CHAPTER **44**

RATES AND RISKS OF THROMBOEMBOLISM IN FOOT AND ANKLE SURGERIES: A Retrospective Study of Ten Years Data Collected Based on ICD-9 Diagnosis and Procedure Codes From Two Southern California Hospitals

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INTRODUCTION

Deep vein thrombosis (DVT) is formation of a thrombus in deep veins of the body. Deep vein thromboses are of interest to the podiatrist because they can have devastating outcomes. Patients presenting with symptoms of a DVT are considered high-risk patients because of the sequelae that may follow. The rationale for thrombo prophylaxis is based on the high prevalence of venous thromboembolism (VTE) among hospitalized patients, the clinically silent nature of the disease in the majority of patients, the morbidity, the costs, and the potential mortality associated with unprevented thrombi.[1]

Even without pulmonary embolism (PE), DVT may have significant impact on the future health status of patients. Sequela may include sudden death as well as post-thrombotic syndrome (PTS), which is a chronic condition characterized by venous insufficiency, edema, pain, hyperpigmentation, and skin ulceration, and may be indistinguishable from recurrent DVT.[1-3] This can occur in as many as 60 to 70% of patients.[2,3] Patients may remain at increased risk of recurrent DVT and this risk can threaten clinical, functional, and financial outcomes. More localized effects of DVT are damage to surrounding valves and superficial veins due to the venous hypertension, valvular injury, and the damage caused by prolonged edema.[4,5] The most important of these is when an embolus breaks off from a thrombus, which can lodge in a lung and give rise to PE.[4-6]

Complications related to DVT kill more people every year than AIDS, breast cancer, and highway fatalities combined.[7-11] DVT and the possibility of subsequent PE have been well documented as being potential life-threatening complications following any surgery.[4,6,7,12-14] The incidence of DVT ranges from 60-180 cases per 100,000 people annually. Approximately 2 million Americans develop DVT each year and between 300,000 and 600,000 of these people subsequently develop symptomatic PE.[1] PE is a leading cause of death in hospitalized patients and almost 10% of all acute PE patients die within 60 minutes of the incident.[5,12] It is estimated that a fatal PE occurs in 2.5 to 7.7% of hospitalized patients with an acute diagnosis of PE.[5,15] Approximately 50,000-100,000 deaths occur each year as a consequence of PE.[6,12-14]

MATERIALS AND METHODS

Institutional review board permission was obtained to review patient records, with respect to patient confidentiality regulation, from 2 Southern California hospitals in San Diego County. The ICD-M9 (International Classification of Diseases, Ninth Revision, Clinical Modification codes) diagnosis of DVT and PE were extracted from the entire pool of patients who were admitted to these hospitals (1997-2006 for the first hospital, and 2003-2006 for the second hospital) with a discharge diagnosis of DVT and/or PE including variations in location (Table 1). The ICD-9 codes for DVT included phlebitis and thrombophlebitis of deep veins of lower extremities. The first hospital is a center city,

Table 1
DVT AND PE DIAGNOSIS USED IN THIS STUDY

ICD-9	Description
415.1	Pulmonary embolism
415.11	Iatrogenic pulmonary embolism
415.19	Pulmonary embolism, Other
451.1	Deep vessels of lower extremities
451.11	Deep vein thrombosis, femoral
451.19	Deep vein thrombosis, other leg veins
451.2	Phlebitis of lower extremities, unspecified
451.81	Phlebitis of iliac vein

trauma level one type hospital and the second hospital is a well economically situated hospital with a small urgent care facility.

The collected diagnostic tests for the DVT and the PE where checked against all the foot and ankle ICD-9 procedure codes that had been performed in these hospitals (Table 2). The diagnosis of DVT and PE were counted only if they existed at the time of hospitalization, and if the patient had a foot and or ankle procedure. This meant that the findings were clinically and radiographically significant and the medical or surgical attending physicians were able to diagnose the DVT and PE. Between the 2 hospitals, the foot and ankle ICD-9 procedure codes were the same and thus the data were processed together.

Patients were admitted to these hospitals for a variety of reasons including infection of the foot or ankle, fractures, trauma, and reconstructive and routine foot and ankle surgeries. Patients were admitted through a variety of routes including emergency room visits or through direct admission for a simple or complex foot or ankle reconstruction. Patients were hospitalized for perioperative management. Also, data were recorded up to 3 months later if the same patient was treated for VTE after a previous foot or ankle procedure. Up to 10 years of computerized data was available from the first hospital and up to 3 years from the second hospital.

Comorbidities of diagnosed DVT and PE patients were reviewed, and if the comorbidity was repeated more than twice, it was then included (Table 3). These comorbidities were very similar to previous studies, but our data also included human immunodeficiency syndrome as another significant comorbidity. The data from radiology departments that could possibly increase the collected data due to repeated diagnosis of VTE of the same patient and consequently increase the rate of VTE, were excluded.

Table 2

ICD-9 PROCEDURE CODES USED IN FOOT AND ANKLE CASES

77.08-77.88	Incision, excision, & division of other bones
78.18-78.98	Other operation on bones, except fascial bones
79.06-79.88	Reduction of fracture & dislocation
80.07-80.48	Incision & excision of joint structure
81.11-81.98	Repair and plastic operation on joint structure
83.02-83.62	Operation on muscle, tendon, fascia, & bursa, except hand
84.11-84.35	Other procedures on musculoskeletal system

RESULTS

A total of 317,936 patients visited these 2 hospitals; and 5,409 patients were treated for a diagnosis of VTE including DVT, PE, and/or both diagnoses. Of 317,936 who visited these hospitals 4,617 patients had undergone a foot and/or ankle procedure. Of the 4,617 foot and ankle cases, 109 patients had a diagnosis of DVT, PE, and/or both. This number included either the same hospital visit or if the patient returned for VTE diagnosis up to 3 months later (Tables 4,5).

The data from the first hospital were collected annually, which helped us to analyze the variation of occurrence during a period of 10 years. The number of patients who visited the hospital remained the same from 1997-2006 without significant changes (Figure 1); but the number of patients who were diagnosed with VTE increased almost every year from 198 in 1997 to 500 in 2006. This showed an increase of approximately 153% in a 10-year period (Figure 2). This finding was also true during the years for the number of patients diagnosed with DVT and or PE who had a foot or ankle condition. Although the number of foot and ankle procedures done in the first hospital gradually increased (from 284 in 1997 to 411 in 2006) (Figure 3), this increase was not as significant as the increase in number of diagnosed VTEs.

