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Role of Physical Therapists in the Management of Individuals at Risk for or Diagnosed With Venous Thromboembolism: Evidence-Based Clinical Practice Guideline

Ellen Hillegass, Michael Puthoff, Ethel M. Frese, Mary Thigpen, Dennis C. Sobush, Beth Auten; for the Guideline Development Group

The American Physical Therapy Association (APTA), in conjunction with the Cardiovascular & Pulmonary and Acute Care sections of APTA, have developed this clinical practice guideline to assist physical therapists in their decision-making process when treating patients at risk for venous thromboembolism (VTE) or diagnosed with a lower extremity deep vein thrombosis (LE DVT). No matter the practice setting, physical therapists work with patients who are at risk for or have a history of VTE. This document will guide physical therapist practice in the prevention of, screening for, and treatment of patients at risk for or diagnosed with LE DVT. Through a systematic review of published studies and a structured appraisal process, key action statements were written to guide the physical therapist. The evidence supporting each action was rated, and the strength of statement was determined. Clinical practice algorithms, based on the key action statements, were developed that can assist with clinical decision making. Physical therapists, along with other members of the health care team, should work to implement these key action statements to decrease the incidence of VTE, improve the diagnosis and acute management of LE DVT, and reduce the long-term complications of LE DVT.

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See eAppendix 1 (available at ptjournal.apta.org) for brief author biographies.

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Venous thromboembolism (VTE) is the formation of a blood clot in a deep vein that can lead to complications, including deep vein thrombosis (DVT), a pulmonary embolism (PE), or postthrombotic syndrome (PTS). Venous thromboembolism is a serious condition, with an incidence of 10% to 30% of people dying within 1 month of diagnosis, and half of those diagnosed with a DVT have long-term complications.[1] Even with a standard course of anticoagulant therapy, one third of individuals will experience another VTE within 10 years.[1] For those who survive a VTE, quality of life can be decreased due to the need for long-term anticoagulation to prevent another VTE.[2]

No matter the practice setting, physical therapists work with patients who are at risk for or have a history of VTE. Additionally, physical therapists are routinely tasked with mobilizing patients immediately after diagnosis of a VTE. Because of the seriousness of VTE, the frequency that physical therapists encounter patients with a suspected or confirmed VTE, and the need to prevent future VTE, the American Physical Therapy Association (APTA) in conjunction with the Cardiovascular & Pulmonary and Acute Care sections of APTA, support the development of this clinical practice guideline (CPG). It is intended to assist all physical therapists in their decision making process when managing patients at risk for VTE or diagnosed with a lower extremity deep vein thrombosis (LE DVT).

In general, CPGs optimize the care of patients by building upon the best evidence available while examining the benefits and risks of each care option.[3] The VTE Guideline Development Group (GDG) followed a systematic process to write this CPG with the overall objective of providing physical therapists with the best evidence in preventing VTE, screening for LE DVT, mobilization of patients with LE DVT, and management of complications of LE DVT. Specifically, this CPG will:

- Discuss the role of physical therapists in identifying patients who are at high risk for a VTE and actions that can be taken to decrease the risk of a first or recurring VTE.
- Provide physical therapists with specific tools to identify patients who may have an LE DVT and determine the likelihood of an LE DVT.
- Assist physical therapists in determining when mobilization is safe for a patient diagnosed with an LE DVT based on the treatment chosen by the interprofessional team.
- Describe interventions that will decrease diagnosis complications, such as PTS or another VTE.
- Create a reference publication for health care providers, patients, families and caretakers, educators, policy makers, and payers on the best current practice of physical therapist management of patients at risk for VTE and diagnosed with an LE DVT.
- Identify areas of research that are needed to improve the evidence base for physical therapist management of patients at risk for or diagnosed with VTE.

This CPG, which contains 14 key action statements (Tab. 1), can be applied to adult patients across all practice settings, but it does not address or apply to women who are pregnant or to children. Additionally, this guideline does not discuss the management of PE, upper extremity DVT (UE DVT), or chronic thromboembolic pulmonary hypertension (CTEPH). Although primarily written for physical therapists, other health care professionals should find this CPG helpful in their treatment of patients who are at risk for or have a diagnosed VTE.

Background and Need for a CPG on VTE

Venous thromboembolism is a life-threatening disorder that ranks as the third most common cardiovascular illness, after acute coronary syndrome and stroke.[4] This disorder consists of DVT and PE, 2 interrelated primary conditions caused by venous blood clots, along with several secondary conditions including PTS and CTEPH.[5] From primary and secondary prevention perspectives, the seriousness of VTE development related to mortality, morbidity, and diminished life quality is a worldwide concern.[6] The incidence of VTE differs greatly among countries. For example, the United States ranges from 70 to 120 cases per 100,000 inhabitants per year, and in Europe there are between 140 and 240 cases per 100,000 inhabitants per year, with sudden death being a frequent outcome.[7]

Deep vein thrombosis is a serious, yet potentially preventable, medical condition that occurs when a blood clot forms in a deep vein, most commonly in the calf, thigh, or pelvis. A life-threatening, acute complication of LE DVT is PE. This complication occurs when the clot dislodges, travels through the venous system, and causes a blockage in the pulmonary circulatory system. A proximal LE DVT, defined as occurring in the popliteal vein or veins more cephalad, is associated with an estimated 50% risk of PE if not treated, as compared with approximately 20% to 25% of LE DVTs below the knee.[8] Approximately 1 in 5 individuals with acute PE die almost immediately, and 40% will die within 3 months.[9] In those who survive PE, significant cardiopulmonary morbidity can occur, most notably CTEPH.

Chronic thromboembolic pulmonary hypertension can be the result of a single PE, multiple PEs, or recurrent PEs. Acutely, PE causes an obstruction of flow. This narrowing of the lumen may lead to reduced oxygenation and pulmonary hypertension. Chronically, the infarction of lung tissue following PE may result in a reduction of vascularization and concomitant pulmonary hypertension. Over time, the workload imposed on the right heart increases and contributes to right heart dysfunction and then failure.[10] A new syndrome, post-PE syndrome, has more recently been proposed to capture those patients with persistent abnormal cardiac and



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- eTable: Current Anticoagulation Options in Use
- eAppendix 1: Brief Author Biographies
- eAppendix 2: AGREE II Review of Current Guideline

Table 1.
Key Action Statements[a]

Number	Statement	Key Phrase
1	Physical therapists should advocate for a culture of mobility and physical activity unless medical contraindications for mobility exist. (Evidence Quality: I; Recommendation Strength: A–Strong)	Advocate for a culture of mobility and physical activity
2	Physical therapists should screen for risk of VTE during the initial patient interview and physical examination. (Evidence Quality: I; Recommendation Strength: A–Strong)	Screen for risk of VTE
3	Physical therapists should provide preventive measures for patients who are identified as high risk for LE DVT. These measures should include education regarding signs and symptoms of LE DVT, activity, hydration, mechanical compression, and referral for medication. (Evidence Quality: I; Recommendation Strength: A–Strong)	Provide preventive measures for LE DVT
4	Physical therapists should recommend mechanical compression (eg, IPC, GCS) when individuals are at high risk for LE DVT. (Evidence Quality: I; Recommendation Strength: A–Strong)	Recommend mechanical compression as a preventive measure for LE DVT
5	Physical therapists should establish the likelihood of an LE DVT when the patient has pain, tenderness, swelling, warmth, or discoloration in the lower extremity. (Evidence Quality: II; Recommendation Strength: B–Moderate)	Identify the likelihood of LE DVT when signs and symptoms are present
6	Physical therapists should recommend further medical testing after the completion of the Wells criteria for LE DVT prior to mobilization. (Evidence Quality: I; Recommendation Strength: A–Strong)	Communicate the likelihood of LE DVT and recommend further medical testing
7	When a patient has a recently diagnosed LE DVT, physical therapists should verify whether the patient is taking an anticoagulant medication, what type of anticoagulant medication, and when the anticoagulant medication was initiated. (Evidence Quality: V; Recommendation Strength: D–Theoretical/Foundational)	Verify the patient is taking an anticoagulant
8	When a patient has a recently diagnosed LE DVT, physical therapists should initiate mobilization when therapeutic threshold levels of anticoagulants have been reached. (Evidence Quality: I; Recommendation Strength: A–Strong)	Mobilize patients who are at a therapeutic level of anticoagulation
9	Physical therapists should recommend mechanical compression (eg, IPC, GCS) when a patient has an LE DVT. (Evidence Quality: II; Recommendation Strength: B–Moderate)	Recommend mechanical compression for patients with LE DVT
10	Physical therapists should recommend that patients be mobilized, once hemodynamically stable, following IVC filter placement. (Evidence Quality: V; Recommendation Strength: P–Best Practice)	Mobilize patients after IVC filter placement once hemodynamically stable
11	When a patient with a documented LE DVT below the knee is not treated with anticoagulation and does not have an IVC filter and is prescribed out of bed mobility by the physician, the physical therapist should consult with the medical team regarding mobilizing versus keeping the patient on bed rest. (Evidence Quality: V; Recommendation Strength: P–Best Practice)	Consult with the medical team when a patient is not anticoagulated and without an IVC filter
12	Physical therapists should screen for fall risk whenever a patient is taking an anticoagulant medication. (Evidence Quality: III; Recommendation Strength: C–Weak)	Screen for fall risk
13	Physical therapists should recommend mechanical compression (eg, intermittent pneumatic compression, graduated compression stockings) when a patient has signs and symptoms suggestive of PTS. (Evidence Quality: I; Recommendation Strength: A–Strong)	Recommend mechanical compression when signs and symptoms of PTS are present
14	Physical therapists should monitor patients who may develop long-term consequences of LE DVT (eg, PTS severity) and provide management strategies that prevent them from occurring to improve the human experience and increase quality of life. (Evidence Quality: V; Recommendation Strength: P–Best Practice)	Implement management strategies to prevent future VTE

[a] VTE=venous thromboembolism, LE DVT=lower extremity deep vein thrombosis, IPC=intermittent pneumatic compression, GCS=graduated compression stockings, IVC=inferior vena cava, PTS=postthrombotic syndrome.

pulmonary function who do not meet the criteria for CTEPH.[5] These conditions are associated with diminished function and lowered quality of life.[11]

Beyond the threat of PE and its sequelae, LE DVT may lead to long-term complications. Postthrombotic syndrome is the most frequent complication and develops in up to 50% of these patients even when an appropriate anticoagulant is used.[12,13] A clot remaining in the vein of the lower extremity can obstruct blood flow, leading to venous hypertension. Additionally, damage to the vein itself occurs and leads to inflammation and necrosis of the vein, which eventually are removed by phagocytic cells, leading to venous hypertension. This impaired blood flow can lead to classic symptoms of PTS, which often includes chronic aching pain, intractable edema, limb heaviness, and leg ulcers.[10] This chronic pathology can cause serious long-term ill health, impaired functional mobility, poor quality of life, and increased costs for the patient and the health care system.

Across various practice settings, physical therapists encounter patients who are at risk for VTE, may have an undiagnosed LE DVT, or have recently been diagnosed with an LE DVT. The physical therapist's responsibility to every patient is 5-fold: (1) prevention of VTE, (2) screening for LE DVT, (3) contributing to the health care team in making prudent decisions regarding safe mobility for these patients, (4) patient education and shared decision making, and (5) prevention of long-term consequences of LE DVT. Such decisions should always be made in collaboration with the referring physician and other members of the health care team (ie, it is assumed that such decisions will not be made in isolation and that the physical therapist will communicate with the medical team).

Due to the long-standing controversy regarding mobilization versus bed rest following VTE diagnosis and with the development of new anticoagulation medications, the physical therapy community needs evidence-based guidelines to assist in clinical decision making. This CPG is intended to be used as a reference document to guide physical therapist practice in the prevention of, screening for, and treatment of patients at risk for or diagnosed with LE DVT. This CPG is based on a systematic review of published studies on the risks of early ambulation in patients with diagnosed DVT and on other established clinical guidelines on prevention, risk factors, and screening for VTE and PTS. In addition to providing practice recommendations, this guideline also addresses gaps in the evidence and areas that warrant further investigation.

Methods

The GDG, which comprised physical therapists with special interest in acute care and cardiovascular and pulmonary practice, was appointed by the Cardiovascular & Pulmonary and the Acute Care sections of APTA to develop a guideline to address the physical therapist's role in the management of VTE. Specifically, the role of mobility was identified as a major issue facing both sections. Models used by the APTA Pediatric Section for its CPG on physical therapy management of congenital muscular torticollis[14] were primarily used to develop this CPG, as well as other APTA-supported CPGs and international processes. In July 2012, the GDG initiated the process under the guidance of APTA and developed a list of topic areas to be covered by the CPG. In addition, topic areas were solicited from clinicians with content experience in the area of VTE who volunteered to assist. A resultant list of topic areas was developed to determine the scope of the CPG and provided the GPG with limits to the literature search.

Literature Review

A search strategy was developed and performed by a librarian to identify literature published between May 1, 2003, and May 2014 addressing mobilization and anticoagulation therapy to prevent and treat VTE. Searches were performed in the following databases: PubMed, CINAHL, Web of Science, Cochrane Database of Systematic Reviews, Database of Abstracts of Reviews of Effects (DARE), and the Physiotherapy Evidence Database (PEDro). Controlled vocabularies, such as MeSH and CINAHL headings, were used whenever possible in addition to key words. Results were limited to articles written in English. The search strategy by key words, MeSH terms, and databases is shown in Table 2. Using this search strategy, 350 out of 8,652 abstracts and citations of relevance were obtained from Web of Science, CINAHL, PubMed, and Cochrane Database of Systematic Reviews.

Clinical practice guidelines published between 2003 and 2014 were searched including the same key words and MeSH terms using the National Guideline Clearinghouse (NGC, http://www.guideline.gov/) database and the Trip database (http://www.tripdatabase.com/). The NGC database identified 169 guidelines, of which 40 were deemed as appropriate to be reviewed. Three additional guidelines were identified through the Trip database, and the appropriate target populations were included.

Method: Literature Review Procedures

The results of the literature and guideline searches were distributed to the members of the GDG. One member of the group reviewed a list of citations, and another member performed a second review of the same list of citations. Articles were included based on whether key topics were addressed and the appropriate target populations were included. Case reports and pediatric articles were excluded. The GDG, along with clinicians and academicians who volunteered from both the Cardiovascular & Pulmonary Section and the Acute Care Section, were invited to review the identified literature.

