



Prevention of Deep Vein Thrombosis and Pulmonary Embolism

Samuel Z. Goldhaber, MD; John Fanikos, RPh, MBA



Venous thromboembolism comprises deep vein thrombosis (DVT) and pulmonary embolism (PE) and strikes more than 1 in 1000 adults per year, causing discomfort, suffering, and occasionally death. DVT is defined as blood clots in the pelvic, leg, or major upper-extremity veins. These clots can break off from the veins, travel through the heart, and lodge in the lung arteries, causing potentially deadly PE. Although about 300 000 new cases are diagnosed yearly in the United States, probably 3 to 4 times as many cases occur without obvious symptoms and are never detected. This illness is often “silent” and can mimic other common conditions such as heart attack, pneumonia, and anxiety. Its aftermath spans a wide spectrum, from inconsequential to fatal.

Awareness of DVT and PE is the best way to prevent this condition. Medical professionals have recognized DVT for almost 2 centuries, but until recently, only about half of Americans were informed about the disease. Without knowledge of DVT as a medical problem, the public could not engage healthcare providers to discuss lifestyle changes and more intensive

measures that usually succeed in preventing this illness. Historically, many prominent public figures have been afflicted with DVT but received little attention. However, several tragic cases of fatal PE received widespread media coverage. In 2000, a 28-year-old woman who had been a spectator at the Sydney Olympics collapsed and died of PE after deplaning in London. In 2003, a renowned reporter who was embedded with a US infantry unit during the Second Gulf War complained of leg discomfort for several days and then died suddenly of PE. These events, coupled with a recent public awareness campaign, “Killer Legs,” have raised unprecedented interest in this previously overlooked but common condition.

DVT and PE were the topics of a previous Cardiology Patient Page in *Circulation*.¹ Treatment of this illness was described in a separate Cardiology Patient Page.² However, prevention is the best policy to combat DVT and PE. Although preventing venous thromboembolism is more mundane and less glamorous than treatment of DVT, it remains more effective than waiting for a DVT to develop, performing complex diagnostic tests, and then

treating a newly established blood clot. Strategies for prevention of DVT (Tables 1 and 2) are discussed below.

DVT Prevention Strategies

Lifestyle Changes

The most common lifestyle risk factors for venous thromboembolism are the same problems that plague our Western society: obesity, inactivity, and cigarette smoking. Nevertheless, most inquiries about DVT prevention come from patients about to embark on long-haul air travel. Despite the drama of collapse and death from PE while in flight or after disembarking, the chance of this happening is only about 1 in 1 000 000 travelers.

Mechanical Measures

For many patients at low risk of DVT, graduated elastic compression stockings will suffice. Vascular compression stockings usually lose their elasticity after about 3 months and should be replaced to maintain their effectiveness. Pneumatic compression boots are not practical unless the patient is hospitalized or homebound.

Pharmacological Options

A recent survey of 183 US hospitals showed that prophylaxis remains un-

From the Cardiovascular Division, Department of Medicine (S.Z.G.), and Department of Pharmacy (J.F.), Brigham and Women’s Hospital, Harvard Medical School, Boston, Mass.

Correspondence to Samuel Z. Goldhaber, MD, Cardiovascular Division, Brigham and Women’s Hospital, 75 Francis St, Boston, MA 02115. E-mail sgoldhaber@partners.org

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TABLE 1. Methods for Preventing DVT and PE

I. Lifestyle modifications
A. Avoid obesity and inactivity
i. Nutrition without excess calories
ii. Exercise
1. Daily aerobic such as walking
2. Anaerobic activity useful for muscle toning
a. Heavy weightlifting may traumatize muscles
b. Anaerobic does not substitute for aerobic
B. Avoid dehydration
i. Drink water
ii. Minimize alcohol consumption
C. Avoid cigarette smoking
i. Quit smoking
1. Willpower is best
2. Nicotine patch, gum, nasal spray
3. Bupropion (Wellbutrin [GlaxoSmithKline])
D. Maintain normal blood pressure
i. Note some guidelines define normal as <120/80 mm Hg rather than <140/90 mm Hg
ii. If lifestyle changes do not reduce blood pressure, use medication
II. Mechanical measures
A. Vascular compression stockings
i. 10 to 18 mm Hg if immobilized or in bed; otherwise, use higher compression levels
ii. 20 to 30 mm Hg below-knee stockings if no varicose veins, swelling, or skin pigmentation changes
iii. 30 to 40 mm Hg below-knee stockings if leg exam has evidence of prior venous disease
B. Intermittent pneumatic compression boots
i. Ideal for immobilized patients, either in hospital, skilled nursing facility, or at home
ii. Device is better tolerated when combined with 10- to 18-mm Hg vascular compression stockings
iii. Some devices have “cooling buttons” to enhance comfort
III. Pharmacological measures
A. Injectable medications
i. Low-molecular-weight heparin
1. Enoxaparin 40 mg daily
2. Dalteparin 5000 Units daily
ii. Unfractionated heparin 5000 Units every 8 hours
iii. Fondaparinux 2.5 mg daily
B. Oral medication
i. Warfarin
C. Baby aspirin 81 mg daily
i. Provides more protection against heart attack and stroke than against DVT
ii. DVT prevention effect is weak
IV. Combined mechanical and pharmacological measures