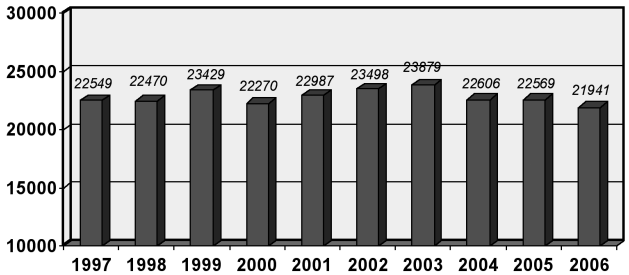

Figure 1. Number of Patients Admitted From 1997 to 2006.

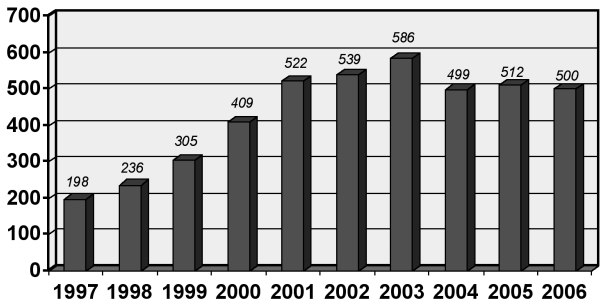

Figure 2. Total Number of Patients with DVT and PE.

Table 3

EXISTING COMORBIDITIES WITH DVT AND PE DURING PATIENT'S HOSPITALIZATION

Cellulitis of Foot and or other parts of body, Superficial and Deep Infection/Abscess	Tobacco Use Osteomyelitis
Atrial Fibrillation/ Mitral Valve Disorder	Atherosclerosis
Hypertension	Nephritis
Congestive Obstructive Pulmonary Disease	Urinary Tract Infection
Sleep Apnea	Diabetes (Type I and II)
Malignancy (demonstrating immobilization)	Decubitus Ulcer Lower Back
Methicillin resistant Staphylococcus Aureus	Malnutrition
Pseudomonas Infection	Multiple Sclerosis
Anemia	Malnutrition/Dehydration
Human Immunodeficiency Virus (within one year of HAART treatment)	Gangrene distal to ankle
Candidiasis infection	Chronic Bronchitis
Angina Pectoris	Mitral valve disorder
Oral Contraceptives (Estrogen) In cast or splint	Long term hospital Stay/immobilized
Generally age above 40 years old	Obesity (BMI > 30)
History of Vascular Surgery/History of DVT or PE	Lengthy procedures/prolonged tourniquet

Table 4

DATA FROM THE FIRST HOSPITAL.

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
In-pts admitted	22,549	22,470	23,429	22,270	22,987	23,498	23,879	22,606	22,569	21,941	228,198
In-pts with DVT/ PE (on admission and after admission)	198	236	305	409	522	539	586	499	512	500	4,306
Total Foot & Ankle procedures	284	269	284	261	320	347	353	324	340	411	3,193
In-pts with DVT (on admission and after admission)	161	203	281	383	469	489	538	429	491	467	3,911
In-pts with PE (on admission and after admission)	31	60	56	74	115	116	132	126	117	128	955
In-pts with Foot & Ankle procedures had DVT/PE (on admission and after admission)	0	4	3	7	12	9	16	17	9	19	96

Table 5

DATA FROM THE SECOND HOSPITAL

Year	From July 2003 to December 2006
Number of Patients Admitted	89,738
Total Number Patients with VTE (DVT/PE)	1103
Total Number of Foot & Ankle Procedures	1425 (2170 procedures)
Number of Patients with VTE (Foot & Ankle)	13

In between the years 1997 to 2006, DVT cases increased from 0-19.

Analysis of data from the first hospital demonstrated a VTE rate of 3.01% in patients with foot and ankle cases (Table 6). Analysis of data from the second hospital, however, demonstrated a lower VTE rate for patients who had foot or ankle procedures. The rate for VTE in this hospital for a period of 3 years was 0.91% (Table 7).

The rate of DVT in foot and ankle surgeries was 2.63% for the first hospital and 0.77% for the second hospital. The general rate of VTE for the first hospital was 1.89% and 1.23% for the second hospital. The PE rate for the first hospital number was 0.4% and 0.17% for the second hospital. Despite the fact that the DVT rate has been rising, the rate of PE stayed the same during the 10-year study period. To have a better understanding of this information from hospital number one, Figure 5 will provide a side-by-side comparison of the collected data.

Signs and Symptoms

Clinical presentations of DVT are typically unilateral inflammation with redness, warmth, and indurated edema (Figure 6).[16] It also includes leg pain, swelling, prominent superficial veins, discoloration (cyanosis), tenderness, and the presence of a palpable cord (thrombosed vein).[3] Pain and discomfort may be present depending on the severity of the occlusion. Peripheral edema >2 centimeters in comparison with the opposite leg is another nonspecific symptom.[16] Homan's sign is 50% accurate for DVT, and is characterized by discomfort in the upper calf with dorsiflexion of the foot, which mainly is noted in iliofemoral occlusions.[17] Symptoms are often nonspecific, and as many as 50% of patients with VTE may present without any objective findings at the bedside. Only

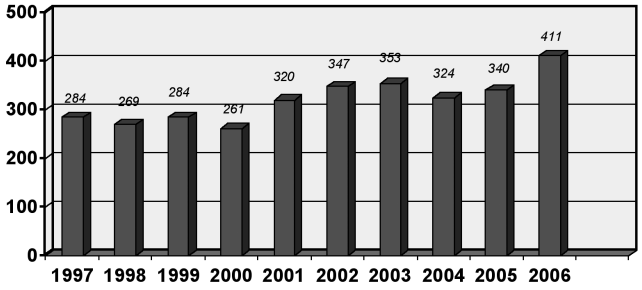

Figure 3. Total Number of Patients with Foot and Ankle Procedures.

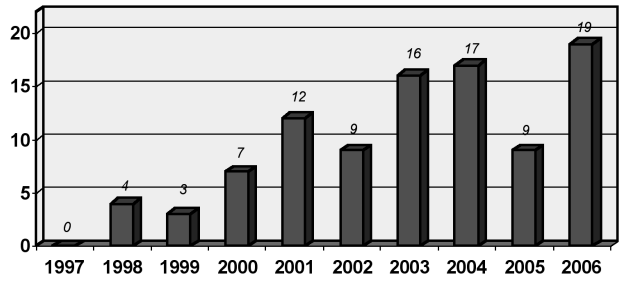

Figure 4. Patients with DVT/PE in Foot and Ankle Cases.