Reliability of appraisers was established prior to articles being reviewed. Selected articles were reviewed by 3 individuals who used 1 of 3 critical appraisal tools adapted from an evidence-based practice textbook to evaluate each according to its type (ie, critical appraisal for studies of prognosis, diagnosis, or intervention).[15] The Assessment of Multiple Systematic Reviews (AMSTAR) tool was used for systematic reviews.[16] Selected diagnosis, prognosis, and intervention articles and systematic reviews were critically appraised by the GDG to establish test standards. Interrater reliability

Table 2.
Search Strategy by Key Words, MeSH Terms, and Databases

Key Words	MeSH Terms	Databases
DVT "Venous Thrombosis" "Deep Vein Thrombosis" VTE "Venous Thromboembolism" "Pulmonary Embolism" Walking Walk Ambulation Ambulate Ambulated Movement Mobility Immobilization Immobilisation "Mobility Limitation" "Motor Activity" "Early Ambulation" "Early Activization" "Early Activisation" "Early Mobilization" "Early Mobilisation" Anticoagulants Anticoagulant Anticoagulation Dabigatran Desirudin Ximelagatran Edoxaban Rivaroxaban Apixaban Betrixaban "YM150" Razaxaban "Factor Xa Inhibitor" "Direct Thrombin Inhibitors" "Direct Thrombin Inhibitor" Coumadin Warfarin Fondaparinux Idraparinux "International Normalized Ratio" "INR" "Prothrombin Time" "Vena Cava Filter*" "Intermittent Pneumatic Compression Devices" "Compression Stockings" "Compression Socks" "Compression Hose" "Compression Hosiery"	"Venous Thrombosis" "Pulmonary Embolism" "Walking" "Movement" "Immobilization" "Mobility Limitation" "Motor Activity" "Early Ambulation" "Activities of Daily Living" "Anticoagulants" "Coumarins" "Fibrin Modulating Agents" "Factor Xa/antagonists and inhibitors" "Thrombosis/prevention and control" "Antithrombins" "Citric Acid" "Heparinoids" "Vitamin K/antagonists and inhibitors" "Antithrombin Proteins" "Fibrinolytic Agents" "International Normalized Ratio" "Prothrombin Time" "Vena Cava Filters" "Intermittent Pneumatic Compression Devices" "Stockings, Compression"	PubMed CINAHL Web of Science Cochrane Database of Systematic Reviews Database of Abstracts of Reviews of Effects (DARE) Physiotherapy Evidence Database (PEDro)

among the 4 core group members was first established on test articles. Volunteers completed critical appraisals of the test articles to establish interrater reliability. Volunteers qualified to be appraisers with agreement of 90% or more. Appraisers were randomly paired to read each of the remaining diagnostic, prognostic, or intervention articles. Discrepancies in scoring between the readers were resolved by a member of the GDG.

Clinical practice guidelines were reviewed that fit the scope of this CPG and the patient population. Guidelines were included based on whether key topics were addressed and the target populations were included. The results of the CPG search were reviewed by one member of the GDG. Four additional clinical expert volunteers underwent training in the Appraisal of Guidelines for Research and Evaluation II (AGREE II)[17] tool to evaluate CPGs with subsequent reliability testing being performed on all reviewers.

Levels of Evidence and Grades of Recommendations

The GDG followed a previously published process on developing physical therapy CPGs.[14] Table 3 lists criteria used to determine the level of evidence associated with each practice statement,

Table 3.
Levels of Evidence[a]

Level	Criteria
I	Evidence obtained from high-quality diagnostic studies, prognostic or prospective studies, cohort studies or randomized controlled trials, meta-analyses or systematic reviews (critical appraisal score >50% of criteria)
II	Evidence obtained from lesser-quality diagnostic studies, prognostic or prospective studies, cohort studies or randomized controlled trials, meta-analyses or systematic reviews (eg, weaker diagnostic criteria and reference standards, improper randomization, no blinding, <80% follow-up) (critical appraisal score <50% of criteria)
III	Case-controlled studies or retrospective studies
IV	Case studies and case series
V	Expert opinion

[a] Reprinted from Kaplan S, Coulter C, Fetters L. Developing evidence-based physical therapy clinical practice guidelines. *Pediatr Phys Ther.* 2013;25:257–270, with permission of Wolters Kluwer Health Inc.

with level I as the highest level of evidence and level V as the lowest level of evidence. Table 4 presents the criteria for the grades assigned to each action statement. The grade reflects the overall and highest levels of evidence available to support the action statement.

Statements that received an A or B grade should be considered as well supported. The CPG lists each key action statement followed by rating of level of evidence and grade of the recommendation. Under each statement is a summary providing the supporting evidence and clinical interpretation. The statements are organized in Table 1 according to the action statement number, the statement, and the key phrase or action statement.

Table 4.
Grades of Recommendation for Action Statements[a]

Grade	Recommendation	Quality of Evidence
A	Strong	A preponderance of level I studies but at least 1 level I study directly on the topic support the recommendation.
B	Moderate	A preponderance of level II studies but at least 1 level II study directly on the topic support the recommendation.
C	Weak	A single level II study at <25% critical appraisal score or a preponderance of level III and IV studies, including statements of consensus by content experts support the recommendation.
D	Theoretical/foundational	A preponderance of evidence from animal or cadaver studies, from conceptual/theoretical models/principles, or from basic science/bench research, or published expert opinion in peer-reviewed journals supports the recommendation.
P	Best practice	Recommended practice based on current clinical practice norms, exceptional situations where validating studies have not or cannot be performed and there is a clear benefit, harm, or cost, and/or the clinical experience of the guideline development group.
R	Research	There is an absence of research on the topic, or higher-quality studies conducted on the topic disagree with respect to their conclusions. The recommendation is based on these conflicting conclusions or absent studies.

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AGREE II Review

This CPG was evaluated by 5 GPG members using the AGREE II instrument to assess the methodological quality of the guideline. The 5 members scored this guideline as high quality according to the AGREE II tool (eAppendix 2, available at ptjournal.apta.org).

External Review Process by Stakeholders

This CPG underwent 2 formal reviews. First, draft reviewers were invited stakeholders representing the American College of Chest Physicians, Society for Vascular Nursing, physical therapy clinicians and researchers, and patient representatives. The second draft was posted for public comment on both the APTA Cardiovascular & Pulmonary Section and Acute Care Section websites; notices were sent via email and an electronic newsletter to Cardiovascular & Pulmonary Section members, literature appraisers, and clinicians who inquired about the CPG during its development.

Document Structure

The action statements organized in Table 1 are introduced with their assigned recommendation grade, followed by a standardized content outline generated by BRIDGE-Wiz software (http://gem.med.yale.edu/BRIDGE-Wiz/).[18] Each statement has a content title, a recommendation in the form of an observable action statement, indicators of the evidence quality, and the strength of the recommendation. The action statement profile describes the benefits, harms, and costs associated with the recommendation; a delineation of the assumptions or judgments made by the GDG in formatting the recommendation; reasons for any intentional vagueness in the recommendation; and a summary and clinical interpretation of the evidence supporting the recommendation. The Delphi process was used to determine level of evidence and recommended strength for each key action statement. Each member of the GPG reviewed the supporting evidence for each key action statement and voted

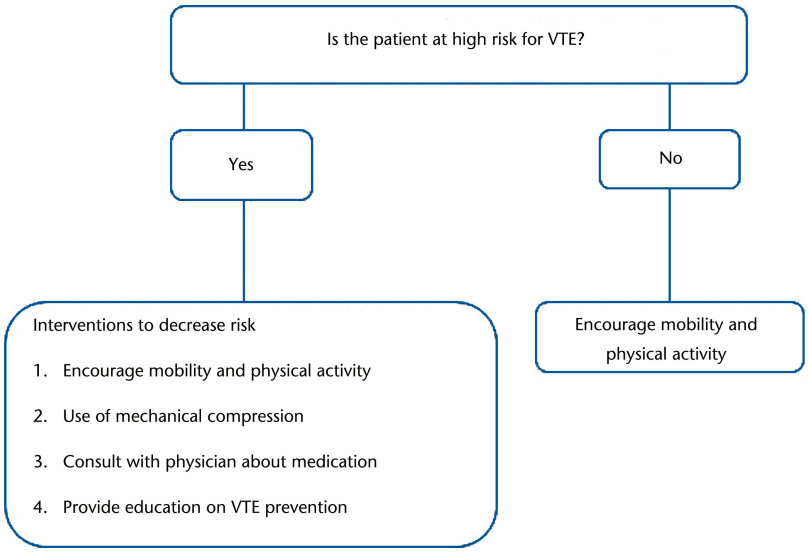


Figure 1.
Algorithm for screening for risk of venous thromboembolism (VTE).

on level of evidence and strength of recommendation independent of the other group members using a Google survey upon which all votes were tallied and then reported.

Scope of the Guideline

This CPG uses literature available from 2003 through 2014 to address the following aspects of physical therapists' management of patients with potential or diagnosed VTE. The CPG addresses these aspects of VTE management via 14 action statements. Clinical practice algorithms (Figs. 1, 2, and 3), based on the key action statements, were developed that can assist with clinical decision making.

Key Action Statements With Evidence

Action Statement 1: Advocate for a culture of mobility and physical activity

Physical therapists and other health care practitioners should advocate for a culture of mobility and physical activity. (Evidence Quality: I; Recommendation Strength: A–Strong)

Action statement profile

Aggregate Evidence Quality: Level I
Benefits: Decreased likelihood of LE DVT and/or PE and/or PTS
Risk, Harm, Cost: Injuries from falls
Benefit-Harm Assessment: Preponderance of benefit
Value Judgments: Physical therapists should advocate for mobility in all situations due to the evidence on the benefits of activity and risks associated with inactivity and bed rest except when there could be a risk of harm (eg, emboli depositing in the pulmonary system).
Intentional Vagueness: None
Role of Patient Preferences: As the evidence for risks associated with inactivity is strong and with little associated risk of mobility in the absence of thromboembolism, patients should be edu-

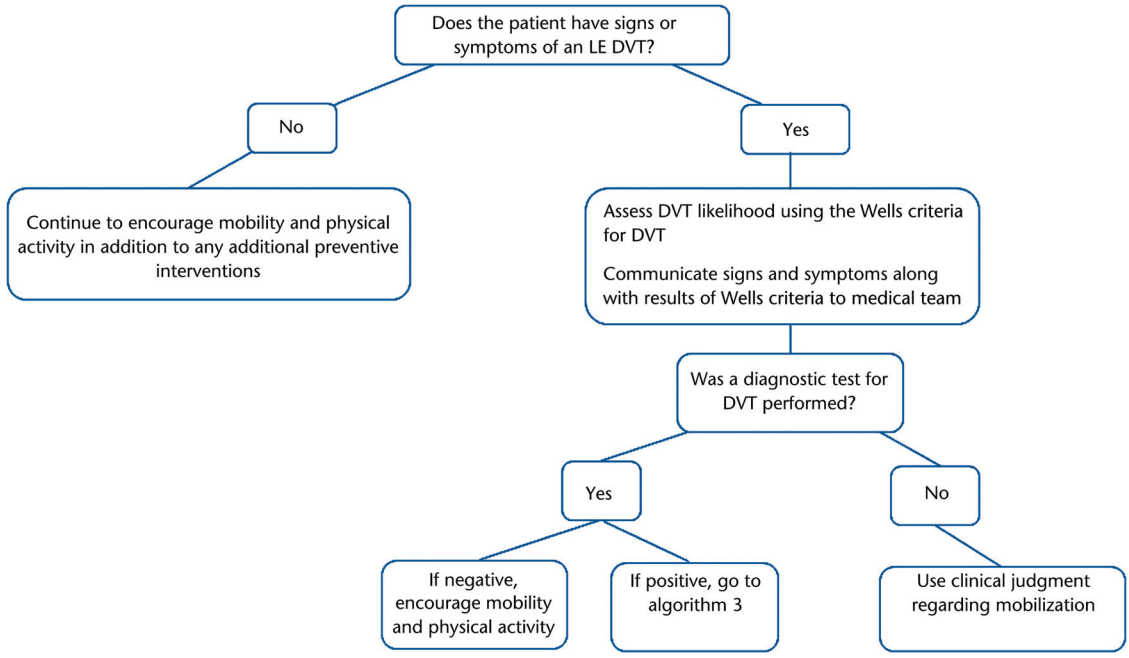


Figure 2.
Algorithm for determining likelihood of a lower extremity deep vein thrombosis (LE DVT). DVT=deep vein thrombosis.

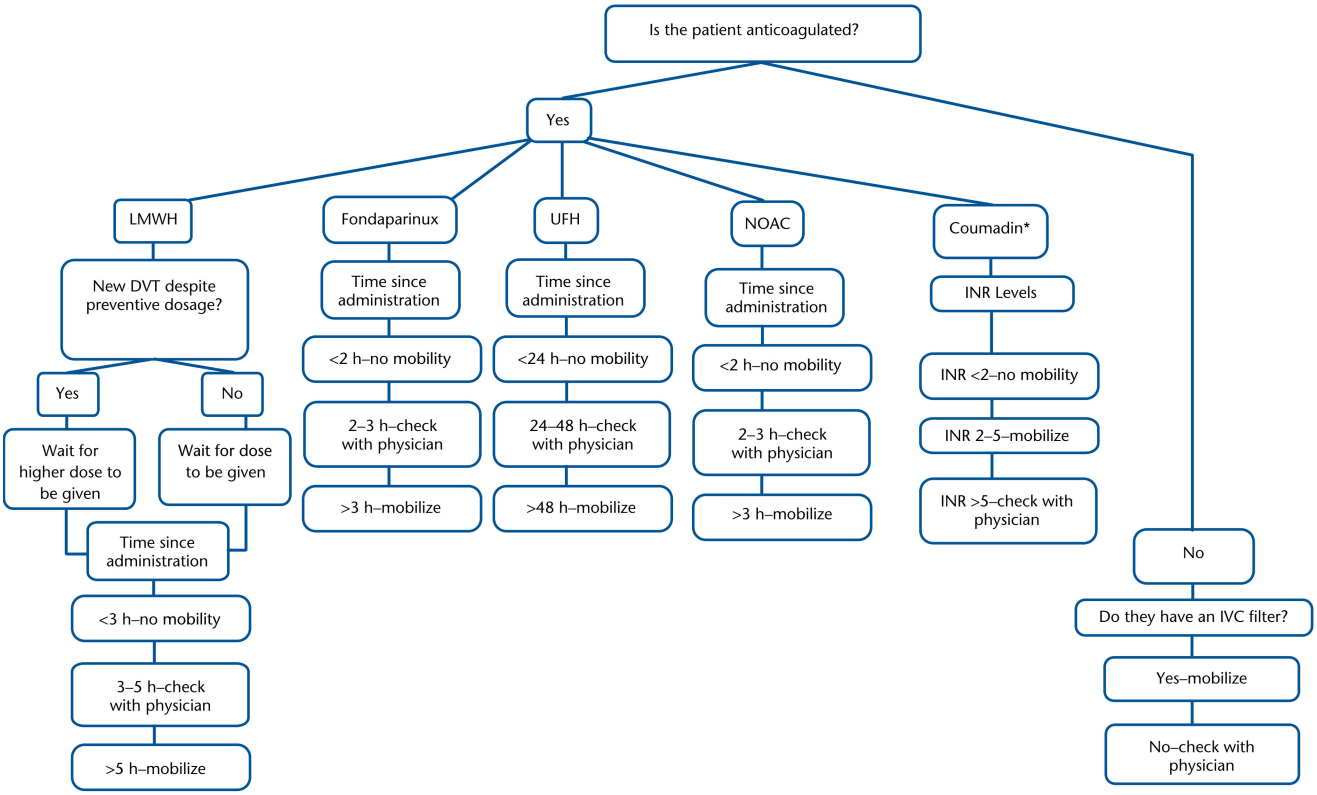


Figure 3.
Algorithm for mobilizing patients with known lower extremity deep vein thrombosis. DVT=deep vein thrombosis, LMWH=low-molecular-weight heparin, UFH=unfractionated heparin, NOAC=novel oral anticoagulants, INR=international normalized ratio, IVC=inferior vena cava. *If started on Coumadin, LMWH usually also started. Use LMWH guidelines for mobilization decision in these situations.

