than those who have had open procedures.
Despite the paucity of evidence, the European Association for Endoscopic Surgery has recom mended that intraoperative IPC be used for all prolonged laparoscopic procedures (66). In 2006, the Society of American Gastrointestinal Endoscopic Surgeons recommended the use of similar thromboprophylaxis options for laparoscopic procedures as for the equivalent open surgical procedures (67). However, available evidence does not support a recommendation for the routine use of thromboprophylaxis in these patients (68,69,70). Furthermore, with anticoagulant thromboprophylaxis, the risk of major bleeding may exceed the rate of thrombotic complications(71). Patients who are at particularly high thromboembolic risk can be considered for thromboprophylaxis with any of the modalities currently recommended for surgical patients (3,72).

8. Treatment of VTE

Treatment for VTE has been widely studied, and treatment guidelines have been published and frequently updated by the American College of Chest Physicians (ACCP), American College of Emergency Physicians, Eastern Association for the Surgery of Trauma, and Institute for Clinical Systems Improvement(1,3). Generally, acute treatment consists of low-molecular-weight heparin (LMWH) or unfractionated heparin (UFH) for 4 to 5 days, with overlapping therapy to warfarin until an international normalized ratio (INR) of >2 for two consecutive days is achieved. Anticoagulation should be continued for at least 3 to 12 months, depending on the site of thrombosis and risk factors. Failure to provide adequate VTE treatment can result in patient morbidity and mortality, with a substantial economic burden(73). Although the evidence and consensus strongly favor LMWH treatment for up to 6 months in patients with cancer with established VTE, evidence is lacking to support continuing treatment beyond 6 months. It is likely that anticoagulation can be safely discontinued in certain patients (eg, patients who developed a VTE while on adjuvant chemotherapy and are in complete remission withnoplans for further treatment). Conversely, certain patients will continue to be at risk for recurrent VTE (eg, a patient with cancer with metastatic disease with plans for indefinite chemotherapy). Data from well-designed randomized clinical trials are essential for clinicians to make evidencebased recommendations in these varied settings.
Activation of the hemostatic system promotes tumor growth, angiogenesis, and metastasis. Antithrombotic agents could therefore potentially influence tumor biology and outcomes in patients with cancer. Multiple recent studies have evaluated the effect of anticoagulants on

survival, with encouraging but inconclusive results (74). Given that anticoagulant prophylaxis could have dual benefits for patients with cancer reducing VTE and prolonging survival it is vital to pursue well-designed clinical trials of thromboprophylaxis focusing on survival(75).

9. Appendix

An informative summary from American College of Chest Physicians Evidence-Based Clinical Practice Prevention of Venous Thromboembolism Guidelines (8th Edition)(3).

10. Guyatt grading(76)

Grade 1 recommendations are strong and indicate that the benefits do or do not outweigh risks, burden, and costs.
Grade 2 suggestions imply that individual patient values may lead to different choices

11. General surgery

- For low-risk general surgery patients who are undergoing minor procedures and have no additional thromboembolic risk factors, ACCP recommend against the use of specific thromboprophylaxis other than early and frequent ambulation (Grade 1A).
- For moderate-risk general surgery patients who are undergoing a major procedure for benign disease, patients should receive thromboprophylaxis with LMWH, LDUH, or fondaparinux (each Grade 1A).
- For higher-risk general surgery patients who are undergoing a major procedure for cancer, patient should receive thromboprophylaxis with LMWH, LDUH three times daily, or fondaparinux (each Grade 1A).
- For general surgery patients with multiple risk factors for VTE who are thought to be at particularly high risk, AACP recommend that a pharmacologic method *(ie,* LMWH, LDUH three times daily, or fondaparinux) be combined with the optimal use of a mechanical method (te, graduated compression stockings [GCS] and/or IPC) [Grade 1C].
- For general surgery patients with a high risk of bleeding, optimal use of mechanical thromboprophylaxis with properly fitted GCS or IPC is best method (Grade 1A). When the high bleeding risk decreases, we recommend that pharmacologic thromboprophylaxis be substituted for or added to the mechanical thromboprophylaxis (Grade 1C).
- For patients undergoing major general surgical procedures, we recommend that thromboprophylaxis continue until discharge from hospital (Grade 1A). For selected high-risk general surgery patients, including some of those who have undergone major cancer surgery or have previously had VTE, ACCP suggest that continuing thromboprophylaxis after hospital discharge with LMWH for up to 28 days be considered (Grade 2A).