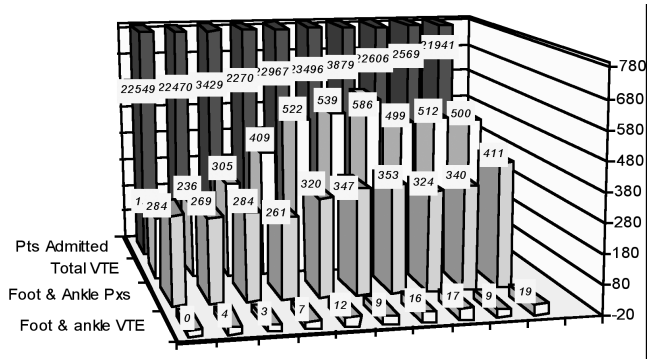

Figure 5. A Comparison of Data from Hospital #1.

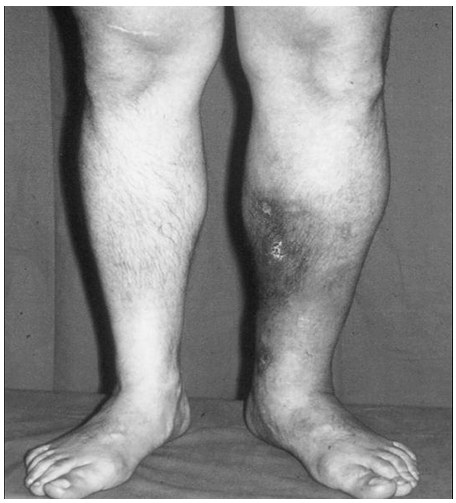

Figure 6. Deep vein thrombosis with phlebitis in the leg. Note the swelling and discoloration of the left leg.

Table 6

ANALYSIS OF DATA FROM THE FIRST HOSPITAL

# Pts Admitted	228,198	# F&A (In-Pts)	3193
# Pts with VTE	4306	# Pts c VTE	96
# Pts with DVT	3911	# Pts with DVT	84
# Pts with PE	955	# Pts with PE	12
Total Rate of DVT	1.71%	Rate of DVT	2.63%
Total Rate of PE	0.42%	Rate of PE	0.4%
Total Rate of VTE	1.89%	Rate of VTE	3.01%

one-third of the patients usually show the classic symptoms.[3] DVT could clinically be silent and may be hard to diagnose.[16] The first manifestation of DVT may be a fatal PE.[11] Patients with iliofemoral DVT tend to have marked pain and swelling and 50% experience pulmonary emboli.[18,19]

Symptoms of PE are divided in 2 categories: pulmonary infarction and right ventricular infarction.[1] Pulmonary infarction symptoms include pleuritic chest pain, hemoptysis, pleural friction rub, rale, loss of resonance at lung base, and a feeling of "impending doom." Chest radiographs can sometimes indicate a PE. Symptoms concomitant with right ventricular failure include diaphoresis, faintness, drop in blood pressure, increased jugular vein pressure, chest pain, shortness of breath, a feeling of "impending doom," and an abnormal EKG.[15]

Table 7

ANALYSIS OF DATA FROM THE SECOND HOSPITAL

# Pts Admitted	89,738	# F&A (In-Pts)	1425
# Pts with VTE	1103	# Pts c VTE	13
Total Rate of VTE	1.23%	# Pts with DVT	11
# Pts with PE		# Pts with PE	2
		Rate of DVT	0.77%
		Rate of PE	0.14%
		Rate of VTE	91%

Diagnosis

Clinical assessment is not always successful in the diagnosis of VTE. DVT screening could be performed by Duplex Ultrasonography, D-Dimer, fibrinogen leg scanning, magnetic resonance imaging or computed tomography (CT), plethysmography, or venography. However, these methods do not provide a final answer.[20-22] Venography is the gold standard in the detection of DVT, but it is invasive, time-consuming, and requires considerable operator experience to interpret adequately.[21] The clinical findings do not always match the venography. The rate of non-diagnostic studies in venography is significant.[21] Consequently, the current standard of care is ultrasound; the sensitivity and specificity of Doppler ultrasound in detecting DVT in the lower extremities is >95%, but its sensitivity in asymptomatic patients is poor (Table 8).[23] In patients in whom sonographic correlation is available, CT venography has a sensitivity of 97% and a specificity of 100% for femoropopliteal deep venous thrombosis.[24] The D-Dimer study is a very sensitive test; however, it is not very specific. Other conditions such as infection, surgery, or malignancy could also produce positive results in a D-Dimer study.[21]

The pathophysiology of DVT, described by Rudolf Virchow in 1851, is characterized by the classic triad of endothelial injury, stasis of blood flow, and hypercoagulable states.[2] This triad can act independently or simultaneously to form thromboembolism. Roughened vessel surfaces associated with surgery or even atherosclerosis can lead to thrombus formation. Damaged endothelium may be caused by direct trauma, infections of surrounding soft tissue, intravenous catheters or prolonged use of them. The trauma exposes subendothelial tissue, which releases platelet activating factors, initiating coagulation cascade, resulting in platelet adhesion to the wall and the beginning of thrombus formation.[25] Normal vessel lining releases prostacyclin, a chemical that profoundly inhibits platelet aggregation. Thus, the platelet plug is limited to the defect and does not spread to normal vascular tissue. However occasionally, clots can form in intact vessels.[1] Imbalances in the clotting-anticlotting

Table 8

DVT SCREENING METHODS

DVT Screening Methods	Drawbacks
Fibrinogen leg scanning (FUT)	Lacks specificity and sensitivity
Duplex ultrasonography	Poor sensitivity in asymptomatic patients
D-Dimer	Lack of Specificity
Venography	Significant rate of non diagnostic studies; clinical relevance of many of the thrombi detected is questionable, Invasive, Time consuming
CT Venography	Good sensitivity and specificity
Doppler Ultra Sonography	Sensitivity and specificity > 95% But low sensitivity in asymptomatic patients

system can likewise trigger clot formation. Hypercoagulability of blood may be caused by hematologic conditions such as anemia, polycythemia vera, infectious disease such as typhoid and pneumonia, complications due to nephrotic disease, or hypercoagulable drugs and oral contraceptives.[26] Slow-moving blood is more apt to clot, probably because small quantities of fibrin are formed and allowed to accumulate in the stagnant blood (Figure 6). Blood stasis in the veins interferes with nutrition to the endothelial lining, rendering the wall susceptible to small thrombus formation.[25] Causes of venous stasis are immobilization or inactivity, typically following a stay in hospital, a long airplane flight, application of a cast, blood pooled in varicosed leg veins, or caused by poor deep venous muscle pump from a nonpropulsive gait. Stasis may also be caused by sluggish or impaired venous return to the heart following cardiovascular accident, congestive heart failure, myocardial infarct, and valvular incompetence.[27] Wide-spread clotting is occasionally triggered by the release of tissue thromboplastin into the blood from large amounts of traumatized tissue, and during surgery.