cated regarding the benefits of mobility and encouraged to maintain mobility as much as possible to decrease the risk of adverse outcomes.
Exclusions: None

Summary of evidence

Reduced mobility is a known risk factor for VTE, yet the quantity and duration of the reduced mobility that defines degree of risk for VTE are not known.[19–21] Significant variability exists in the literature regarding reduced mobility and the resulting risk for VTE.[22] Patients who were ambulatory were found to be at increased risk for developing a VTE with a standing time of 6 or more hours (odds ratio [OR]=1.9) or resting in bed or a chair (OR=5.6).[23] Likewise, a significant correlation exists between loss of mobility status for 3 or more days and the presence of LE DVT on duplex ultrasound.[24]

When additional risk factors for VTE are present in an individual who has any reduction in mobility, the risk for VTE is significantly increased. Increased age serves as an example. One study of hospitalized patients older than 65 years found reduced mobility to be an independent risk factor for VTE. The risk increased based on the degree of immobility, and relative risk scores were derived according to the degree of immobility (Tab. 5).[19,25] The OR risk was found to be higher in older patients with more severe limitation of mobility (bed rest versus wheelchair) and when the loss of mobility was more recent (<15 days versus >30 days).

Recent national guidelines have associated reduced mobility with increased risk for VTE.[20,26] The National Institute for Health and Care Excellence (NICE) guidelines present strong recommendations for the need to regard patients undergoing surgery and patients with trauma as at an increased risk of VTE. When patients undergo surgery with an anesthesia time of greater than 90 minutes or if the surgical procedure involves the pelvis or lower limb and anesthesia time is greater than 60 minutes, the risk is much greater. Individuals who are admitted acutely for surgical reasons or admitted with inflammatory or intra-abdominal conditions also are at high risk for developing a VTE. These same guidelines emphasized the need to identify all individuals who are expected to have any significant reductions in mobility to be at risk for VTE and to mobilize them as soon as possible.[20] The American College of Chest Physicians (ACCP) guidelines emphasize prevention of VTE in patients not undergoing surgery by incorporating nonpharmacological prophylaxis measures, including frequent ambulation, calf muscle exercise, and sitting in the aisle and mobilizing the lower extremities when traveling (Grade 2C recommendations).[26,27]

Previously, when individuals were diagnosed with an LE DVT, they were placed on bed rest due to the concern that

Table 5.
Reduced Mobility as a Risk Factor for Venous Thromboembolism[19,25,a]

Degree of Immobility	OR	95% CI	*P*
Normal	1.0		
Limited	1.73	1.08, 2.75	.02
Wheelchair 30 d	2.43	1.37, 4.30	.002
Bed rest 30 d	2.73	1.20, 6.20	.02
Wheelchair 15–30 d	3.33	1.26, 8.84	.02
Bed rest 15–20 d	3.37	1.00, 11.29	.05
Wheelchair 15 d	4.32	1.50, 12.45	.007
Bed rest <15 d	5.64	2.04, 15.56	.0008

[a] OR=odds ratio, CI=confidence interval.

ambulation would cause clot dislodgment and lead to a potentially fatal PE. However, a meta-analysis compiled data from 5 randomized controlled trials (RCTs) on more than 3,000 patients and concluded that early ambulation following diagnosis of an LE DVT was not associated with a higher incidence of a new PE or progression of LE DVT compared with bed rest.[28] Rather, there was a lower incidence of new PE and overall mortality in those patients who engaged in early ambulation. Similar findings, as well as more rapid resolution of pain, were reported in a systematic review that included 7 RCTs and 2 prospective observational studies.[29] The importance of mobility is further discussed in key Action Statement 8.

In summary, mobility should be encouraged in patients while in the hospital and when discharged to prevent the complications associated with immobility. In addition, mobility is recommended for those diagnosed with VTE once therapeutic anticoagulant levels have been reached (see Action Statement 8).

Action Statement 2: Screen for risk of VTE

Physical therapists should screen for risk of VTE during the initial patient interview and physical examination (Evidence Quality: I; Recommendation Strength: A–Strong)

Action statement profile

Aggregate Evidence Quality: Level I
Benefits: Prevention or early detection of LE DVT
Risk, Harm, and Cost: Adverse effects of prophylaxis interventions
Benefit-Harm Assessment: Preponderance of benefit over harm
Value Judgments: None
Intentional Vagueness: Physical therapists should work within their health care system to determine specific algorithms or risk assessment models (RAMs) to use.
Role of Patient Preferences: None
Exclusions: None

Summary of evidence

The *Guide to Physical Therapist Practice* states that the physical therapist examination is a comprehensive screening and specific testing process leading to diagnostic classification or, as appropriate, to a referral to another practitioner.[30] Understanding the factors that place individuals at risk for a VTE is important for all physical therapists. During the patient interview, physical therapists should ask questions and review the medical history to determine whether the patient is at risk for LE DVT. Risk factors include previous venous thrombosis or embolism, age, active cancer or cancer treatment, severe infection, oral contraceptives, hormonal replacement therapy, pregnancy or given birth within the previous 6 weeks, immobility (bed rest, flight travel, fractures), surgery, anesthesia, critical care admission, central venous catheters, inherited thrombophilia, and obesity. The relationship between particular risk factors and presence of LE DVT has been found through retrospective and prospective studies and identified as having support from level I evidence in other CPGs.[19,31–34]

The need for all health care providers to screen for risk of LE DVT through system-wide approaches has been highlighted by the US Agency for Healthcare Research and Quality,[35] the Finnish Medical Society,[31] and the Scottish Intercollegiate Guidelines Network,[36] and such screening is strongly recommended by each of these groups. Furthermore, the importance of screening was strongly supported in a 2008 multinational cross-sectional study of patients from more than 350 hospitals across 32 countries. The findings revealed that 39.5% of patients at risk for VTE were not receiving appropriate prophylaxis.[37] Hospital-wide strategies were recommended to assess patients' VTE risk and to monitor whether those at risk received appropriate prophylaxis.

To facilitate and standardize the process of screening for risk within health care systems and across professions, RAMs should be considered.[36,38] Risk assessment models use a checklist to determine whether risk factors for LE DVT are present and each risk factor is assigned a point value. If a set point level is reached, the patient is considered at an increased risk, and more aggressive prophylactic interventions can be used. There are numerous examples of RAMs in the literature, including the Padua score for assessing VTE risk in hospitalized patients,[39] the IMPROVE VTE RAM,[40] the Autar DVT Risk Assessment Scale,[41] and the Geneva Risk Score.[42] None have been shown to be superior to others through direct comparisons, and, for this reason, the GDG cannot recommend a single RAM. It is more important that physical therapists work within their health care system to understand and even help develop an overall VTE protocol that uses an agreed-upon tool for VTE risk assessment.

In summary, given the risks and harms associated with a VTE and the relation-

ship of VTE incidence to the presence of risk factors, physical therapists should screen for VTE risk. These results should be communicated with the rest of the health care team.

Action Statement 3: Provide preventive measures for LE DVT

Physical therapists should provide preventive measures for LE DVT for patients who are identified as being at risk for LE DVT. These measures should include education regarding signs and symptoms of LE DVT, activity, hydration, mechanical compression, and referral for medication assessment. (Evidence Quality: I; Recommendation Strength: A–Strong)

Action statement profile

Aggregate Evidence Quality: Level I
Benefits: Prevention of LE DVT
Risk, Harm, Cost: None to minimal
Benefit-Harm Assessment: Preponderance of benefit over harm
Value Judgments: None
Intentional Vagueness: None
Role of Patient Preferences: Patients may or may not choose to adhere to preventive measures. There is a role for having shared decision making with regard to their priorities.
Exclusions: None

Summary of evidence

For individuals who are at risk for LE DVT, preventive measures should be initiated immediately, including education regarding leg exercises, ambulation, proper hydration, mechanical compression, and assessment regarding the need for medication referral.

Education is a key factor in risk reduction of VTE and should be provided for patients who are at elevated risk for LE DVT and for their families. Documentation of the patient's understanding of these concepts also should be included.[43] Topics that should be included in this education program for these patients and their families are: risk factors for DVT, possible consequences of DVT, interventions to decrease the risk of DVT, signs and symptoms of DVT and importance of seeking medical help if DVT is suspected, importance of follow-up monitoring, importance of treatment adherence, and medication issues (eg, regimen, adverse side effects and interactions, dietary restrictions).[44]

Immobilization is one of the primary risk factors for VTE and is a problem for patients in the home and in acute care settings and long-term care facilities. Immobility, as it relates to residents in long-term care facilities, is defined by the presence of at least one of the following: lower limb cast, bedridden, bedridden except for bathroom privileges, recent decreased ability to walk at least 3.1 m (10 ft) for a least 72 hours, and inability to walk at least 3.1 m (10 ft).[45] Patients who are limited to a chair or bed greater than half the day during waking hours are considered at elevated risk for VTE. The acuteness and severity of the immobility determines the elevated risk level of developing VTE.[19]

As immobility also occurs with long-distance travel, travelers on planes for greater than 2 to 3 hours are also at increased risk for LE DVT. The ACCP[27] recommends that such travelers ambulate frequently, perform calf muscle exercises, sit in an aisle seat, and use below-the-knee compression stockings with at least 15 to 30 mm Hg compression (2C recommendation).

Action Statement 4: Recommend mechanical compression as a preventive measure for DVT

Physical therapists should recommend mechanical compression (eg, intermittent pneumatic compression [IPC], graded compression stockings [GCS]) when individuals are at moderate to high risk for LE DVT or when anticoagulation is contraindicated. (Evidence Quality: I; Recommendation Strength: A–Strong)

Action statement profile

Aggregate Evidence Quality: Level I
Benefits: Prevents LE DVT without increasing the risk of bleeding
Risk, Harm, Cost: Improper fit can lead to skin irritation, ulceration, or interruption of blood flow.
Benefit-Harm Assessment: Preponderance of benefit over harm
Value Judgments: None
Intentional Vagueness: Specific types of mechanical compression were not recommended. Physical therapists should work within their health care system to develop institution-specific protocols.
Role of Patient Preferences: Ease of use, comfort level, and ability to operate mechanical compression equipment properly should be evaluated with each patient.
Exclusions: Patients who have severe peripheral neuropathy, decompensated heart failure, arterial insufficiency, dermatologic diseases, or lesions may have contraindications to selective mechanical compression modes.

Summary of evidence

The influence of mechanical compression on LE DVT or PE prophylaxis was examined in 7 systematic reviews.[46–52] The populations included patients who were in postoperative recovery from a variety of surgical procedures, with or without pharmacological prophylaxis. Also included were airline travelers of varying VTE risk levels. These studies supported that GCS used alone significantly decreased the incidence of LE DVT or PE and that this mechanical compression method provided additional benefit when combined with other prophylactic methods. Although GCS was the method of mechanical compression in all 7 of these publications, the descriptive features of the GCS were inconsistent.

Screening to identify VTE risk is essential and will identify which, if any, mechanical compression method is appropriate to implement. In the CPG of the Japanese Circulation Society for PE and LE DVT prevention, elastic stockings or IPC, IPC or anticoagulation, and anticoagulation plus IPC or elastic stockings are recommended for postoperative patients with elevated risk.[53] The Institute for Clinical Systems Improvement guidelines for VTE prophylaxis recommend that if contraindications exist for both low-molecular-weight heparin (LMWH) and low-dose unfractionated heparin (UFH) and there is high risk for VTE but not high risk for bleeding, fondaparinux or low-dose aspirin or IPC be used.[43] One example would

be someone with a history of heparin-induced thrombocytopenia (HIT). Intermittent pneumatic compression or GCS are recommended for patients who are acutely or critically ill and who are bleeding or are at high risk for major bleeding, until bleeding risk decreases, at which time pharmacological thromboprophylactic methods can be substituted.[38,54]

A systematic review of 6 RCTs looked at patients at high risk for VTE who underwent various surgical procedures to assess the effectiveness of IPC combined with pharmacological prophylaxis versus single modality usage.[55] Combining IPC with an anticoagulant (eg, LMWH) was more effective in VTE prevention than either IPC or anticoagulant use alone, which is consistent with the CPG recommendation offered by the Japanese Circulation Society.

In summary, there is substantial supportive evidence for the use of mechanical compression methods for patients with medical conditions or undergoing surgery,[36,56–60] prolonged air-flight travelers,[6,47,49] and patients in long-term care facilities.[45] For those people at increased risk for VTE, the use of GCS or IPC, with or without anticoagulation therapy, is considered to be beneficial. The evidence is inconsistent, however, in describing the optimal protocols for use of GCS, elastic stockings, or IPC. Potential for rare circulatory compromise with the use of GCS (ie, knee or thigh length) warrants proper fitting and careful monitoring of skin condition by the patient and physical therapist.

Action Statement 5: Identify the likelihood of LE DVT when signs and symptoms are present

Physical therapists should establish the likelihood of LE DVT when the patient has pain, tenderness, swelling, warmth, or discoloration in the lower extremity. (Evidence Quality: II; Recommendation Strength: B–Moderate)

Action statement profile

Aggregate Evidence Quality: Level II
Benefit: Early intervention and prevention of adverse effects of LE DVT
Risk, Harm, Cost: None
Benefit-Harm Assessment: Preponderance of benefit over harm
Value Judgments: Although the Wells criteria for LE DVT are recommended by this GDG, there are other tools that may be preferred by other interprofessional teams.
Intentional Vagueness: None
Role of Patient Preferences: None
Exclusions: None

Summary of evidence

The major signs and symptoms of LE DVT include pitting edema, pain, tenderness, swelling, warmth, redness or discoloration (erythema), and prominent superficial veins.[36,45,61,62] The presence of these signs and symptoms should raise the suspicion of an LE DVT, but they cannot be used alone in the diagnostic process.[31,61] The likelihood of LE DVT should be established through use of a standardized tool. This recommendation is supported by numerous CPGs[26,36,61,63] and a meta-analysis.[62] A standardized tool uses the presence of clinical features of an LE DVT to determine the likelihood that an LE DVT is present and guides the selection of the most appropriate test to diagnose an LE DVT. Physical therapists should use a standardized tool as part of their examination process when signs and symptoms of LE DVT are present. The results of the assessment should then be communicated with the medical team.