12. Cancer patients

- For cancer patients undergoing surgical procedures, ACCP recommend routine thromboprophylaxis that is appropriate for the type of surgery (Grade 1A). Refer to the

recommendations in the relevant surgical subsections. 7.0.2. For cancer patients who are bedridden with an acute medical illness, ACCP recommend routine thromboprophylaxis as for other high-risk medical patients (Grade 1A). Refer to the recommendations in Section 6.0. 7.0.3. For cancer patients with indwelling central venous catheters, ACCP recommend that clinicians not use either prophylactic doses of LMWH (Grade IB), or minidose warfarin (Grade IB) to try to prevent catheter-related thrombosis.

- For cancer patients receiving chemotherapy or hormonal therapy, ACCP recommend against the routine use of thromboprophylaxis for the primary prevention of VTE (Grade 1C). 7.0.5. For cancer patients, ACCP recommend against the routine use of primary thromboprophylaxis to try to improve survival (Grade IB).

13. Laparoscopic surgery

- For patients undergoing entirely laparoscopic procedures who do not have additional thromboembolic risk factors, routine use of thromboprophylaxis is unneccessary. Early and frequent ambulation should be forced (Grade 1B).
- For patients undergoing laparoscopic procedures in whom additional VTE risk factors are present, ACCP recommend the use of thromboprophylaxis with one or more of LMWH, LDUH, fondaparinux, IPC, or GCS (all Grade 1C).

14. Trauma

- For all major trauma patients, ACCP recommend routine thromboprophylaxis if possible (Grade 1A).
- For major trauma patients, in the absence of a major contraindication, ACCP recommend that clinicians use LMWH thromboprophylaxis starting as soon as it is considered safe to do so (Grade 1A). An acceptable alternative is the combination of LMWH and the optimal use of a mechanical method of thromboprophylaxis (Grade IB).
- For major trauma patients, if LMWH thromboprophylaxis is contraindicated due to active bleeding or high risk for clinically important bleeding, we recommend that mechanical thromboprophylaxis with IPC or possibly with GCS alone be used (Grade IB). When the high bleeding risk decreases, we recommend that pharmacologic thromboprophylaxis be substituted for or added to the mechanical thromboprophylaxis (Grade 1C).
- In trauma patients, ACCP recommend against routine DUS screening for asymptomatic deep vein thrombosis (DVT) (Grade IB). We do recommend DUS screening in patients who are at high risk for VTE (eg, in the presence of a spinal cord injury [SCI], lower-extremity or pelvic fracture, or major head injury), and who have received suboptimal thromboprophylaxis or no thromboprophylaxis (Grade 1C).
- For trauma patients, ACCP recommend against the use of an inferior vena cava (IVC) filter as thromboprophylaxis (Grade 1C).
- For major trauma patients, ACCP recommend the continuation of thromboprophylaxis until hospital discharge (Grade 1C). For trauma patients with impaired mobility who

undergo inpatient rehabilitation, ACCP suggest continuing thromboprophylaxis with LMWH or a VKA (target INK, 2.5; range, 2.0 to 3.0) (Grade 2C).

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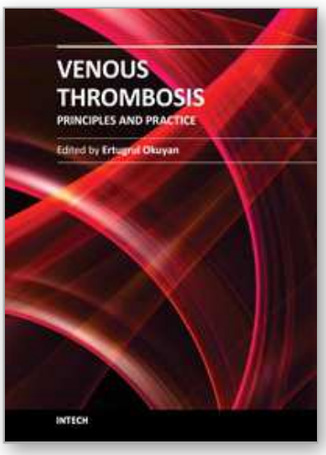

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According to Virchow's triad, venous thrombosis can occur as a result of one or more of three factors: changes in the dynamics of the blood flow, endothelial injury/dysfunction of the blood vessel and hypercoagulability. The blood in the veins is constantly forming microscopic thrombi that are routinely broken down by the body, and significant clotting can occur only when the balance of thrombus formation and resolution is altered. This book is a fresh synthesis of venous thromboembolism care and considers the opinions and studies from different fields of medicine. As venous thrombosis spectrum is wide and can affect many organ systems, from deep veins of the leg to the cerebral venous system, our intent is for this to be a comprehensive, up-to-date and readable book. We tried to present a synthesis of existing material infused with new ideas and perspectives and authors own clinical studies and even case-reports.

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InTech Europe
University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
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中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
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