Based on the above explanation we can conclude that chemotherapy for malignancy, severe infection, atherosclerosis as a sequela of diabetes and hyperlipidemia, coronary artery disease, venous catheters, or intravenous medicine that could damage the endothelial surface of vessels, are all comorbidities for formation of a venous thrombus.

Risk assessment

To assure patient's safety, a complete history and physical should be performed. The patient's comorbidities and the number of risk factors should be recognized. Preoperative planning as well as postoperative prophylactic treatment should be considered if necessary. Risk factors for thromboembolic events vary for each patient.[1,23] Virchow considered immobilization as one of the main risk factors for a thromboembolic event.[1] Medical conditions such as stroke, myocardial infarction, malignancy, and systemic infections are some of the risk factors that predispose the patients to a thrombotic event. Major general and orthopedic surgeries such as a total knee arthroplasty or hip replacement are the main iatrogenic cause of DVT and PE postoperatively.[4,13]

Several general risk factors are common to all orthopedic procedures and thus applicable to ankle and foot surgeries. Patients with predisposing thrombotic abnormalities are extensively at risk for a thromboembolic event. However, until the patient has experienced such an event, these abnormalities are hidden. This emphasizes the importance of the family history of thrombotic events.[12] Individuals 40 years or older have an increased incidence of DVT,[28] and the odds increase approximately 0.05 times per year of age.[29,30] Some of the additional risk factors for thromboembolic events that should be considered are prior history of DVT/PE, associated cardiac and neurologic disease, sepsis, presence of a femoral venous catheter, hormonal therapy, pregnancy and post-partum state, and obesity.[12,31] Family history of thrombosis[28] immobilization,[32] lengthened hospital stay,[30] stroke,[33] cancer,[34] lengthy surgical procedures,[29] delay before fracture fixation,[29] air travel,[35,36] cigarette smoking, and certain types of hormonal contraception[28] are all other risk factors for thromboembolism.

In our study, patients with human immunodeficiency virus (HIV) under treatment did have an increase in risk of VTE. However, more study is needed to determine whether HIV alone could be the cause of DVT or is it just an additional risk factor. In retrospect, it is unclear which, if any, of these has an actual role in the development of PE for each patient. Nonetheless, a careful search of risk factors in these patients prior to surgery may be useful for ascertaining DVT potential.

Bone marrow and fat embolism are other causes of DVT and PE in patients with trauma and multiple fractures of long bones. Movement of nonstabilized fractures can increase the intramedullary pressure and would create phenomenon such as Snow-flurry and configured emboli. Snow-flurries are small amounts of bone marrow that are released into the circulation in unstable fractures of long bone, or during intramedullary reaming process for fixation of these fractures.

Intramedullary reaming of long bones such as tibia and femur can increase the intramedullary pressure up to 200-600 mm Hg, and can create configured embol that consist of a core of bone marrow surrounded by thrombotic aggregate.[37] Table 9 reviews these risks factors with their possible risk of occurrence in surgical scenarios.[1]

Numbers of risk factors in an individual are a good predictor to assess a patient's risk of a thrombotic event and to plan postoperative anticoagulation therapy. Table 10 shows the rate of DVT in patients with multifactorial risk factors having major general or major orthopedic surgeries. The greater the number of risk factors, the greater the threat.[1,38-40]

The Caprini Thrombosis Risk Factor Assessment for Surgical Patients (Table 11) provides each patient with a total risk factor score based on points assigned to a variety of risk factors within 24 hours of surgery.[41] Caprini categorizes patients as low, moderate, or high risk based on the number of risk factors, and also recommend a prophylactic regimen accordingly. Muntz et al, based on Caprini's table, designed a slightly different risk assessment category and added a very high risk array of patients for preoperative consideration of VTE prophylaxis (Table 12).

Prophylaxis and Treatment

Routine screening has not been demonstrated to reduce the frequency of clinically important outcomes, such as symptomatic VTE or fatal PE. Broad application of effective methods of prophylaxis has been more cost-effective and is probably safer than selective, intensive surveillance.[1] Despite recent advances in noninvasive imaging that have increased the detection of DVT, management of the disorder remains a clinical challenge for physicians.[13] Traditional treatment regimens including anticoagulation, venous compression stockings, and leg elevation often are insufficient for patients with significant pain and swelling from extensive venous thrombosis. Recent breakthroughs in minimally invasive interventional radiology techniques, however, are improving the prognosis of DVT. These therapies can rapidly reduce limb swelling, restore blood flow through the vein, and potentially reduce the long-term complication of post-thrombotic syndrome, particularly when therapy is initiated within 7 to 10 days of onset of symptoms.[13]

The rationale for anticoagulation is to prevent thrombus propagation, decrease the risk of recurrent DVT, and prevent PE. Traditional treatment protocols include continuous intravenous unfractionated heparin combined with long-term oral warfarin sodium.[1] The optimal duration of anticoagulation therapy remains in question, but for patients with a first episode of VTE or PE, 3 to 6 months of warfarin treatment is generally recommended.[23] Recently introduced injectable low-molecular weight heparinoid (enoxaparin, Fragmin) are currently indicated for prevention of DVT and soon will be available for treating documented VTE.[10,23] Low-molecular weight heparins potentially provide significant cost-savings since patients do not require laboratory testing for PTT and may not require hospitalization. Unfortunately, anticoagulation has not reduced the incidence or severity of the post-thrombotic syndrome.[7,8]

Choosing effective methods for DVT prophylaxis are as important as proper diagnosis and treatment. Multiple modalities including mechanical and chemical treatments are suggested in the literature. Mechanical prophylaxis methods such as elastic stockings and intermittent pneumatic compression may be appropriate in cases of low to moderate risk.[1] Caution should be used when interpreting risk reductions from mechanical methods. There are no study trials that could blind the mechanical devices and results may be biased. Also poor patient compliance is associated with all mechanical methods.[1]