The Wells criteria for LE DVT are the most commonly used tool to determine likelihood of LE DVT (Tab. 6).[21,64] Originally, the Wells criteria for LE DVT used a 3-tier risk stratification of low, moderate, and high. A score of 3 or greater was high risk, a score of 1 to 2 was moderate risk, and a score of 0 or below was low risk. In a study of 593 patients, 16% had an LE DVT. When the rate of LE DVT was examined in each stratification level, the rates were 3% (95% confidence interval [CI]=1.7%, 5.9%), 16.6% (95% CI=12%, 23%), and 74.6% (95% CI=63%, 84%) for low, moderate, and high risk, respectively. Other studies have shown a clear distinction in the rate of LE DVT among the 3 risk stratification levels.[62,65] A 2014 systematic review showed that, as the score on the Wells criteria increased, so did the likelihood of an LE DVT.[66] This relationship has held up across multiple subgroups of patients, including outpatients, inpatients, those with malignancy, and patients grouped by sex and previous history of an LE DVT.

In 2003, the Wells criteria for LE DVT were modified to a 2-stage stratification (ie, LE DVT likely or LE DVT unlikely), and a history of previous LE DVT was added to the tool.[67] Reducing the model to 2 levels made it easier to use and did not compromise patient safety when used in conjunction with a D-dimer test. Individuals with 2 or more points were categorized as likely, and those with less than 2 points were categorized as unlikely. In a study of 1,082 outpatients, 27.9% (95% CI=23.9%, 31.8%) of those classified as likely had a proximal LE DVT or a PE. Of those patients classified as unlikely, 5.5% (95% CI=3.8%, 7.6%) had a proximal LE DVT or a PE.

Beyond the Wells criteria for LE DVT, other risk stratification tools have been developed, but there are limited comparison studies among the tools. One example is the Oudega rule, developed for primary care providers. When compared to the Wells criteria for LE DVT, it has similar effectiveness.[68,69]

The Wells criteria for LE DVT have a long and well-supported history of successfully stratifying risk or likelihood of LE DVT across patient populations and practice settings; therefore, the GDG recommends this tool for risk stratification. Physical therapists should advocate for its use with their interdisciplinary team and determine the best way to communicate the results and risks.

Action Statement 6: Communicate the likelihood of LE DVT and recommend further medical testing

Physical therapists should recommend further medical testing after the completion of the Wells criteria for LE DVT prior to mobilization (Evidence quality: I; Recommendation strength: A–Strong)

Table 6.
Two-Level Deep Vein Thrombosis (DVT) Wells Criteria Score[a]

Clinical Feature	Points
Active cancer (treatment ongoing, within 6 mo, or palliative)	1
Paralysis, paresis, or recent plaster immobilization of the lower extremities	1
Recently bedridden for 3 d or longer or major surgery within 12 wk requiring general or regional anesthesia	1
Localized tenderness along the distribution of the deep venous system	1
Entire leg swollen	1
Calf swelling at least 3 cm larger than asymptomatic side	1
Pitting edema confined to the symptomatic leg	1
Collateral superficial veins (nonvaricose)	1
Previously documented DVT	1
Alternative diagnosis at least as likely as DVT	−2
Clinical probability simplified score	
DVT likely	2 points or more
DVT unlikely	Less than 2 points

[a] Reprinted from Wells PS, Anderson DR, Rodger M, et al. Evaluation of D-dimer in the diagnosis of suspected deep-vein thrombosis. *N Engl J Med.* 2003;349:1227–1235. © 2003 Massachusetts Medical Society. Reprinted with permission from the Massachusetts Medical Society.

Action statement profile

Aggregate Evidence Quality: Level I
Benefit: Risk stratification can ensure proper diagnostic testing is completed
Risk, Harm, Cost: None
Benefit-Harm Assessment: Preponderance of benefit over harm
Value Judgments: None
Intentional Vagueness: None
Role of Patient Preferences: None
Exclusions: None

Summary of evidence

Once the Wells criteria for LE DVT are complete, medical testing can be ordered by the medical team to diagnose or rule out an LE DVT. The selection of which medical test is beyond the scope of physical therapist practice, but there is benefit in understanding why tests are selected and how results guide the diagnostic process. If a patient is classified as unlikely to have an LE DVT, the overwhelming recommendation is for the medical team to order a D-dimer test over other more costly and invasive tools.[26,31,43,44,70] Within the referenced CPGs, the evidence is rated as level I, with grade of A to B for the recommendation. The D-dimer test is a measure of the breakdown or degradation of cross-linked fibrin, which increases in the presence of a thrombosis. In patients with an LE DVT–unlikely classification and a negative D-dimer test, fewer than 1% have an LE DVT, and studies report sensitivity in the upper 90% to 100%.[71–73] These patients need no further testing and can be considered safe to mobilize.[26,31,36,43,70]

Although the D-dimer test has high sensitivity, it has poor specificity. A positive D-dimer test does not indicate a definite LE DVT. A range of conditions, such as older age, infections, burns, and heart failure, can lead to an elevated D-dimer test, and hospitalized individuals have a high rate of false positives when the D-dimer is used for a suspected LE DVT.[74] When a patient who is LE DVT–unlikely has a positive or high D-dimer level, further testing is necessary. Most guidelines recommend a duplex ultrasound to confirm an LE DVT.[26,43,44,63] There is some debate on the type of ultrasound that is ordered, but this factor is beyond the focus of these guidelines. If the ultrasound confirms an LE DVT, medical treatment should be initiated and mobilization postponed. If the ultrasound is negative, the patient is safe to mobilize.

A patient rated as LE DVT–likely should immediately undergo a duplex ultrasound.[26,31,44,63] Individuals in the DVT–likely category will test positive on the D-dimer test, so the D-dimer test has little value. If the ultrasound is negative, the physical therapist should consider the patient safe to mobilize. If the ultrasound is positive, the physical therapist should defer mobility until medical treatment has achieved therapeutic levels.

In summary, the results of the Wells criteria for LE DVT should guide the selection of medical testing. Following the results of the medical testing, the physical therapist can then make a decision about when it is safe to mobilize the patient.

Action Statement 7: Verify the patient is taking an anticoagulant

When a patient has a recently diagnosed LE DVT, the physical therapist should verify whether the patient is taking an anticoagulant medication, what type of anticoagulant medication, and when the anticoagulant medication was initiated. (Evidence Quality: V; Recommendation Strength: D–Theoretical/Foundational)

Action statement profile

Aggregate Evidence Quality: Level V
Benefit: Decreased risk of a PE in patients who are adequately anticoagulated
Risk, Harm, Cost: Risk of bleeding with anticoagulation, risk of adverse effects with restrictions in inactivity, and cost of new anticoagulants may be prohibitive in those with inadequate pharmacy insurance coverage.
Benefit-Harm Assessment: Preponderance of benefit over harm
Value Judgments: Intentional vagueness. This CPG has provided therapeutic ranges for anticoagulants that have been provided by the manufacturers due to the limited evidence beyond this. Although the recommendation strength is weak based on scientific evidence, the GDG considers it prudent to follow the manufacturer's recommendations.
Role of Patient Preference: Patients should be informed of the importance for continuing anticoagulation upon discharge from the hospital as different anti-

coagulants require monitoring, cost, and modification of diet and bleeding risk.
Exclusions: None

Summary of evidence

Anticoagulants are the primary defense used to prevent and treat an LE DVT and consequent PE or PTS. Contrary to popular belief, anticoagulants do not actively dissolve a blood clot but instead prevent new clots from forming. Although anticoagulants are often referred to as blood thinners, they do not actually thin the blood. This class of drugs works by altering certain chemicals in the blood necessary for clotting to occur. Consequently, blood clots are less likely to form in the veins or arteries, and yet continue to form where needed. Although anticoagulants do not break down clots that have already formed, they do allow the body's natural clot lysis mechanisms to work normally to break down clots that have formed.

Once an LE DVT is diagnosed, anticoagulant therapy is initiated, most commonly with LMWH. Anticoagulant therapy will help to stop an existing clot from getting larger and prevent any new clots from forming. In addition, LMWH has been shown to stabilize an existing clot and resolve symptoms through the drug's anti-inflammatory properties, making a clot less likely to migrate as an embolus.

A patient diagnosed with an LE DVT is at risk of developing a PE; therefore, mobility is contraindicated until intervention is initiated to reduce the chance of emboli traveling to the lungs.[75–79] According to the ACCP guidelines on antithrombotic therapy, anticoagulation is the main intervention and should be initiated as soon as possible (level I, strong evidence).[26,43,44,61] If the patient is at a high risk for bleeding, the primary contraindication to anticoagulation, then medications may not be prescribed. Therefore, prior to initiating mobility out of bed, a physical therapist should review all medications the patient has been prescribed and verify that the patient is taking an anticoagulant. The physical therapist should next consult with the medical team regarding appropriateness of mobility. Although physical therapists do not play a role in recommending the anticoagulant of choice, they should identify which anticoagulant the patient has been prescribed and date and time of the first dose. This approach will assist the physical therapist in determining when the patient has reached a therapeutic dose, and consequently, when mobility may be initiated safely.

The current options for anticoagulation include UFH, LMWH, Coumadin (Bristol-Myers Squibb, New York, New York) (warfarin), fondaparinux, and oral thrombin or Xa inhibitors (eTable, available at ptjournal.apta.org). Most patients with a confirmed diagnosis of LE DVT or PE are prescribed a form of LMWH or fondaparinux (both given with subcutaneous injections).[31,44,61] Low-molecular-weight heparin is principally used to treat any LE DVT below the knee, at thigh level, and more proximal thrombi.[31] It is the anticoagulant of choice for pregnancy and for active cancer and the primary choice of physicians for treatment of VTE in the outpatient or home setting due to ease of use and low incidence of side effects.[31,43,61] Low-molecular-weight heparin is used in most cases except when a patient has renal dysfunction or a creatinine clearance less than 30 mL/min. Concomitant Coumadin use may be started and provided for 3 days, with subsequent international normalized ratio (INR) values being determined. Most individuals will continue with their initial anticoagulant (LMWH or fondaparinux) for 3 to 6 months for the first episode of diagnosed thrombosis. If Coumadin is given concomitantly, they will likely be removed from the initial anticoagulant and continued on Coumadin for 3 to 6 months.[44,80]

Anti-Xa levels can be used to monitor LMWH. However, evidence does not support the use of anti-Xa assay levels for predicting thrombosis and bleeding risk.[81] Pharmacokinetic studies on LMWH report that maximum anti-factor Xa and antithrombin IIa activities occur 3 to 5 hours after subcutaneous injection of LMWH.[82] The optimal therapeutic anti-Xa levels for treatment are 0.5 to 1.0 U/mL. Due to the fact that LMWH is excreted primarily by the kidneys, increased bleeding complications have been reported when LMWH is used in patients with renal insufficiency and other populations. Therefore, precautions for bruising and bleeding with physical therapy interventions should be taken when LMWH is used in patients with kidney injury or dysfunction, patients in extreme weight ranges, patients who are pregnant, and neonates and infants.[63]

Unfractionated heparin is indicated for individuals with high bleeding risk (eTable) or renal disease. Patients with established or severe renal impairment are defined as those with an estimated glomerular filtration rate of less than 30 mL/min/1.73 m^2. Unfractionated heparin is often prescribed and dosed to achieve therapeutic levels quickly. Lower speeds of infusion are usually given in acute coronary syndromes, whereas higher speeds of infusion are given with VTE. Several institutions have transitioned from monitoring heparin with anti-factor Xa levels instead of activated partial thromboplastin time (aPTT) due to influencing factors that can alter aPTT levels.[83] One study has shown anti-Xa detects therapeutic levels faster than aPTT (patients with UFH achieved therapeutic anticoagulation in approximately 24 hours compared with patients monitored with aPTT, which averaged 48 hours).[83] Patients with a documented PE, including those who are hemodynamically unstable, are often prescribed UFH, and similar aPTT monitoring should be reviewed by the physical therapist seeing the patient.[44]

Coumadin is usually not the first medication choice for anticoagulation due to the length of time to achieve peak therapeutic levels. Coumadin is typically introduced on day 1 during administration of another anticoagulation, usually with LMWH or UFH.[61] The loading anticoagulant (LMWH or UFH) is continued for at least 5 days until an INR greater than 2.0 is achieved for at least 24 hours, prior to discontinuing the loading anticoagulant, and first episodes of VTE should be treated with a target INR range of 2.5.[80] The UFH or LMWH is often discontinued when the INR is greater than 2.0.[61]

Fondaparinux (Arixtra, GlaxoSmithKline, Research Triangle Park, North Carolina) is similar to LMWH, is monitored using anti-Xa assays, and is often used when individuals need treatment or prophylaxis for VTE but have a history of HIT.[43] The maximal therapeutic dosage is reached in approximately 2 to 3 hours.[43,79] Fondaparinux also is used for thromboprophylaxis in patients with medical and surgical conditions, as is LMWH.[63]

Both UFH and LMWH are associated with HIT, defined as an immune-mediated reaction to heparins. Heparin-induced thrombocytopenia can occur in 2% to 3% of patients treated with UFH and in approximately 1% of patients treated with LMWH.[43] Heparin-induced thrombocytopenia will result in a paradoxical increased risk for venous and arterial thrombosis, and this risk lasts approximately for 100 days following initial reaction. Therefore, patients with a history of HIT should not receive either LMWH or UFH with subsequent VTE.[43,84] Treatment for anticoagulation in individuals with HIT involves using fondaparinux or other thrombin-specific inhibitors such as lepirudin or argatroban. Indicators of HIT are: skin lesion reaction at injection site, systemic reaction to a bolus administration of heparin, and 50% decrease in platelet count from normal ranges while on heparin. Indicators of delayed-onset HIT are: thromboembolic complications 1 to 2 weeks after receiving the last dose of LMWH or UFH, and mild-to-moderate thrombocytopenia.