derutilized, especially among hospitalized patients with medical illnesses. For patients at medium or high risk of DVT, once-daily self-injection of a low fixed dose of low-molecular-weight heparin or fondaparinux is ef-

fective and safe. Proper injection technique requires administration into fat tissue, not muscle, and avoiding the area surrounding the belly button. Patients should “pinch an inch” of fat before injection and avoid rubbing the

site with alcohol swabs after the injection. The Figure illustrates proper step-by-step technique.

Oral anticoagulation with warfarin to prevent DVT is utilized primarily in patients undergoing orthopedic surgery. Warfarin requires meticulous management and close collaboration between the patient and healthcare provider. Warfarin is administered once daily. It is not given in a fixed dose. Instead, the dose of warfarin varies and must be tailored to remain within a target range with the use of a blood test, the International Normalized Ratio. Warfarin therapy is complicated by multiple drug–drug and drug–food interactions that affect the dosing level, but most often, the dose of warfarin changes for no apparent reason. Fortunately, anticoagulation clinics have evolved to provide patients with expert dosing of this blood thinner. One baby aspirin daily for patients not on anticoagulants is sometimes recommended as prophylaxis against DVT. However, aspirin alone, although quite effective for reducing the risk of heart attack or stroke, is not very useful for preventing DVT.

Combined Mechanical Plus Pharmacological Approaches

Combining vascular compression stockings with low-dose heparin is an effective strategy for patients at high or very high risk of venous thromboembolism. An example is the combination of 10- to 18-mm Hg graduated compression stockings, pneumatic compression boots, and heparin 5000 U every 8 hours in patients undergoing high-risk surgeries.

Why Are Some Anticoagulants Administered Orally Whereas Others Require Injection?

Unfractionated heparin and low-molecular-weight heparin are made from sugars. Like most sugars, when given orally, they are digested by stomach acid and no longer maintain their anticoagulant properties. These drugs are only



Proper injection technique for low-molecular-weight heparin or fondaparinux. Top row, left: Select injection site and swab with rubbing alcohol. Top row, right: "Pinch an inch" of the belly, forming a skin-fold. Avoid the belly button area. Center row, left: While pinching, insert needle at a 90° angle directly into the skin. Center row, right: Push syringe plunger down, injecting drug into the skin. Bottom row, left: Release skin-fold and pull back syringe. Bottom row, right: Dispose of syringe in coffee can or "sharps" container.

effective when given by injection. Oral heparin is under development.

What Should We Do If Preventive Efforts Fail?

The failure rate is low, less than 10%. Nevertheless, if preventive efforts do not succeed, effective therapy exists to manage successfully most cases of DVT and PE. The cornerstone of ther-

apy after failed prophylaxis is intensive anticoagulation, administered in doses higher than those used for prevention.

How Can I Start Preparing My Individualized Prevention Strategy?

We encourage our patients to collaborate with us to optimize prophylaxis

TABLE 2. How to Design a Personal Prevention Strategy

- I. Determine risk of developing DVT: outpatient setting
 - A. Is there a prior history of DVT or PE?
 - B. Is there a family history of DVT or PE?
 - C. Are there poorly controlled lifestyle factors?
 - i. Obesity
 - ii. Lack of exercise
 - iii. Cigarette smoking
 - iv. Hypertension
 - D. Is long-haul air travel planned?
- II. Determine the risk of developing DVT: inpatient setting
 - A. Is major elective surgery planned, such as cardiac, thoracic, or orthopedic surgery?
 - B. Has major trauma occurred?
 - C. Is oral contraception, pregnancy, or postmenopausal hormonal therapy a factor?
 - D. Has cancer developed or is cancer chemotherapy under way?
 - E. Has hospitalization occurred for medical illnesses such as congestive heart failure or pneumonia?
- III. Match risk of DVT with intensity of prophylaxis
 - A. Discuss with healthcare provider what preventive measures are appropriate for a given level of risk
 - B. Be proactive; consider obtaining additional reliable information at web sites such as www.clotcare.com and joining the Coalition to Prevent Deep-Vein Thrombosis (www.preventdvt.org)

against DVT. Your healthcare provider can discuss your risk level with you and help you develop an appropriate level of preventive effort.

References

1. Goldhaber SZ, Morrison RB. Pulmonary embolism and deep vein thrombosis. *Circulation*. 2002;106:1436–1438.
2. Goldhaber SZ, Grasso-Correnti N. Treatment of blood clots. *Circulation*. 2002; 106:e138–e140.