Prospective data from several clinical trials of various low-molecular-weight heparins indicate that prophylaxis may decrease the incidence of DVT in patients who are immobilized with plaster casts or braces for lower extremity fractures.[42] For the population with high to very high risk comorbidities, administration of warfarin perioperatively, with the aim of a maintaining a target international normalized ratio of 2.0-3.0 for 3 to 4 weeks is recommended. This regimen could be followed with a 7 to 10 day postoperative course of either enoxaparin 40 mg subcutaneously once daily or dalteparin 5000 IU subcutaneously daily. Therapy could continue if there is a history of DVT or PE, or when the patient requires continued immobility.[40]

Low-molecular-weight heparin (LMWH) and low-dose unfractionated heparin (LDUH) have been proven to be most effective.[1] These have been the most completely studied antithrombotic agents. LMWH is less likely to cause heparin-induced thrombocytopenia and thrombosis. Unlike LDUH, LMWH provides a predictable anticoagulant effect that could provide a perioperative prophylaxis option.[1,5,13] Combining elastic stockings with other pharmacological agents may give a better protection against DVT than either approach alone.[1] A 2% risk of DVT was found when LMWH, intraoperative intermittent pneumatic compression, and elastic stockings were combined.[1]

Table 13 shows some of the suggested regimens for prophylaxis in each risk category based on literature reviews.[40,43] These data are based on multiple orthopedic and podiatric literature and could be used in foot and ankle procedures.[40-44]

Table 9

RISK FACTORS THAT MAY WARRANT ROUTINE PROPHYLAXIS

Venous Thromboembolism Risk Stratification

Medical Conditions:

Stroke with paralysis
MI/CHF/Mitral valve prolapse
COPD
Cancer and chemotherapy
Nephrotic syndrome
Atherosclerosis
Diabetes
Lipoprotein (a)
Polycythemia
Hyperviscosity Syndrome
Leukostasis Syndrome
Leg swelling, Ulcer, Stasis, Varicose veins
Shock/Dehydration
Pneumonia
Inflammatory bowel disease
Systemic lupus
Acute arthritis or rheumatoid arthritis of the legs
Acute rheumatic disorders
Infections/sepsis
Hypertension
LDL Cholesterol
Hypertriglyceridemia
History of DVT/PE/Family History
Left Ventricular Failure
Obesity
HIV (on HAART)

Major Surgery/Injury:

General (% with DVT = 25%)
[including elective GI and splenectomy]
Gynecological (% with DVT = up to 38%)
Urological
Neurosurgery (% with DVT = 20%-30%)
Acute spinal injury (% with DVT = 67%-100%)
Burns (% with DVT = up to 53%)

Orthopedic Surgery/Trauma:

Hip (% with DVT = up to 60%)
Knee (% with DVT = up to 80%)
Hip fracture surgery
(% with DVT = up to 60%)
Spinal surgery
Isolated lower extremity fractures
(% with DVT = up to 45%)
Trauma (% with DVT = may exceed 50%)
Intramedullary reaming

Thrombotic Abnormalities:

Activated protein C resistance (factor V Leiden)
Factor II Prothrombin variant 20210A
Antiphospholipid antibodies
Lupus anticoagulant/anticardiolipin antibody
Deficiency or dysfunction of antithrombin,
protein C or S, or heparin cofactor II
Dysfibrinogenemia
Decreased levels of plasminogen and plasminogen activators
Increase levels of factor XI
Increase levels of factor VII
Hyper homocystinemia
Polycythemia or primary thrombocytosis
Hyper viscosity syndrome

Additional Risk Factors:

Malignancy
Immobility/Plaster cast
Increasing age (>40)
Indwelling venous line
Pregnancy
Estrogen replacement therapy/Oral Contraceptive
Chemotherapy
Cigarette Smoking
Anesthesia > 2 hrs
Use of tourniquet

Limitations of Anticoagulation Therapy

Contrary to popular belief, heparin and warfarin therapy do not actively dissolve thrombus.[4,19] Veins have a limited capacity to break down a clot naturally, and in patients with symptomatic DVT, anticoagulation alone cannot remove the offending thrombus, reduce limb swelling, or alleviate pain. With extensive DVT involving the larger veins in the thigh and pelvis, the inherent thrombolytic process is overwhelmed and the patency and function of the involved veins rarely return to their normal state.[4-6,13,19] Spontaneous thrombolysis of DVT after anticoagulation therapy will occur in fewer than 10% of patients and 40% of patients will continue to propagate thrombus despite therapeutic levels of heparin.[4,11] The usual consequence is

Table 10

RATE OF DVT BASED ON THE NUMBER OF RISK FACTORS

No. of Risk Factors	Rate of DVT
0	11%
1	24%
2	36%
3	50%
4 or More	100%

transformation of the clot into fibrous web-like bands within the vein, valvular damage, and/or permanent vein occlusion, and development of symptoms of post-thrombotic syndrome.[6,19]

Contraindication of Anticoagulation Therapy

Prophylactic anticoagulation has its own importance in reducing the risk of VTE, but there are relative and absolute medical conditions that should be considered prior to application of any VTE prophylaxis. These conditions, if not treated prior to the application of prophylactic anticoagulation, could produce devastating outcomes.

Contraindications to anticoagulation therapy are bleeding disorders, history of hemorrhagic stroke, metastatic disease involving the central nervous system, pregnancy or immediate postpartum state, major abdominal or orthopedic surgery, and gastrointestinal bleeding.[23,28] History of cerebral hemorrhage, thrombocytopenia, and intracranial lesions are some of the relative contraindications. Active hemorrhage, warfarin use in pregnancy, and severe head or spinal injuries with hemorrhage are some of the absolute contraindications to anticoagulation therapy (Table 14).[40]

Table 11

RECOMMENDED PROPHYLACTIC STRATEGY BASED ON CAPRINI THROMBOSIS RISK FACTOR ASSESSMENT SCORE

No. of Risk Factors	Risk Category	Recommended Regimen
1	Low	Early ambulation plus compression stockings
2-4	Moderate	Early ambulation plus compression stockings plus SCD and anticoagulant
>4	High	Early ambulation plus compression stockings plus SCD plus LMWH, Heparin, or Warfarin

DISCUSSION

Despite the high risk of VTE in orthopedic surgeries, foot and ankle surgeries are counted among the lowest risk procedures for VTE. The risk of VTE in fractures of the lower extremity has been poorly studied and the risks of DVT and PE following foot and ankle surgery are not established as reports are rare.[44] A study by Clagett et al found that the rate of DVT without prophylaxis is 45-57% in patients who undergo hip replacement and 40-84% in those who undergo knee replacement procedures.[45] The frequency of PE in these patients is also greater, ranging from 3.2- 23% for hip replacement and 2.7- 24% for knee replacement.[34] Kundson et al believes that the rate of VTE in trauma patients is low. They reviewed data of 450,375