Mobility decisions with an individual receiving Coumadin are based on the initial anticoagulant and not Coumadin. Concern regarding exercise and out-of-bed activity should be raised for elevated INRs greater than 4.0 when patients are taking warfarin.[85] If the INR is between 4.0 and 5.0, resistive exercises should be avoided, with participation in light exercise only (eg, rating of perceived exertion $\leq$11) due to increased risk of bleeding.[85] Ambulation should be restricted if gait is unsteady to prevent falls.[85] The likelihood of bleeding rises steeply as INR increases above 5.0.[86–88] If the INR is greater than 5.0, discussion should be held with the referring physician regarding patient safety. When the INR is greater than 6.0, the medical team should consider bed rest until the INR is corrected.[85,86] In most cases, INRs can be corrected within 2 days.[85] When reversal of anticoagulation is needed for surgery and the patient is taking Coumadin, fresh frozen plasma is the choice to replace the anticoagulation.[86]

New oral anticoagulant drugs (direct thrombin inhibitors and direct factor Xa inhibitors) are growing in popularity due to their ease of use (no laboratory monitoring, no adverse dietary or other drug interactions) and their rapid time to peak therapeutic levels. In addition, there appears to be less risk of cerebral hemorrhage, as occurs in vitamin K antagonists.[86] Rivaroxaban (Xarelto, Janssen Pharmaceuticals Inc, Titusville, New Jersey), dabigatran (Pradaxa, Boehringer Ingelheim Pharmaceuticals Inc, Ridgefield, Connecticut), and apixaban (Eliquis, Bristol-Myers Squibb Co) are the 3 new oral anticoagulant drugs in use at this time (refer to eTable for dosage, method of delivery, and peak therapeutic-level time frames). The new oral anticoagulant drugs are recommended by the American Academy of Orthopaedic Surgeons for hip and knee arthroplasty but have not been tested or recommended for individuals who have cancer, are undergoing treatment for cancer, or are pregnant.[89] There are concerns regarding reversal of anticoagulation with these medications. However, reconstructed recombinant factor Xa or activated charcoal have both been proposed as antidotes.[89,90] The time for reversal is the amount of time to eliminate the drug from the body, which is based on the drug's half-life, usually within 12 to 24 hours. With all anticoagulants there is a risk of bleeding. Therefore, in addition to the risk of VTE, physical therapists should be aware of and assess for risk of bleeding in all patients. Factors associated with high risk of bleeding are: active bleeding; acute stroke; acquired bleeding disorders (eg, acute liver failure); concurrent use of anticoagulants known to increase the risk of bleeding (eg, Coumadin with an international normalized ratio >2); lumbar puncture, epidural, or spinal anesthesia expected to be given within next 12 hours; thrombocytopenia (platelet count less than 7,500); uncontrolled systolic hypertension (defined as blood pressure of 230/120 mm Hg or higher), and untreated inherited bleeding disorders, such as hemophilia or von Willebrand disease.[20]

Action Statement 8: Mobilize patients who are at a therapeutic level of anticoagulation

When a patient has a recently diagnosed LE DVT, physical therapists should initiate mobilization when therapeutic threshold levels of anticoagulants have been reached. (Evidence Quality: I; Recommendation Strength: A–Strong)

Action statement profile

Aggregate Evidence Quality: Level I

Benefit: Decreased risk of subsequent LE DVT or PE; decreased risk of adverse effects of bed rest

Risk, Harm, Cost: Risks associated with use of anticoagulants include increased risk of bleeding. If an anticoagulant is not at a therapeutic level, there may be an increased risk of PE with mobilization.

Benefit-Harm Assessment: Preponderance of benefit

Value Judgments: The evidence for mobility to prevent VTE is strong, although the evidence on when to initiate mobility may not be as strong and is based on the patient achieving the therapeutic level of the anticoagulant. Physical therapists should mobilize patients as soon as possible after diagnosis of VTE as long as the risk of PE is decreased. Achieving the therapeutic level of the anticoagulant has been shown to diminish the risk of developing a PE.

Intentional Vagueness: Specific anticoagulants or their therapeutic levels are not recommended. Instead, evidence-based guidelines and algorithms have been provided for guidance. Physical therapists should work within their health care system to develop institution-specific protocols.

Role of Patient Preference: Patients should be aware of the anticoagulation they are prescribed and the effect that the anticoagulant will have on their lifestyle (eg, amount of medical monitoring, risk of bleeding, foods to avoid, risk of brain bleed). In addition, patients should

be informed regarding the risk of immobility in developing further VTE and the benefit of mobility.

Exclusions: The risk of bleeding is present when anyone takes anticoagulants. However, patients with HIT, a history of HIT, recent bleeding events, or increased risk of bleeding should be prescribed treatment other than anticoagulation, including mechanical compression or intravenous filters.

Summary of evidence

Patients who have a documented LE DVT and have reached therapeutic levels of the prescribed anticoagulant should be mobilized out of bed and ambulate to prevent venous stasis. In doing so, deconditioning is minimized, length of hospital stay may be shortened, and other adverse effects of prolonged bed rest (eg, decubiti) can be avoided. A common concern for mobilizing a patient with an LE DVT is that the clot will dislodge and embolize to the lungs, causing a potentially fatal PE. However, early ambulation has been shown to lead to no greater risk of PE than bed rest for people with a diagnosed LE DVT who have been treated with anticoagulants.[28]

A meta-analysis showed the absence of a higher risk of new PE or other adverse clinical events when individuals were ambulated instead of kept on bed rest.[28] The studies included in this meta-analysis had differences in the timing of ambulation following initiation of anticoagulation. Nevertheless, the conclusion arrived at was that "early" ambulation was possible as soon as the level of effective anticoagulation had been reached.[28] In 2 earlier systematic reviews, 1 with 3 studies totaling 300 patients[91] and 1 with 9 studies,[23] similar conclusions were reported. A potentially reduced risk for extension of a proximal LE DVT and reduced long-term symptoms of PTS with early mobility was reported, demonstrating the benefits of early mobilization of patients having LE DVT.[29]

In 2012, the ACCP published guidelines on antithrombotic therapy and prevention of thrombosis provided a moderate strength recommendation that patients with an acute LE DVT should receive early ambulation over initial bed rest because of the potential to decrease PTS and improve quality of life.[27]

In summary, early mobilization of patients with an LE DVT who are anticoagulated does not put the patient at increased risk of PE. Early mobilization has added benefits. The GDG recommends mobilizing patients with an LE DVT once anticoagulation is initiated and therapeutic levels have been achieved. Based on the evidence that exists on time to peak therapeutic levels of the anticoagulants (refer to eTable), expert consensus exists to recommend early ambulation of individuals with an LE DVT who are receiving anticoagulation and have reached their peak therapeutic levels based on the specific anticoagulation medication they are prescribed.

Action Statement 9: Recommend mechanical compression for patients with LE DVT

Physical therapists should recommend mechanical compression (eg, IPC, GCS) when a patient has an LE DVT. (Evidence Quality: II; Recommendation Strength: B–Moderate)

Action statement profile

Aggregate Evidence Quality: Level II
Benefit: Secondary prevention of recurrent DVT/PE or PTS and faster resolution of LE DVT signs and symptoms
Risk, Harm, Cost: Improper fit can lead to skin irritation, ulceration, or interruption of blood flow
Benefit-Harm Assessment: Preponderance of benefit over harm
Value Judgments: None
Intentional Vagueness: Types of mechanical compression were not recommended. Physical therapists should work within their health care system to develop institution-specific protocols.
Role of Patient Preference: Ease of use, comfort level, and ability to operate mechanical compression equipment properly should be discussed with patients and their families or caregivers.
Exclusions: Patients who have severe peripheral neuropathy, arterial insufficiency, dermatologic diseases, or lesions may have contraindications to selective mechanical compression modes.

Summary of evidence

In the ninth edition (2012) CPG by the ACCP, recommendations pertaining to mechanical compression based on moderate-quality data for patients with diagnosed LE DVT were given.[91] For patients with acute symptomatic LE DVT and in those having PTS, GCS were suggested based on studies using at least 30 mm Hg of pressure at the ankle. In patients with severe PTS of the leg not adequately relieved with GCS, a trial with IPC was suggested.

Systematic reviews pertaining to the adjuvant use of mechanical compression garments for patients who are anticoagulated and have acute VTE (eg, LE DVT) while on bed rest or with early ambulation compared with controls provide supportive evidence for their use.[92] The 7 RCTs in these reviews concluded that mechanical compression lowered the relative risk for progression of a thrombus or the development of a new thrombus.

Two earlier RCTs conducted over 2 years on patients who had symptomatic, first-occurrence proximal LE DVTs concluded that knee-length elastic GCS with interface pressures of 30 to 40 mm Hg at the ankle reduced the incidence of mild, moderate, and severe PTS compared with controls who did not wear GCS.[93,94] In stark contrast, a more recent randomized placebo-controlled multicenter trial with 410 patients having a first proximal LE DVT followed for 2 years (ie, SOX trial) did not support the routine wearing of GCS (ie, knee length at 30–40 mm Hg compared with ≤5 mm Hg placebo knee-length stockings) after LE DVT.[95]

Two additional RCTs[96,97] on patients who were anticoagulated and had acute LE DVT combined early ambulation with the wearing of either inelastic (rigid) stockings above the knee (ie, zinc plaster Unna boots providing 50 mm Hg of interface pressure at the ankle) or thigh-length elastic stockings (ie, providing an interface pressure of 30 mm Hg at the ankle) compared with control patients on bed rest. The combination of GCS with ambulation resulted in a faster resolution of pain and swelling and an

Table 7.
Indications and Contraindications to Inferior Vena Cava Filter Placement[138]

Absolute Indications	Relative Indications
Contraindication to anticoagulation	Large free-floating proximal deep vein thrombosis
Therapeutic anticoagulation is unable to be achieved or maintained	Therapeutic anticoagulation not achieved
	Venous thromboembolism with decreased cardiopulmonary reserve
	Poor adherence to anticoagulation medication
	High risk of complication from anticoagulation
Absolute Contraindications	**Relative Contraindications**
Complete, chronic thrombosis of the inferior vena cava filter	Severe, uncorrectable coagulopathy
Inability to gain central venous access	Bacteremia or sepsis

increased quality-of-life outcome measure.

In summary, the evidence to support mechanical compression methods as effective treatment interventions for secondary VTE prevention varies according to patient VTE risk profile, acute (eg, hemodynamic stability) versus chronic (eg, PTS concern) status, degree of signs (eg, swelling) and symptoms (eg, pain), and consideration for potentially harmful outcomes (eg, skin lesions). Whether used adjunctively along with anticoagulants, alone as in patients when anticoagulant use is contraindicated, or in combination (eg, ambulation plus GCS) with or without anticoagulation, mechanical compression use has mostly been favorable. Controversy persists, however, regarding whether to support the routine use of mechanical compression (eg, GCS) for LE DVT management and secondary prevention. Studies tend to suggest that having GCS compression forces at the ankle, regardless of whether elastic or rigid, is beneficial when ≥30 mm Hg, especially when combined with early ambulation. Regardless of whether the mode of mechanical compression is by GCS or another means (eg, IPC), the optimal mechanical compression treatment strategy has yet to be identified.[98]

Action Statement 10: Mobilize patients after inferior vena cava (IVC) filter placement once hemodynamically stable

Physical therapists should mobilize patients after IVC filter placement once they are hemodynamically stable and there is no bleeding at the puncture site. (Evidence Quality: V; Recommendation Strength: P–Best Practice)

Action statement profile

Aggregate Evidence Quality: Level V
Benefits: Decreased risk of PE reduced in-hospital fatality rate in patients who are stable and those who are unstable
Risk, Harm, Cost: IVC complications and potential overuse of IVC filters may increase costs
Benefit-Harm Assessment: Preponderance of benefit over harm for patients who have an acute proximal LE DVT and contraindications to anticoagulants
Value Judgments: An IVC filter is valuable for patients at high risk who are unable to be given anticoagulants.
Intentional Vagueness: None
Role of Patient Preference: None
Exclusions: Patients with contraindications to IVC filter placement

Summary of evidence

Inferior vena cava filter placement is a type of percutaneous endovascular intervention for venous thromboembolic disease and is usually performed by an interventional radiologist. Venous access is via the right internal jugular or right femoral veins. The best placement location for the IVC filter to prevent lower extremity and pelvic VTE is just inferior to the renal veins.[99] Table 7 lists the indications and contraindications for IVC filter placement. In general, IVC filters are used to prevent PE in patients who are thought to be at high risk for LE DVT or PE, have contraindications to anticoagulants, or for whom medications have not been effective. Findings are mixed regarding the effectiveness of IVC filters in preventing PE, and there are risks associated with IVC filter placement (Tab. 8). Following placement of an IVC filter, the patient should be mobilized once he or she is hemodynamically stable and there is no bleeding at the puncture site.[99] Physical therapists should monitor ambulation and mobility to ensure patient safety and to determine the appropriate level of required assistance prior to the patient being discharged.[99]

Action Statement 11: Consult with the medical team when a patient is not anticoagulated and without an IVC filter

When a patient with a documented LE DVT below the knee is not treated with anticoagulation and does not have an IVC filter and is prescribed out of bed mobility by the physician, the physical therapist should consult with the medical team regarding mobilizing versus keeping the patient on bed rest. (Evidence Quality: V; Recommendation Strength: P–Best Practice)

Action statement profile

Aggregate Evidence Quality: Level V
Benefits: Mobility has demonstrated a decreased risk of VTE
Risk, Harm, Cost: Potential increased risk of PE should the LE DVT embolize
Benefit-Harm Assessment: Preponderance of benefit over harm
Value Judgments: As movement specialists, physical therapists recommend mobilization over bed rest due to the documented benefits of early mobilization.
Intentional Vagueness: Specific guidelines are not provided because it is rare that a patient will not have anticoagulants prescribed or an IVC filter in this country. Each patient should be considered individually.
Role of Patient Preferences: Patients should be informed of the risks and benefits of bed rest and inactivity and of mobilization.
Exclusions: Any LE DVT present above the knee

Table 8.
Complications Related to Inferior Vena Cava Filters[138,139]

Insertion Complications	Thrombotic Complications
Hematoma at insertion site	Insertion site thrombosis
Misplacement	Inferior vena cava filter thrombosis
Pneumothorax	New or progression of deep vein thrombosis
Inferior vena cava damage/wall penetration	New or progression of pulmonary embolism
Filter migration	Postthrombotic syndrome
Air embolism	
Carotid artery puncture	
Arteriovenous fistula	
Infection	

Summary of evidence

There may be times when a patient has a diagnosed LE DVT but no medical interventions are initiated. The patients may have contraindications for receiving anticoagulant medications or they do not meet the criteria for an IVC (eg, in palliative care or hospice care). In these situations, a consult with the primary physician or medical team should guide the decision to mobilize the patient. Continuing to remain on bed rest will only increase the risk of additional VTE and other adverse effects of immobilization. At some point, the patient needs to return to daily activities, and it might be appropriate to begin mobilization even though an untreated LE DVT is present. In other situations, the reason for not addressing the LE DVT may be short term. It may be wise to wait until anticoagulation can begin. The physical therapist needs to discuss all of these factors with the interprofessional team and the patient when making a clinical judgment about mobilization. Although a physician may order physical therapy to increase the physical activity level of a patient, it is the physical therapist's clinical decision whether to mobilize the patient based on the available information about the patient's LE DVT and risk status.