Table 12

RISK ASSESSMENT CATEGORY

Low Risk	Moderate Risk	High Risk	Very High Risk
1 or less risk factor	2 risk factors	3 or 4 risk factors	5 or more risk factors
Minor surgery	Major surgery	Major surgery	Major surgery
	Age >40 years	Age >40 years	Age >40 years
	No additional risk factors	Myocardial Infarction	History of venous thromboembolism
		Additional risk factors	Hip Fracture/Total joint procedures of leg
			Stroke/Spinal cord injury/ Visceral malignancy
			Additional risk factors

Table 13

SUGGESTED REGIMENS FOR PROPHYLAXIS IN EACH RISK CATEGORY

LOW RISK (0-1 RISK FACTOR)	MODERATE RISK (2 RISK FACTORS)	HIGH RISK (3-4 RISK FACTORS)	VERY HIGH RISK (5 OR MORE RISK FACTORS)
Early ambulation Or Elastic Stocking. No pharmaceutical treatments needed.	**Inpatient Regimen** SCD +/- Elastic Stocking. EC ASA 325-650 mg po bid (start 1st day post op). Early prophylactic passive exercises in bed and/or weight bearing as indicated.	**Inpatient Regimen** Heparin 5000U SC q8-12h (start 1st day post op).SCD +/- Elastic Stocking. EC ASA 325-650 mg po bid (start 1st day post op).Early prophylactic passive exercises in bed and/ or weight bearing as indicated.	**Inpatient Regimen** Heparin 5000U SC q8h (start pre op or within 12 h post op). Or LMWH SC qd (start pre op or within 12 h post op). SCD +/- Elastic Stocking. Early prophylactic passive exercises in bed and/ or weight bearing as indicated. Or oral anticoagulation (target INR 2.0-3.0)
	If ASA contraindicated: Heparin 5000U SC q12h (start 1st day post op). Early prophylactic passive exercises in bed and/or weight bearing as indicated.	If ASA contraindicated: LMWH SC qd. Early prophylactic passive exercises in bed and/or weight bearing as indicated.	
	Outpatient or upon D/C EC ASA 325-650 mg po bid If ASA contraindicated then continue with Elastic Stocking and early prophylactic passive exercises in bed and/or weight bearing as indicated.	**Outpatient or upon D/C** EC ASA 325-650 mg po bid (start 1st day post op) Heparin or LMWH preop or immediately post op in PACU. Early prophylactic passive exercises in bed and/or weight bearing as indicated. If ASA contraindicated then LMWH beginning 1st day post op and continue with Elastic Stocking and early prophylactic passive exercises in bed and/or weight bearing as indicated.	**Outpatient or upon D/C** LMWH SC qd (start upon D/C). ASA 325-650 mg po bid if possible. Early prophylactic passive exercises in bed and/ or weight bearing as indicated without restriction of ankle motion.
	Duration While in hospital and until 1st post op assessment, then can be extended up to 10-14 days.	**Duration** While in hospital and 7-14 days post op. Then continue prophylaxis based on degree of immobilization. Encourage early passive exercises and/ or weight bearing as indicated.	**Duration** While in hospital and 7-14 days post op. Aggressive prophylaxis should be extended the entire time of immobilization. Encourage early passive range of motion exercises and/or weight bearing as indicated.

Table 14

CONTRAINDICATIONS TO ANTICOAGULATION THERAPY

Relative Contraindications	Absolute Contraindications
- Cerebral hemorrhage at any time previously. - GI, GU, bleed or stroke within past 6 months. - Thrombocytopenia. - Coagulopathy. - Active intracranial lesion/ neoplasm. - Proliferative retinopathy. - Vascular access/biopsy sites inaccessible to hemostatic control.	- Active hemorrhage from wound, drains, lesions. - Heparin use in RITT. - Warfarin use in pregnancy. - Severe trauma to head, spinal cord or extremities with hemorrhage within past 4 weeks.

trauma patients admitted to 131 contributing trauma centers. Of this number, 1,602 had a VTE (998 DVT, 522 PE, 82 both) for an incidence of 0.36%. Ninety-percent of patients with VTE had 1 of the 9 risk factors commonly associated with VTE. Six risk factors found to be independently significant for VTE were age ≥40 years, lower extremity fractures with AIS ≥3, head injury with AIS ≥3, ventilator days >3, venous injury, and major operative procedures.

The number of thromboembolic events following foot and ankle surgery has been found to be considerably lower than that following other types of orthopedic surgery. According to Mizel et al, the frequency of DVT and PE is approximately 0.22% and 0.15%, respectively, in foot and ankle surgery patients.[44] There are no studies that could accurately separate the risk of VTE in foot versus ankle surgeries and even Mizel's study did not distinguish this difference. Assessment of the risks in patients could help in recognizing the need for prophylaxis. However, this does not seem to be always the truth. Hjelmsted et al indicated that 17.1% of patients treated surgically and 38.7% of patients managed conservatively for tibial fractures experienced thrombosis. In this study 11.8% of patients between the ages of 15-24 years experienced thrombosis in the absence of thromboprophylaxis.[46]

In search of risk of DVT in DVT prophylaxed patients versus nontreated patients undergoing knee arthroscopy, Dermer et al showed that there was a 4.9% rate of proximal thrombosis in nontreated patients. Of these, 39.4% of patients were asymptomatic and clinical assessment did not accurately detect DVT. With the exception of tourniquet application for >60 minutes, no other list of risk factors were predictive of DVT.[47] Abelseth et al in a venographic study of 102 patients rated the incidence of DVT in tibial fractures as 22.2% and for the tibial plafond this rate was 12.5%. In this study, 3 factors significantly predicted occurrence of DVT: older age (≥60 years), longer intervals until surgery (>27 hours), and longer surgical time (105 minutes). He advocated prophylaxis in patients with femoral shaft or tibial plateau fractures, prolonged operations, high energy injuries, and lower limb trauma in older persons.[29]

Wang et al reported 3 cases of PE after surgical repair of malleolar fractures; he refers to Mizel's study and agrees that the risk of DVT in foot and ankle surgeries are lower than hip or knee surgeries, but he also mentions that the delayed occurrence of VTE might have been the contributing reason for Mizel's study to have a lower incidence DVT and under recognizing such events.[48] Studies of patients with ankle surgeries have demonstrated that DVT is associated with certain risk factors, some more than others. In a study of 80 patients who underwent internal fixation of the distal fibula, Maffulli et al found that thrombosis was more common in patients operated on with a tourniquet (2 of 40) than in patients operated on without a tourniquet (0 of 40).[49] Mizel et al found that the development of DVT in 2,733 patients who had foot or ankle surgery appeared to correlate with nonweightbearing and immobilization following surgery.[44]

If there is no contraindication, DVT prophylaxis might be beneficial in patients undergoing foot and/or ankle surgeries. Most studies show that the occurrence of DVT could be diagnosed even weeks after surgeries, if the patient has predilection factors or has been immobilized for a long time. Kujath et al further investigated the role of immobilization in a study of patients with lower-limb injuries immobilized by a plaster cast and found that DVT was more common in patients without prophylaxis (21/127 or 16.5%) than in those with prophylaxis (4/126 or 4.8%).[32] The same study also found that many of those who developed DVT had varicose veins, were overweight, and older than age 40.[32] Van Rij et al detected the rate of DVT after varicose vein surgery to be 5.3% in 377 patients. They followed these patient 2-4 weeks after surgery and again 6 and 12 months and concluded that the incidence of DVT following varicose vein surgery was higher than previously thought and suggested DVT prophylaxis in patient with comorbid risk factors.[50]

In 1993, Spannagel and Kujath, reported the results of a prospective study that assessed the efficacy of self-injected LMWH (Nadroparin 2850U/day), in 253 patients who required plaster cast due to injuries of the lower limb. The overall rate of DVT in nontreated patients was 16.5%. This rate was significantly reduced to 4.8% when patients received thrombo prophylaxis administration of LMWH.[51] Lassen et al reported the result of a prospective,

randomized, double-blind trial of subcutaneous Reviparin (1750 anti-Xa IU/day) versus placebo in patients undergoing plaster cast immobilization for lower extremity fracture or rupture of the Achillis tendon. In this study the DVT rate of 19% in nontreated patients was reduced to 9% when they received LMWH.[52]

Although perceived as being rare, it is somewhat surprising that thrombosis following foot and ankle trauma is not reported as occurring more frequently, because lower-limb fractures are especially vulnerable to DVT.[30] Wang believes that ankle fractures may incur endothelial tissue damage similar to hip or pelvic injuries, and as such, it is possible that the rate of DVT following ankle surgery is more common than appreciated.[48]

Many surgeons fail to appreciate the potential complications of thromboembolic events because of their rare and delayed occurrence in foot and ankle operations.[48] A possible reason why the frequency of thromboembolism after ankle surgery may be underestimated is that this procedure is considered by many to be a "low-risk" orthopedic procedure.[53] Swan et al in a review study of patients' readmission postoperatively due to DVT/PE, showed that the rate of DVT/PE complications following surgery is underestimated. In his review of 215 patients, 34 were classified as unplanned readmissions following a surgical procedure. Twenty-four patients (70.6%) were readmitted under a different specialty, 3 (8.8%) patients were readmitted under the same specialty but under a different surgeon, and 7 (20.6%) patients were readmitted under the same surgeon. Of the 27 patients admitted under a different consultant, only 12 (44.4%) had documented evidence that the previous surgeon was aware of the readmission.[54]

Solis and Saxby in their prospective study of 201 patients with foot and ankle surgery, were able to divide these surgeries into forefoot (46.6%), midfoot (8.9%), hindfoot (18.32%), and ankle (26.18%) procedures. Their results showed a 6.5% (13 patients) positive diagnosis of DVT, using ultrasound from popliteal vein distally during the first postoperative visit (an average of 10.55 days.) Of this number 3% (6 patients) were diagnosed with only the superficial veins and muscular plexus, which were excluded from study due to lack of clinical significance. Seven patients (3.5%) had true DVT at the peroneal, anterior tibial and posterior tibial veins. Five of these 7 patients (2.5%) had fully occlusive thrombi and 1 of the 7 had a contralateral DVT, but not at the operated side. Since none of the patients had clinical symptoms associated with the DVT (pain, palpable cord, swelling or Homans' sign), the authors believe that prophylaxis is not indicated routinely in patients with foot and ankle surgery. In this study, the risk factors were found to be hindfoot surgery with or without immobilization, increasing age, and tourniquet time. The factors causing occlusive DVT were hindfoot surgery with or without immobilization and increasing body mass index. Age was not associated with occlusive DVT, and body mass index did not associate with overall DVT formation.[55]

Hanslow et al in their retrospective study of 602 patients after foot and ankle surgeries, found twenty four patients with post operative thromboembolic events. Their rate was 4% and thus they concluded that the risk of thromboembolism is higher than that previously estimated. Their identified risk factors were rheumatoid arthritis, recent history of air travel, previous DVT or PE, and limb immobilization. The authors concluded that prospective randomized clinical trials are needed to establish the true incidents.[56]

Slaybaugh et al in a retrospective study of 1,821 patients who had undergone foot and ankle surgeries rated the risk of thromboembolism being 0.5% (9/1821). He compared his study with other previously published studies and concluded that the rates of DVT occurrence are 0.5% to 3.5% in foot and ankle surgeries. In their study, the especially high-risk patient profile includes a late middle-age obese woman on hormone replacement therapy with immobilization in the postoperative recovery period.[43] Slaybaugh, also mentioned that approximately 15% of 1,821 patients were treated with prophylaxis for a short period of time. The number of risks assessed based on Caprini's table were between 2 to 8.[43] This study could have had a higher rate if they would have included the nonsymptomatic patients and not included 15% of their patient's population that were given anticoagulation prophylaxis. As in Solis and Saxby's study, their incident could have gone up if they included the thigh ultrasound scan. Also, the lack of sensitivity of ultrasound (48-57%) specifically in asymptomatic patients (62%) could have been another reason for their low numbers of incidence.[55] The other factor that they did not consider was the fact that a short postoperative time (6 to 18 days compared with 70 days in Mizel's study) is not enough to really assume no further risk of DVT occurrence.

In our study we noted a patient who was diagnosed with PE, however he had no prior diagnosis of DVT and no clinical symptoms even after 4 weeks. In Mizel's study there are 2 significant flaws; one that only symptomatic patients were examined radiographically and the second was that they did not separate the number of patients who received thromboembolism prophylaxis treatment. This means that they could have had a higher incidence of DVT if they would have checked the nonsymptomatic patients and separated the treated patients from nontreated. Also, Mizel mentioned that 23 of their patients had a history of

thromboembolic events; however, they did not mention if these patients received any postoperative thromboembolism prophylaxis.[14]

Our study demonstrated despite the fact that the number visiting and admitting patients have stayed the same with no significant change during the past 10 years, the number of patients with diagnosed DVT has been annually increasing. Although we see a slight increase in the number of foot and ankle procedures, the slope of increase in foot and ankle DVT/PE diagnosed cases were steeper than the increase in number of foot and ankle procedures (Figures 7, 8). This may be due to the fact that the diagnostic technologies have improved and the physician can diagnose even nonsymptomatic DVT. However, increase in awareness of health care providers in recognizing the significant impact of VTE in patients' future health as well as its financial outcome have influenced physicians to follow patients more closely to diagnose and to prevent VTE.