Action Statement 12: Screen for fall risk

Physical therapists should screen for fall risk whenever a patient is taking an anticoagulant medication. (Evidence Quality: III; Recommendation Strength: C–Weak)

Action statement profile

Aggregate Evidence Quality: Level III
Benefits: Decreased risk of hemorrhage due to falls
Risk, Harm, Cost: Immobility versus risk of falling
Benefit-Harm Assessment: Preponderance of benefit over harm
Value Judgments: Fall prevention is a prudent step in managing patients who are at increased risk for bleeding.
Role of Patient Preference: None
Exclusions: None

Summary of evidence

A major bleed event is a possible complication in patients taking an anticoagulant medication. Use of oral anticoagulants increases the risk of intracerebral bleeds by 7 to 10 times.[100] Individuals who fall while on long-term anticoagulation have higher rates of mortality than those not on these medications due to a subsequent major bleed.[101,102] However, the benefits of being on an anticoagulant outweigh the risk of a major bleed.[103,104] Therefore, patients at high risk for falls are not automatically excluded from receiving anticoagulants and will receive these medications when it is considered medically beneficial.

Age is considered a major risk factor for falls. People 75 years of age and older have the highest rate of falls, and 1 in 3 individuals over the age of 65 years fall each year.[105,106] Because of the risk of falls associated with age, the National Institute for Health and Care Excellence, the American Geriatrics Society, and the US Preventive Services Task Force all recommend screening for fall risk in all older adults.[107–109] Individuals should be asked about feelings of unsteadiness and falls over the last year. If a fall or unsteadiness has been reported, further assessment of strength, balance, and other risk factors should be completed. In general, the population of individuals on anticoagulants is made up of older adults who would benefit from fall risk screening.[4,110] The Centers for Disease Control and Prevention's Stopping Elderly Accidents, Deaths and Injuries (STEADI) toolkit provides physical therapists and interprofessional team members with an evidence-based tool to improve fall prevention in clinical practice.

Action Statement 13: Recommend mechanical compression when signs and symptoms of PTS are present

Physical therapists should recommend mechanical compression (eg, IPC, GCS) when a patient has signs and symptoms suggestive of PTS. (Evidence Quality: I; Recommendation Strength: A–Strong)

Action statement profile

Aggregate Evidence Quality: Level I
Benefit: Faster resolution of LE DVT signs and symptoms and decreasing PTS severity
Risk, Harm, Cost: Improper fit can lead to skin irritation, ulceration, and interruption of blood flow.
Benefit-Harm Assessment: Preponderance of benefit over harm
Value Judgments: None
Intentional Vagueness: The specific types of mechanical compression were not recommended. Physical therapists should work within their health care system to develop institution-specific protocols.
Role of Patient Preference: Ease of use, comfort level, and ability to operate mechanical compression equipment properly should be discussed with the patient and caregiver.
Exclusions: Patients who have severe peripheral neuropathy, arterial insufficiency, dermatologic diseases, or lesions may have contraindications to selective mechanical compression modes.

Summary of evidence

Approximately 1 in 3 patients with LE DVT will experience PTS within 5 years, and in 5% to 10% of these patients, PTS occurs in its most severe form as venous ulceration.[13,111,112] The potential exists that should infection develop, septicemia or septic shock could result.[113] Patients with PTS experience chronic complaints of leg pain secondary to the DVT, which may include the sense of the leg feeling heavy, cramping, and itching, and, in severe cases, venous ulceration.[13,98,114] The pathogenesis of PTS is thought to be related to venous hypertension. As the thrombus initiates an inflammatory response, venous valves may become damaged during this process of thrombus resolution, which is often incomplete over time. The damaged venous valves cause valvular reflux, and as remodeling of the vein wall occurs, they may become stiff and contribute to increased outflow resistance, which increases blood pressure in the veins. This increase in transluminal pressure causes leakage into the interstitial space, leading to edema and skin changes. Microcirculation and blood supply to the leg muscles become compromised, which can lead to venous ulcerations in the more severe instances of PTS.[98] With clinical findings of PTS being similar to that of an acute LE DVT, concern is raised regarding the negative impact that PTS may have on a person's quality-of-life experience.[13,111,113,115–117] For reasons described above, physical therapists should consider screening all patients with a history of LE DVT, past and current, for signs and symptoms of PTS. Once PTS is suspected, a specific and sensitive rating instrument referred to as the Villalta scale can be used to grade the severity of PTS.[117–120]

A meta-analysis conducted on 5 RCTs determined that venous compression stockings or compression bandages are effective in reducing PTS in patients.[119] In patients with LE DVT receiving GCS compared with controls, mild-to-moderate PTS occurred in 64 (22%) of 296 patients treated with venous compression compared with 106 (37%) of 284 controls. Severe PTS occurred in 14 (5%) of 296 patients treated compared with 33 (12%) of 284 controls. Development of any degree of PTS occurred in 89 (26%) of 338 patients treated compared with 150 (46%) of 324 controls. Thus, GCS reduces the severity of PTS, although there was a wide variation in the type of stockings used, time interval from diagnosis to application of stockings, and duration of treatment.

Two Cochrane reviews, separated by 1 year, were conducted to determine the treatment interventions of IPC or GCS according to PTS severity. Findings from the first review based on 2 RCTs[112] included favorable trends using higher pressures of IPC over that of lower pressures and that there was not enough evidence to support the use of elastic GCS (30–40 mm Hg pressures at the ankle versus placebo stockings) in patients with mild-to-moderate PTS severity. The second review, based on 3 RCTs,[120] provided statistically significant evidence that elastic GCS of 20 to 40 mm Hg interface pressure at the ankle reduce the severity of PTS after LE DVT.

A separate RCT involving 169 patients with a first or recurrent proximal LE DVT after receiving 6 months of standard treatment to wear GCS or not was conducted.[121] The incidence of PTS was 11 patients (13.1%) in the treatment group compared with 17 individuals (20.0%) in the control group. No venous ulceration was observed in either group, with symptom relief significantly in favor of compression treatment during the first year but not thereafter. The conclusion reached was that prolonged use of GCS after proximal DVT significantly reduces symptoms and signs of postthrombotic skin changes.

In the evidence-based guideline by the Finnish Medical Society Duodecim, immediate bandaging for compression during the acute phase of DVT (up to the groin, if needed) is recommended in circular rather than figure-eight turns.[31] In addition, the patient should be mobilized as soon as clinically possible, and GCS (class II compression) should be worn for at least 2 years.

Pooled results from 4 RCTs in another systematic review[122] in patients with confirmed proximal LE DVT used compression bandaging (inelastic or elastic), with or without early ambulation, as an intervention for PTS.[122] Results stressed the importance of activating the calf muscle pump in addition to compression bandaging, a message echoed by other authors more recently.[123]

The lack of uniformity in reporting standards, such as the timing, duration, and degree of compression interface pressure, among other descriptors, makes it difficult for meaningful comparisons among studies. This concern has been raised by more than one investigative group.[98,122–125]

In summary, mechanical compression (eg, with IPC or compression bandaging, activation of the calf muscle pump), with or without ambulation, is the cornerstone in the treatment of PTS. The intervention strategy is primarily focused on decreasing venous pressure in the involved lower extremity, enhancement of the microcirculation, and reduction of the edema. The efficacy in treating PTS after confirmed acute LE DVT and its development during the subacute period or as a debilitating chronic condition thereafter do favor the early application and prolonged use of mechanical compression. The lack in uniformity of the methods and prescriptive protocols followed in the use of mechanical compression lends itself to controversy. Nevertheless, the preponderance of quality evidence does warrant a strong recommendation.

Action Statement 14: Provide management strategies to prevent recurrent VTE and minimize secondary VTE complications

Physical therapists should monitor patients who may develop long-term consequences of VTE (eg, LE DVT recurrence, PTS severity) and provide management strategies in order to improve quality of life. (Evidence quality: V; Recommendation strength: P–Best Practice)

Action statement profile

Aggregate evidence quality: Level V
Benefit: Decreasing the incidence of LE DVT recurrence and minimizing the

severity of PTS signs and symptoms in order to enhance functional mobility and a person's quality of life experience

Risk, Harm, Cost: Improper fit of mechanical compression can lead to skin irritation, ulceration, and interruption of blood flow.

Benefit-Harm Assessment: Preponderance of benefit over harm

Value Judgments: None

Intentional Vagueness: No specific types of mechanical compression were recommended. Physical therapists should work within their health care system to develop institution-specific protocols.

Role of Patient Preference: Ease of use, comfort level, and ability to operate mechanical compression equipment properly

Exclusions: Patients who have severe peripheral neuropathy, arterial insufficiency, decompensated heart failure, dermatologic diseases, or lesions may have contraindications to selective mechanical compression modes.

Summary of evidence

Whether or not a VTE (ie, LE DVT, PE, or PTS) has a clear cause (eg, surgery, trauma, forced immobilization) or is unprovoked (ie, in the absence of a known risk factor), physical therapists should remain vigilant in screening patients for signs and symptoms of recurrent VTE.[126] It is estimated that the risk of recurrence can reach 5% to 10% during the first 6 to 12 months[127] and 10% to 30% within 5 years[128] following a documented first-episode VTE. According to one recent CPG, the rate of VTE recurrence for patients not on long-term anticoagulation is 5% per year.[36] When pharmacologic anticoagulation is provided, the recurrence rate for VTE within the first 6 months was reported to be less than 2.5% in one RCT[129] and between 1.3% and 7.1% over a period of 18 to 24 months in another RCT.[130] Nevertheless, the incidence of fatal and nonfatal VTE recurrence in patients who are anticoagulated following confirmed VTE in the short term of 3 months was reported to be 0.4% and 3%, respectively, in one meta-analysis,[131] and a fatality incidence due to PE of 1.68% was found in a large cohort study.[132] These findings serve to underscore the importance of having physical therapists monitor patients for VTE recurrence regardless of whether over the short term or the long term.

The ability of a clinician to accurately predict level of risk for recurrent VTE (eg, low versus high) has been investigated using the Pulmonary Embolism Severity Index (PESI) clinical prediction rule and found to be of merit.[129,133] Additionally, the use of global clinical judgment that takes into account all of a patient's signs and symptoms (ie, unstructured clinician gestalt) may be superior to clinical prediction rule use.[130]

The ability to distinguish or recognize that PTS is present is important for the clinician to determine. Postthrombotic syndrome is defined as a combination of clinical signs and symptoms occurring after an LE DVT. One study examined 6 different scoring systems that are intended to document the presence and severity of PTS based on variable clinical signs (ie, 11) and symptoms (ie, 12) used between them.[114] Because PTS also involves a patient's subjective report of symptoms, using the objective PTS indicator of skin pigmentation changes that highly correlate with findings from duplex sonography for venous reflux occlusion was advocated.

Thrombosis resolution is often incomplete, with as many as 50% of legs affected by DVT still having residual vein thrombosis years after the LE DVT is first diagnosed.[98] The negative impact on generic life-of-quality measures (eg, 36-Item Short-Form Health Survey [SF-36] sections for physical functioning and bodily pain) has life-quality consequence comparable to chronic medical conditions such as diabetes and heart failure.[117] It is prudent, therefore, that physical therapists recognize signs and symptoms of PTS and intervene with education, hydration, early mobilization, mechanical compression, and referral for medication when appropriate (refer to key Action Statement 3). For example, mechanical compression aims to manage factors responsible for the pathogenesis of VTE (ie, Virchow's triad of hypercoagulopathy, venous stasis, and endothelial damage) by reducing swelling, accelerating venous return, and improving muscle pump function.[122]

In summary, patients who have a prior history of VTE are at high risk for recurrent VTE, especially when they are immobilized or are of advanced age. It is judicious to screen for VTE recurrence using a clinical prediction rule (eg, PESI, Padua score, Wells criteria for LE DVT; Geneva Risk Score) for objective documentation purposes, although global clinical judgment that would favor intervention for secondary VTE prevention should not be overlooked. Once VTE is diagnosed, clinical practice has shifted away from immobilization with bed rest and toward early ambulation with or without adjunctive mechanical compression. From the literature examined, the degree to which recurrent VTE is treated as a secondary prevention should be a priority. Thus, clinical judgment and expert opinion remain for deciding the clinical actions to take.

Conclusion

The major findings of this CPG are the following:

- Physical therapists should play a large role in identifying patients who are at high risk for a VTE. Once these individuals are identified, preventive measures such as referral for medication, initiation of activity or mobilization, mechanical compression, and education should be implemented to decrease the risk of a first or reoccurring VTE.
- Physical therapists should be aware of the signs and symptoms of an LE DVT. When signs and symptoms are present, the likelihood of an LE DVT should be determined through the Wells criteria for LE DVT, and results should be shared with the interprofessional team to consider treatment options.
- In patients with a diagnosed LE DVT, once a medication's therapeutic levels or an acceptable time period has been reached after administration, mobilization should begin. Although there are risks associated with mobilization, the risk of inactivity is greater.
- Complications following LE DVT can continue for years or even a

lifetime. Physical therapists can help decrease these complications through education, mechanical compression, and exercise.

Implementation

In order to implement and disseminate the recommendations of this CPG, the GDG has taken or is in the process of taking the following steps:

- Preliminary sharing of CPG recommendations at APTA's Combined Sections Meeting 2015.
- Open access to the CPG and all reference materials.
- Creation of a pocket guide about VTE for physical therapists.
- Creation of patient brochures and information flyers about the role of physical therapists in preventing VTE and managing patients with LE DVT.
- Production of podcasts about the CPG aimed at physical therapists.
- Presentations on the CPG by the GDG at local, state, regional, and national seminars.
- Creation of checklist and sample evaluation forms incorporating the recommendations of the CPG.

In order to implement these recommendations, physical therapists and the entire health care team should take the following steps:

- Integrate key action statements within this article into clinical practice. Making resources easily accessible in the clinic, such as lists of signs and symptoms of LE DVT, copies of the Wells criteria for LE DVT tool, and the algorithms in this CPG, are some examples.
- Form interprofessional teams that address VTE and ensure all providers know about and then implement the recommendations in this CPG. This recommendation may be done through embedding risk assessment into standardized examination forms or working with referral sources to encourage early mobilization after diagnoses of VTE. As demonstrated in the areas of early mobilization in the intensive care unit and diabetes and chronic pain management, interprofessional teams are effective when attempting to change the culture of an organization to improve patient outcomes.[134–136]
- Physical therapists need to seek out membership in these interprofessional committees and serve as clinical champions in the areas of VTE prevention and management. As movement specialists, physical therapists understand the importance of mobilization and activity and have the ability to modify interventions based on medical history and patient problems. Physical therapists can add greatly to the scope and depth of these teams.