HIV has not been mentioned as one of the comorbidities in relation to VTE. However, in our study we encountered 2 patients who had a diagnosis of DVT and HIV concurrently and were on antiretroviral medication. In this example, the fact that the patient was also treated for positive PPD could raise a question that could have caused the DVT, the HIV, the tuberculosis, or the immobilization. Also, as it was noticed that most of the patients were immobilized postoperatively, irrelevant of age, sex, or any past medical history.

CONCLUSION

A significant percentage of hospitalized patients do not receive adequate antithrombotic prophylaxis for the primary or secondary prevention of thromboembolic disease. Data from our study showed that the number of diagnosed patients with VTE has been rising every year during the past 10 years. This could be due to the awareness of physicians and health care providers and the better diagnostic technology that enables physicians to detect even nonsymptomatic thromboembolic events more accurately. The first hospital in our study was a center city, trauma level one type hospital and the second hospital was a well economically situated hospital with a small urgent care facility. There was a significant difference in the rates of VTE in the 2 different hospitals. The rate of VTE seems to be geographically, traumatically, and socioeconomically dependent.

As diagnostic technology and physician awareness improve, more DVT is being diagnosed, which has kept the rate of PE the same if not reduced. Attention should be given to the patient's history, family history, and types and numbers of comorbidities to assess the risk of VTE. Many, if not most, episodes of thrombosis can be prevented by appropriate primary antithrombotic therapy, and most instances of recurrence can be prevented by the appropriate choice of secondary therapy.[57,58] Many instances of VTE are unexplained (not associated with surgery, trauma, cardiac emboli, etc.), but the goal is to define patients who harbor the risks of thromboembolism and try to treat with appropriate primary prophylactic prevention therapy and proper secondary antithrombotic therapy to decrease risks of occurrence and or recurrence. The patients' social, economical, and geographical status are another association in determination of the risk of thromboembolism.

It is important to obtain a detailed history and physical and categorize patients based on their risk factors rather than the level and complexity of their surgery. As history repeats itself, so do the thromboembolic events. Laboratory studies, including coagulation studies prior to surgery would provide a vast amount of information that can be used to determine some comorbid conditions. However, it would be difficult to perform these studies on every patient due to financial boundaries. Prophylaxis can be started even prior to surgery and would continue even

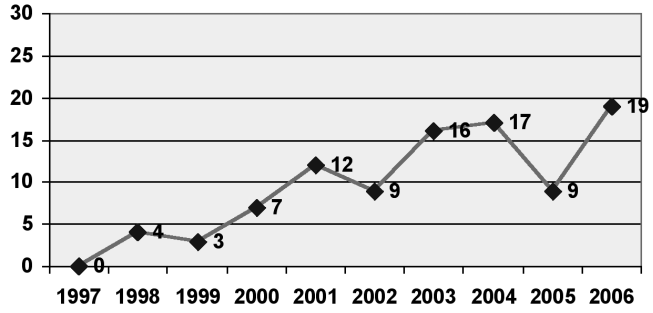

Figure 7. Number of patients with foot & ankle VTE.

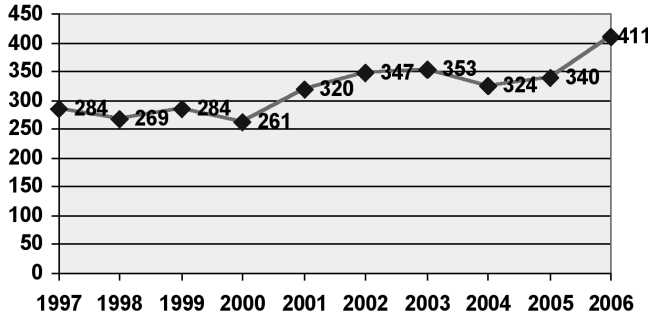

Figure 8. Number of patients with foot & ankle procedures.

after patient's discharge, if comorbidity exists or the patient has undergone a complex surgery. Patient education regarding antiembolic exercises on the day of admission and/or after the day of discharge could be beneficial in preventing VTE. A balance has to be achieved between pre- and postoperative risks and comorbidities to determine initiation of VTE prophylaxis.

When treating diagnosed thrombosis, the physician should follow their level of confidence and experience. Medical consultation is necessary to treat patients with diagnosed DVT and to determine if there are existing hereditary blood coagulation proteins or platelet defects. These patients may need to be followed on a routine basis to prevent recurrence, also there may need to be testing of family members to determine if any have these hereditary conditions.[57]

Reducing the risk of thromboembolism in patients who undergo foot and ankle procedures continues to be an important clinical focus among foot and ankle surgeons. According to our study, the awareness in recognizing VTE is increasing, and thus, prophylaxis has gained widespread acceptance in recent years. The risks and benefits of specific modalities and regimens deserve consideration.[44] Although the rate of VTE in foot and ankle surgeries is not as high as hip or knee surgeries, one has to consider other factors such as cost, convenience, ease and safety of administration, bleeding, and thrombosis risk in decision making surrounding the choice and duration of prophylaxis.

No accurate randomized, prospective studies have evaluated the need, efficacy, and safety of use of VTE prophylaxis in foot and ankle surgeries. However, the data suggest that routine administration of a low molecular weight heparin reduces the rate of DVT in non-large joint surgeries.[40] The risk of VTE must be evaluated in all patients during the preoperative period. The number, as well as the type of the risks should be considered and a strategy for pre or postoperative VTE prophylaxis must be planned. Patients at high risk will benefit from prophylaxis if no contraindication is noted. The one big cause of history's repeating itself in failures of the human race is man.[59] Guillebaud has once said "absence of evidence is not evidence of absence." In the context of risk/benefit equation in VTE the quotation of "first, do no harm" may need to be changed as to "do as little harm as possible."[60] Prophylaxis is a widely recommended and cost-effective solution.[1,4,13] It may positively impact quality of care and patient safety and is more effective, reliable, and cost-effective than screening.[1]

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