Research Needs

Although researchers have addressed multiple aspects of VTE management, there are still many unanswered questions. A few future research questions that are specific to the physical therapy management are listed below:

- Does aggressive screening for LE DVT lead to a decline in the incidence of PE?
- Does the implementation of guidelines for mobilization of patients with LE DVT lead to earlier mobilization and improved patient outcomes?
- How should patients with UE DVT be treated by physical therapists?
- What are guidelines for mobilization of individuals with a hemodynamically unstable PE?
- What is the appropriate degree of graded compression (eg, elastic, inelastic stockings, IPC) and timing of treatment intervention for PTS and LE DVT prevention?

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This CPG is not intended as the sole source of guidance in managing patients at risk for or diagnosed with venous thromboembolism. Rather, it is designed to assist clinicians by providing an evidence-based framework for decision-making strategies. This CPG is not intended to replace clinical judgment or establish a protocol for all individuals with this condition and may not provide the only appropriate approach to managing the problem. This CPG may be used to develop policy or suggest policy changes, or it may provide discussion about current policy. However, it is up to individual facilities to determine whether they want to adopt these CPG key action statement recommendations in place of their existing policies or protocols.

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References

1 Beckman MG, Hooper WC, Critchley SE, Ortel TL. Venous thromboembolism: a public health concern. *Am J Prev Med.* 2010;38:S495–S501.

2 Kahn SR, Ducruet T, Lamping DL, et al. Prospective evaluation of health-related quality of life in patients with deep venous thrombosis. *Arch Intern Med.* 2005;165:1173–1178.

3 Committee on Standards for Developing Trustworthy Clinical Practice Guidelines. *Clinical Practice Guidelines We Can Trust*. Washington DC: The National Academies Press; 2011.

4 White RH. The epidemiology of venous thromboembolism. *Circulation.* 2003; 107(23 suppl 1):14–18.

5 Klok FA, van der Hulle T, den Exter PL, et al. The post-PE syndrome: a new concept for chronic complications of pulmonary embolism. *Blood Rev.* 2014;28:221–226.

6 World Health Organization. WHO Research Into Global Hazards of Travel (WRIGHT) Project. Available at: http://www.who.int/cardiovascular_diseases/wright_project/phase1_report/WRIGHT%20REPORT.pdf?us=1. Published 2007. Accessed April 2015.

7 Cohen AT, Agnelli G, Anderson FA, et al. Venous thromboembolism (VTE) in Europe. The number of VTE events and associated morbidity and mortality. *Thromb Haemost.* 2007;98:756–764.

8 Geerts WH, Heit JA, Clagett GP, et al. Prevention of venous thromboembolism. *Chest.* 2001;119(1 suppl):132S–175S.

9 Galson SK. *The Surgeon General's Call to Action to Prevent Deep Vein Thrombosis and Pulmonary Embolism*. Rockville, MD: US Department of Health and Human Services; 2008.

10 Korkmaz A, Ozlu T, Ozsu S, et al. Long-term outcomes in acute pulmonary thromboembolism: the incidence of chronic thromboembolic pulmonary hypertension and associated risk factors. *Clin Appl Thromb Hemost.* 2012;18: 281–288.

11 Klok FA, van Kralingen KW, van Dijk AP, et al. Quality of life in long-term survivors of acute pulmonary embolism. *Chest.* 2010;138:1432–1440.

12 Kahn SR, Shapiro S, Wells PS, et al. Compression stockings to prevent post-thrombotic syndrome: a randomised placebo-controlled trial. *Lancet.* 2014; 383:880–888.

13 Streiff MB, Brady JP, Grant AM, et al. CDC Grand Rounds: preventing hospital-associated venous thromboembolism. *MMWR Morb Mortal Wkly Rep.* 2014;63: 190–193.

14 Kaplan SL, Coulter C, Fetters L. Developing evidence-based physical therapy clinical practice guidelines. *Pediatr Phys Ther.* 2013;25:257–270.

15 Fetters L, Tilson J. *Evidence Based Physical Therapy*. Philadelphia, PA: FA Davis Co; 2012.

16 Shea BJ, Grimshaw JM, Wells GA, et al. Development of AMSTAR: a measurement tool to assess the methodological quality of systematic reviews. *BMC Med Res Methodol.* 2007;7:10.

17 Canadian Institutes of Health Research. Advancing the science of practice guidelines. Available at: http://www.agreetrust.org/. Accessed December 2, 2014.

18 Shiffman RN, Michel G, Rosenfeld RM, Davidson C. Building better guidelines with BRIDGE-Wiz: development and evaluation of a software assistant to promote clarity, transparency, and implementability. *J Am Med Inform Assoc.* 2012;19:94–101.

19 Rocha AT, Paiva EF, Lichtenstein A, et al. Risk-assessment algorithm and recommendations for venous thromboembolism prophylaxis in medical patients. *Vasc Health Risk Manag.* 2007;3:533–553.

20 *Venous Thromboembolism: Reducing the Risk of Venous Thromboembolism in Patients Admitted to Hospital*. London, United Kingdom: National Institutes for Health and Care Excellence; 2010.

21 Wells PS, Anderson DR, Bormanis J, et al. Value of assessment of pretest probability of deep-vein thrombosis in clinical management. *Lancet.* 1997;350:1795–1798.

22 Alikhan R, Cohen AT. A safety analysis of thromboprophylaxis in acute medical illness. *Thromb Haemost.* 2003;89:590–591.

23 Samama MM. An epidemiologic study of risk factors for deep vein thrombosis in medical outpatients: the Sirius study. *Arch Intern Med.* 2000;160:3415–3420.

24 Motykie GD, Caprini JA, Arcelus JI, et al. Risk factor assessment in the management of patients with suspected deep venous thrombosis. *Int Angiol.* 2000;19: 47–51.

25 Weill-Engerer S, Meaume S, Lahlou A, et al. Risk factors for deep vein thrombosis in inpatients aged 65 and older: a case-control multicenter study. *J Am Geriatr Soc.* 2004;52:1299–1304.

26 Bates SM, Jaeschke R, Stevens SM, et al. Diagnosis of DVT: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. *Chest.* 2012;141(2 suppl):e351S–e418S.

27 Guyatt GH, Akl EA, Crowther M, et al. Executive summary: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines [erratum in: *Chest*. 2012;142: 1698; and *Chest*. 2012;141:1129]. *Chest.* 2012;141(2 suppl):7S–47S.

28 Aissaoui N, Martins E, Mouly S, et al. A meta-analysis of bed rest versus early ambulation in the management of pulmonary embolism, deep vein thrombosis, or both. *Int J Cardiol.* 2009;137:37–41.

29 Kahn SR, Shrier I, Kearon C. Physical activity in patients with deep venous thrombosis: a systematic review. *Thromb Res.* 2008;122:763–773.

30 Guide to Physical Therapist Practice 3.0. Alexandria, VA: American Physical Therapy Association; 2014. Available at: http://guidetoptpractice.apta.org/. Accessed May 28, 2014.

31 Finnish Medical Society Duodecim. *Deep Vein Thrombosis*. Helsinki, Finland: Wiley Interscience; 2011.

32 Qaseem A, Chou R, Humphrey LL, et al. Venous thromboembolism prophylaxis in hospitalized patients: a clinical practice guideline from the American College of Physicians. *Ann Intern Med.* 2011; 155:625–632.

33 Woller SC, Stevens SM, Jones JP, et al. Derivation and validation of a simple model to identify venous thromboembolism risk in medical patients [erratum in: *Am J Med*. 2012;125:e27]. *Am J Med.* 2011;124:947–954.

34 Kucher N, Tapson VF, Goldhaber SZ; DVT FREE Steering Committee. Risk factors associated with symptomatic pulmonary embolism in a large cohort of deep vein thrombosis patients. *Thromb Haemost.* 2005;93:494–498.

35 Prevention of venous thromboembolism: brief update review. In: *Making Health Care Safer II: An Updated Critical Analysis of the Evidence for Patient Safety Practices.* Rockville, MD: Agency for Healthcare Research and Quality; 2013.

36 Scottish Intercollegiate Guidelines Network (SIGN). *Prevention and Management of Venous Thromboembolism: A National Clinical Guideline*. Edinburgh, Scotland: Scottish Intercollegiate Guidelines Network (SIGN); 2011.

37 Cohen AT, Tapson VF, Bergmann JF, et al. Venous thromboembolism risk and prophylaxis in the acute hospital care setting (ENDORSE study): a multinational cross-sectional study [erratum in: *Lancet*. 2008;371:1914]. *Lancet.* 2008;371:387–394.

38 Kahn SR, Lim W, Dunn AS, et al. Prevention of VTE in nonsurgical patients: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians evidence-based clinical practice guidelines. *Chest.* 2012;141(2 suppl):e195S–e226S.

39 Barbar S, Noventa F, Rossetto V, et al. A risk assessment model for the identification of hospitalized medical patients at risk for venous thromboembolism: the Padua Prediction Score. *J Thromb Haemost.* 2010;8:2450–2457.

40 Rosenberg D, Eichorn A, Alarcon M, et al. External validation of the risk assessment model of the International Medical Prevention Registry on Venous Thromboembolism (IMPROVE) for medical patients in a tertiary health system. *J Am Heart Assoc.* 2014;3:e001152.

41 Autar R. The management of deep vein thrombosis: the Autar DVT risk assessment scale re-visited. *J Orthopaedic Nursing.* 2003;7:114–124.

42 Nendaz M, Spirk D, Kucher N, et al. Multicentre validation of the Geneva Risk Score for hospitalised medical patients at risk of venous thromboembolism: Explicit ASsessment of Thromboembolic RIsk and Prophylaxis for Medical PATients in SwitzErland (ESTIMATE). *Thromb Haemost.* 2014;111:531–538.

43 Dupras DB, Felty C, Hansen C, et al. Institute for Clinical Systems Improvement. *Venous Thromboembolism Diagnosis and Treatment.* Available at: http://www.icsi.org/_asset/51dx9k/VTE0113.pdf. Updated January 2013. Accessed April 2015.

44 National Institute for Health and Care Excellence. Venous thromboembolic diseases: diagnosis, management and thrombophilia testing. Available at: https://www.nice.org.uk/guidance/cg144. Published: June 2012. Accessed April 2015.

45 Zarowitz BJ, Tangalos E, Lefkovitz A, et al. Thrombotic risk and immobility in residents of long-term care facilities. *J Am Med Dir Assoc.* 2010;11:211–221.

46 Sachdeva A, Dalton M, Amaragiri SV, Lees T. Elastic compression stockings for prevention of deep vein thrombosis. *Cochrane Database Syst Rev.* 2010;7:CD001484.

47 Clarke M, Hopewell S, Juszczak E, et al. Compression stockings for preventing deep vein thrombosis in airline passengers. *Cochrane Database Syst Rev.* 2006;2:CD004002.

48 Kahn SR, Springmann V, Schulman S, et al. Management and adherence to VTE treatment guidelines in a national prospective cohort study in the Canadian outpatient setting: the Recovery Study. *Thromb Haemost.* 2012;108:493–498.

49 Philbrick JT, Shumate R, Siadaty MS, Becker DM. Air travel and venous thromboembolism: a systematic review. *J Gen Intern Med.* 2007;22:107–114.

50 Amaragiri SV, Lees TA. Elastic compression stockings for prevention of deep vein thrombosis. *Cochrane Database Syst Rev.* 2000;3:CD001484.

51 Agu O, Hamilton G, Baker D. Graduated compression stockings in the prevention of venous thromboembolism. *Br J Surg.* 1999;86:992–1004.

52 Sajid MS, Desai M, Morris RW, Hamilton G. Knee length versus thigh length graduated compression stockings for prevention of deep vein thrombosis in postoperative surgical patients. *Cochrane Database Syst Rev.* 2012;5:CD007162.

53 JCS Joint Working Group. Guidelines for the diagnosis, treatment and prevention of pulmonary thromboembolism and deep vein thrombosis (JCS 2009). *Circ J.* 2011;75:1258–1281.

54 Spencer FA, Lessard D, Emery C, et al. Venous thromboembolism in the outpatient setting. *Arch Intern Med.* 2007;167:1471–1475.

55 Kakkos SK, Caprini JA, Geroulakos G, et al. Combined intermittent pneumatic leg compression and pharmacological prophylaxis for prevention of venous thromboembolism in high-risk patients. *Cochrane Database Syst Rev.* 2008;4:CD005258.

56 Dennis M, Sandercock P, Reid J, et al. Can clinical features distinguish between immobile patients with stroke at high and low risk of deep vein thrombosis? Statistical modelling based on the CLOTS trials cohorts. *J Neurol Neurosurg Psychiatry.* 2011;82:1067–1073.

57 Bono CM, Watters WC III, Heggeness MH, et al. An evidence-based clinical guideline for the use of antithrombotic therapies in spine surgery. *Spine J.* 2009;9:1046–1051.

58 Falck-Ytter Y, Francis CW, Johanson NA, et al. Prevention of VTE in orthopedic surgery patients: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. *Chest.* 2012;141(2 suppl):e278S–e325S.

59 Mont MA, Jacobs JJ. AAOS clinical practice guideline: preventing venous thromboembolic disease in patients undergoing elective hip and knee arthroplasty. *J Am Acad Orthop Surg.* 2011;19:777–778.

60 Windisch C, Kolb W, Kolb K, et al. Pneumatic compression with foot pumps facilitates early postoperative mobilisation in total knee arthroplasty. *Int Orthop.* 2011;35:995–1000.

61 University of Michigan Health System. Venous thromboembolism (VTE). Available at: http://www.med.umich.edu/1info/FHP/practiceguides/vte/vte.pdf. Published June 1998. Updated May 2014. Accessed April 2015.

62 Goodacre S, Sutton AJ, Sampson FC. Meta-analysis: the value of clinical assessment in the diagnosis of deep venous thrombosis. *Ann Intern Med.* 2005;143:129–139.

63 *Antithrombotics: Indications and Management, A National Clinical Guideline*. Edinburgh, Scotland: Scottish Intercollegiate Guidelines Network; 2013.

64 Wells PS, Hirsh J, Anderson DR, et al. Accuracy of clinical assessment of deep-vein thrombosis [erratum in: *Lancet.* 1995;346:516]. *Lancet.* 1995;345:1326–1330.

65 Wells PS, Owen C, Doucette S, et al. Does this patient have deep vein thrombosis? *JAMA.* 2006;295:199–207.

66 Geersing GJ, Zuithoff NP, Kearon C, et al. Exclusion of deep vein thrombosis using the Wells rule in clinically important subgroups: individual patient data meta-analysis. *BMJ.* 2014;348:1340.

67 Wells PS, Anderson DR, Rodger M, et al. Evaluation of D-dimer in the diagnosis of suspected deep-vein thrombosis. *N Engl J Med.* 2003;349:1227–1235.

68 Oudega R, Moons KG, Hoes AW. Ruling out deep venous thrombosis in primary care: a simple diagnostic algorithm including D-dimer testing. *Thromb Haemost.* 2005;94:200–205.

69 van der Velde EF, Toll DB, Ten Cate-Hoek AJ, et al. Comparing the diagnostic performance of 2 clinical decision rules to rule out deep vein thrombosis in primary care patients. *Ann Fam Med.* 2011;9:31–36.

70 Hanley M, Rybicki FJ, Dill KE, et al. ACR Appropriateness Criteria® suspected lower-extremity deep vein thrombosis. Available at: http://www.guideline.gov/content.aspx?id=47686. Published 2013. Accessed March 26, 2014.

71 Bounameaux H, Perrier A, Righini M. Diagnosis of venous thromboembolism: an update. *Vasc Med.* 2010;15:399–406.

72 Mousa AY, Broce M, Gill G, et al. Appropriate use of d-Dimer testing can minimize over-utilization of venous duplex ultrasound in a contemporary high-volume hospital. *Ann Vasc Surg.* 2015;29:311–317.

73 Prell J, Rachinger J, Smaczny R, et al. D-dimer plasma level: a reliable marker for venous thromboembolism after elective craniotomy. *J Neurosurg.* 2013;119:1340–1346.

74 Tripodi A. D-dimer testing in laboratory practice. *Clin Chem.* 2011;57:1256–1262.

75 Dunn AS, Brenner A, Halm EA. The magnitude of an iatrogenic disorder: a systematic review of the incidence of venous thromboembolism for general medical inpatients. *Thromb Haemost.* 2006;95:758–762.

76 Baglin TP, White K, Charles A. Fatal pulmonary embolism in hospitalised medical patients. *J Clin Pathol.* 1997;50:609–610.

77 Samama MM, Cohen AT, Darmon JY, et al. A comparison of enoxaparin with placebo for the prevention of venous thromboembolism in acutely ill medical patients: Prophylaxis in Medical Patients with Enoxaparin Study Group. *N Engl J Med.* 1999;341:793–800.

78 Leizorovicz A, Cohen AT, Turpie AG, et al. Randomized, placebo-controlled trial of dalteparin for the prevention of venous thromboembolism in acutely ill medical patients. *Circulation.* 2004;110:874–879.

79 Cohen AT, Davidson BL, Gallus AS, et al. Efficacy and safety of fondaparinux for the prevention of venous thromboembolism in older acute medical patients: randomised placebo controlled trial. *BMJ.* 2006;332:325–329.

80 Keeling D, Baglin T, Tait C, et al. Guidelines on oral anticoagulation with warfarin: fourth edition. *Br J Haematol.* 2011;154:311–324.

81 Greaves M; Control of Anticoagulation Subcommittee of the Scientific and Standardization Committee of the International Society of Thrombosis and Haemostasis. Limitations of the laboratory monitoring of heparin therapy; Scientific and Standardization Committee Communications: on behalf of the Control of Anticoagulation Subcommittee of the Scientific and Standardization Committee of the International Society of Thrombosis and Haemostasis. *Thromb Haemost.* 2002;87:163–164.

82 Sanofi US. Lovenox prescribing information. Available at: http://products.sanofi.us/lovenox/lovenox.html#Boxed%20Warning. Accessed December 19, 2014.

83 Vandiver JW, Vondracek TG. Antifactor Xa levels versus activated partial thromboplastin time for monitoring unfractionated heparin. *Pharmacotherapy.* 2012;32:546–558.

84 Linkins LA, Dans AL, Moores LK, et al. Treatment and prevention of heparin-induced thrombocytopenia; Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. *Chest.* 2012;141(2 suppl):e495S–e530S.

85 Tuzson A. How high is too high: INR and acute care physical therapy. *Acute Care Perspectives.* 2009;18:8.

86 Ageno W, Gallus AS, Wittkowsky A, et al. Oral anticoagulant therapy; Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. *Chest.* 2012;141(2 suppl):e44S–e88S.

87 Cannegieter SC, Rosendaal FR, Wintzen AR, et al. Optimal oral anticoagulant therapy in patients with mechanical heart valves. *N Engl J Med.* 1995;333:11–17.

88 van der Meer FJ, Rosendaal FR, Vandenbroucke JP, Briet E. Bleeding complications in oral anticoagulant therapy: an analysis of risk factors. *Arch Intern Med.* 1993;153:1557–1562.

89 Mont MA, Jacobs JJ, Boggio LN, et al. Preventing venous thromboembolic disease in patients undergoing elective hip and knee arthroplasty. *J Am Acad Orthop Surg.* 2011;19:768–776.

90 Ward C, Conner G, Donnan G, et al. Practical management of patients on apixaban: a consensus guide. *Thromb J.* 2013;11:27.

91 Kearon C, Akl EA, Comerota AJ, et al. Antithrombotic therapy for VTE disease; Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines [erratum in: *Chest*. 2012;142:1698–1704]. *Chest.* 2012;141(2 suppl):e419S–e494S.

92 Aldrich D, Hunt DP. When can the patient with deep venous thrombosis begin to ambulate? *Phys Ther.* 2004;84:268–273.

93 Brandjes DP, Buller HR, Heijboer H, et al. Randomised trial of effect of compression stockings in patients with symptomatic proximal-vein thrombosis. *Lancet.* 1997;349:759–762.

94 Prandoni P, Lensing AW, Prins MH, et al. Below-knee elastic compression stockings to prevent the post-thrombotic syndrome: a randomized, controlled trial. *Ann Intern Med.* 2004;141:249–256.

95 Kahn SR, Comerota AJ, Cushman M, et al. The postthrombotic syndrome; evidence-based prevention, diagnosis, and treatment strategies: a scientific statement from the American Heart Association [erratum in: *Circulation*. 2015]. *Circulation.* 2014;130:1636–1661.

96 Partsch H, Blattler W. Compression and walking versus bed rest in the treatment of proximal deep venous thrombosis with low molecular weight heparin. *J Vasc Surg.* 2000;32:861–869.

97 Blattler W, Partsch H. Leg compression and ambulation is better than bed rest for the treatment of acute deep venous thrombosis. *Int Angiol.* 2003;22:393–400.

98 Bouman A, Cate-Hoek AT. Timing and duration of compression therapy after deep vein thrombosis. *Phlebology.* 2014;29(1 suppl):78–82.

99 American College of Radiology, Society of Interventional Radiology. ACR-SIR practice guideline for the performance of inferior vena cava (IVC) filter placement for the prevention of pulmonary embolism. Rockville, MD: Agency for Healthcare Research and Quality; 2010:13.

100 Veltkamp R, Rizos T, Horstmann S. Intracerebral bleeding in patients on antithrombotic agents. *Semin Thromb Hemost.* 2013;39:963–971.

101 Pieracci FM, Eachempati SR, Shou J, et al. Use of long-term anticoagulation is associated with traumatic intracranial hemorrhage and subsequent mortality in elderly patients hospitalized after falls: analysis of the New York State Administrative Database. *J Trauma.* 2007;63:519–524.

102 Inui TS, Parina R, Chang DC, et al. Mortality after ground-level fall in the elderly patient taking oral anticoagulation for atrial fibrillation/flutter: a long-term analysis of risk versus benefit. *J Trauma Acute Care Surg.* 2014;76:642–649.

103 Garvin R, Howard E. Are major bleeding events from falls more likely in patients on warfarin? *J Fam Pract.* 2006;55:159–160.

104 Garwood CL, Corbett TL. Use of anticoagulation in elderly patients with atrial fibrillation who are at risk for falls. *Ann Pharmacother.* 2008;42:523–532.

105 Adams PF, Kirzinger WK, Martinez M. Summary health statistics for the US population: National Health Interview Survey, 2012. *Vital Health Stat 10.* 2013;259:1–95.

106 Centers for Disease Control and Prevention. Falls among older adults: an overview. Available at: http://www.cdc.gov/HomeandRecreationalSafety/Falls/adultfalls.html. Accessed August 29, 2014.

107 National Institute for Health and Care Excellence. Falls in older people: assessing risk and prevention. Available at: https://www.nice.org.uk/guidance/cg161. Published June 2013. Accessed August 21, 2014. NICE Clinical Guideline 161.

108 American Geriatrics Society. AGS clinical practice guidelines: prevention of falls in older persons. Available at: http://www.medcats.com/FALLS/frameset.htm. Accessed July 21, 2010.

109 Moyer VA; US Preventive Services Task Force. Prevention of falls in community-dwelling older adults: US Preventive Services Task Force recommendation statement. *Ann Intern Med.* 2012;157:197–204.

110 Feinberg WM, Blackshear JL, Laupacis A, et al. Prevalence, age distribution, and gender of patients with atrial fibrillation: analysis and implications. *Arch Intern Med.* 1995;155:469–473.

111 Lippi G, Favaloro EJ, Cervellin G. Prevention of venous thromboembolism: focus on mechanical prophylaxis. *Semin Thromb Hemost.* 2011;37:237–251.

112 Kolbach DN, Sandbrink MW, Neumann HA, Prins MH. Compression therapy for treating stage I and II (Widmer) postthrombotic syndrome. *Cochrane Database Syst Rev.* 2003;4:CD004177.

113 Wheeler AP, Bernard GR. Treating patients with severe sepsis. *N Engl J Med.* 1999;340:207–214.

114 Jeanneret C, Aschwanden M, Staub D. Compression to prevent the postthrombotic syndrome. *Phlebology.* 2014;29(1 suppl):71–77.

115 Watson LI, Armon MP. Thrombolysis for acute deep vein thrombosis. *Cochrane Database Syst Rev.* 2004;4:CD002783.

116 Kahn SR, Lamping DL, Ducruet T, et al. VEINES-QOL/Sym questionnaire was a reliable and valid disease-specific quality of life measure for deep venous thrombosis [erratum in: *J Clin Epidemiol*. 2006;59:1334]. *J Clin Epidemiol.* 2006;59:1049–1056.

117 Roberts LN, Patel RK, Donaldson N, et al. Post-thrombotic syndrome is an independent determinant of health-related quality of life following both first proximal and distal deep vein thrombosis. *Haematologica.* 2014;99:e41–e43.

118 Kahn SR. Measurement properties of the Villalta scale to define and classify the severity of the post-thrombotic syndrome. *J Thromb Haemost.* 2009;7:884–888.

119 Musani MH, Matta F, Yaekoub AY, et al. Venous compression for prevention of postthrombotic syndrome: a meta-analysis. *Am J Med.* 2010;123:735–740.

120 Kolbach DN, Sandbrink MW, Hamulyak K, et al. Non-pharmaceutical measures for prevention of post-thrombotic syndrome. *Cochrane Database Syst Rev.* 2004;1:CD004174.

121 Aschwanden M, Jeanneret C, Koller MT, et al. Effect of prolonged treatment with compression stockings to prevent post-thrombotic sequelae: a randomized controlled trial. *J Vasc Surg.* 2008;47:1015–1021.

122 Giannoukas AD, Labropoulos N, Michaels JA. Compression with or without early ambulation in the prevention of post-thrombotic syndrome: a systematic review. *Eur J Vasc Endovasc Surg.* 2006; 32:217–221.

123 van der Velden S, Neumann H. The post-thrombotic syndrome and compression therapy. *Phlebology.* 2014;29(1 suppl): 83–89.

124 Kahn SR, Elman E, Rodger MA, Wells PS. Use of elastic compression stockings after deep venous thrombosis: a comparison of practices and perceptions of thrombosis physicians and patients. *J Thromb Haemost.* 2003;1:500–506.

125 Ten Cate-Hoek AJ, Ten Cate H, Tordoir J, et al. Individually tailored duration of elastic compression therapy in relation to incidence of the postthrombotic syndrome. *J Vasc Surg.* 2010;52:132–138.

126 Verhovsek M, Douketis JD, Yi Q, et al. Systematic review: D-dimer to predict recurrent disease after stopping anticoagulant therapy for unprovoked venous thromboembolism. *Ann Intern Med.* 2008;149:481–490, W94.

127 Prandoni P, Lensing AW, Cogo A, et al. The long-term clinical course of acute deep venous thrombosis. *Ann Intern Med.* 1996;125:1–7.

128 Kyrle PA, Rosendaal FR, Eichinger S. Risk assessment for recurrent venous thrombosis. *Lancet.* 2010;376:2032–2039.

129 Jimenez D, Aujesky D, Moores L, et al. Simplification of the pulmonary embolism severity index for prognostication in patients with acute symptomatic pulmonary embolism. *Arch Intern Med.* 2010; 170:1383–1389.

130 Penaloza A, Verschuren F, Meyer G, et al. Comparison of the unstructured clinician gestalt, the wells score, and the revised Geneva score to estimate pretest probability for suspected pulmonary embolism. *Ann Emerg Med.* 2013;62:117–124. e2.

131 Zondag W, Kooiman J, Klok FA, et al. Outpatient versus inpatient treatment in patients with pulmonary embolism: a meta-analysis. *Eur Respir J.* 2013;42: 134–144.

132 Laporte S, Mismetti P, Decousus H, et al. Clinical predictors for fatal pulmonary embolism in 15,520 patients with venous thromboembolism: findings from the Registro Informatizado de la Enfermedad TromboEmbolica venosa (RIETE) Registry. *Circulation.* 2008;117:1711–1716.

133 Jimenez D, Aujesky D, Yusen RD. Risk stratification of normotensive patients with acute symptomatic pulmonary embolism. *Br J Haematol.* 2010;151: 415–424.

134 Engel HJ, Needham DM, Morris PE, Gropper MA. ICU early mobilization: from recommendation to implementation at three medical centers. *Crit Care Med.* 2013;41(9 suppl 1):S69–S80.

135 Tapp H, Phillips SE, Waxman D, et al. Multidisciplinary team approach to improved chronic care management for diabetic patients in an urban safety net ambulatory care clinic. *J Am Board Fam Med.* 2012;25:245–246.

136 Carr ECJ, Brockbank K, Barrett RF. Improving pain management through interprofessional education: evaluation of a pilot project. *Learning in Health & Social Care.* 2003;2:6–17.

137 Ageno W, Garcia D, Aguilar MI, et al. Prevention and treatment of bleeding complications in patients receiving vitamin K antagonists, part 2: treatment. *Am J Hematol.* 2009;84:584–588.

138 Shamian B, Chamberlain RS. The role for prophylaxis inferior vena cava filters in patients undergoing bariatric surgery: replacing anecdote with evidence. *Am Surg.* 2012;78:1349–1361.

139 Duffett LD, Gandara E, Cheung A, et al. Outcomes of patients requiring insertion of an inferior vena cava filter: a retrospective observational study. *Blood Coagul Fibrinolysis.* 2014;25:266–271.