The Worcester Venous Thromboembolism Study

A Population-Based Study of the Clinical Epidemiology of Venous Thromboembolism

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BACKGROUND: While there have been marked advances in diagnostic and therapeutic strategies for venous thromboembolism, our understanding of its clinical epidemiology is based on studies conducted more than a decade ago.

OBJECTIVE: The purpose of this observational study was to describe the incidence and attack rates of venous thromboembolism in residents of the Worcester Statistical Metropolitan Area in 1999. We also describe demographic and clinical characteristics, management strategies, and associated hospital and 30-day outcomes.

DESIGN AND MEASUREMENTS: The medical records of all residents from Worcester, MA (2000 census = 477,800), diagnosed with International Classification of Diseases, 9th revision (ICD-9) codes consistent with possible venous thromboembolism during 1999 were independently validated, classified, and reviewed by trained abstractors.

RESULTS: A total of 587 subjects were enrolled with validated venous thromboembolism. The incidence and attack rates of venous thromboembolism were 104 and 128 per 100,000 population, respectively. Three quarters of patients developed their venous thromboembolism in the outpatient setting – a substantial proportion of these patients had undergone recent surgery or had a recent prior hospitalization. Less than half of the patients received anticoagulant prophylaxis during high-risk periods before their venous thromboembolism. Thirty-day rates of venous thromboembolism recurrence, major bleeding, and mortality were 4.8%, 7.7%, and 6.6%, respectively.

CONCLUSION: These data provide insights into recent incidence and attack rates, changing patient profiles, management strategies, and subsequent outcomes in patients with venous thromboembolism. The underutilization of prophylaxis before venous thromboembolism, and relatively high 30-day recurrence rates, suggest a continued need for the improvement of venous thromboembolism prophylaxis and management in the community.

KEY WORDS: venous thromboembolism; deep vein thrombosis; pulmonary embolism; population-health.

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Venous thromboembolism, consisting of deep vein thrombosis and pulmonary embolism, has been estimated to be the third most common vascular disorder after acute coronary syndromes and stroke.¹ While there have been marked advances in diagnostic and therapeutic strategies to manage this condition more effectively, our understanding of its clinical epidemiology is based on studies conducted more than a decade ago.^{2–4}

The goals of the Worcester Venous Thromboembolism study are to collect more contemporary population-based data about the clinical epidemiology of venous thromboembolism.

OBJECTIVES

The purpose of this analysis was to describe age-adjusted incidence and attack rates of venous thromboembolism in residents of the Worcester (MA) Statistical Metropolitan Area (SMSA) in 1999. We will also describe the demographic and clinical characteristics, management strategies, and short-term outcomes in patients with validated venous thromboembolism. Where possible, our findings are compared with those reported previously for patients enrolled in the initial Worcester DVT study over the period 1986 to 1989.^{2,3}

DESIGN AND MEASUREMENTS

Computerized printouts of all Worcester residents with health care system encounters in which any of 34 ICD-9 diagnosis codes possibly consistent with venous thromboembolism (see Appendix A) had been listed in 1999 were obtained from each of 12 hospitals serving the Worcester SMSA. These data queries were not limited to discharge diagnoses but also encompassed all outpatient, emergency department, radiology, and laboratory encounters. In addition, the logs and/or computerized billing lists of patients evaluated in area ultrasound departments for potential deep vein thrombosis were screened. This was performed to identify potential cases of venous thromboembolism that may have been missed because of coding errors, and to identify patients referred directly from outside physicians' offices, rehabilitation facilities, and nursing homes for testing who then returned directly to these outside settings for treatment. Finally, to obtain an estimate of how many residents with potential venous thromboembolism (VTE) sought care outside of the Worcester SMSA, we queried the Massachusetts Health Data Consortium, which collects health encounter information on all Massachusetts residents seeking health care at hospitals in all of Massachusetts, as well as neighboring areas of New York, Rhode Island, and Connecticut.

The medical records of all identified patients meeting the geographic inclusion criteria were reviewed by trained abstractors. Validation and characterization of each case of venous thromboembolism as definite, probable, possible, or absent were performed by trained abstractors using prespecified criteria. These criteria were based on a modification of a

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classification schema proposed by Silverman et al.⁴ (see Appendix B). Each case and its classification were also validated by the study project coordinator (C.E.). If the classification of venous thromboembolism was not immediately clear using the criteria specified, the medical record was reviewed by the principal investigator (F.S.). Potential cases of recurrence of venous thromboembolism were classified using criteria similar to those used for incident cases – however, definite or probable recurrence required new occurrence of thrombosis in a previously uninvolved venous or pulmonary segment.

The medical records of each patient's current as well as previous hospitalizations and/or outpatient visits were reviewed to identify whether the index venous thromboembolism event represented an incident (initial) or a recurrent case. Ambulatory patients presenting to the hospital with signs and symptoms consistent with venous thromboembolism were considered to have developed venous thromboembolism in the outpatient setting.

DATA COLLECTION

Information was collected about patients' demographic characteristics, medical history, prior hospital admissions, clinical characteristics, diagnostic test results, hospital management practices, and hospital and 30-day outcomes. Only medical history variables documented in the patient medical record by a physician were abstracted. For general variables in which multiple entries were possible, data abstractors were instructed to record only entries matching those on a prespecified list, and subcategories were utilized as appropriate. The variable surgery included major operations where general or epidural anesthesia lasted 30 min or more. Medical history variables defined as "recent" were those occurring or active in the 3 months before the diagnosis of venous thromboembolism. Major bleeding was defined as any bleed requiring transfusion, resulting in hospitalization, stroke, or myocardial infarction (MI), or causing death. A random selection of 5% of cases was independently audited by the study coordinator and principal investigator to ensure the accuracy of data abstraction.

Thirty-day venous thromboembolism recurrence and major bleeding rates were determined through review of the index medical record as well as concomitant review of the subject's medical records at the other 11 hospitals. Thirty-day mortality data were obtained through hospital record reviews and review of death certificates at the State Division of Vital Statistics.

ANALYSIS

Age-adjusted (overall and gender-specific) incidence and attack rates were calculated based on U.S. census estimates of the Worcester population in 2000 ($n=477,800$; 51% female; 90% Caucasian, 3% African American, 3% Asian, 7% Hispanic of any race). Means and frequency distributions of patients' demographic and clinical characteristics, as well as principal study outcomes, were calculated in a standard fashion. Where possible, data were compared in a descriptive fashion with those reported previously in the initial Worcester DVT study.^{2,3}

RESULTS

A total of 2,249 Worcester residents with potential venous thromboembolism were identified at the 12 hospitals. An additional 20 cases among Worcester residents seeking care at outside hospitals were identified using the Massachusetts Health Data Consortium database. In less than 1% of total cases data (test results or clinical) were missing such that a validation of venous thromboembolism could not be made. These cases were not included in the final study sample. In the remaining subjects, a total of 587 Worcester residents were validated as having possible, probable, or definite venous thromboembolism and comprised the study sample.

Incidence and Attack Rates for Venous Thromboembolism

The age-adjusted (overall and by gender) incidence and attack rates of venous thromboembolism (overall, isolated deep vein thrombosis, and pulmonary embolism with or without deep vein thrombosis) are shown in Table 1. Of 587 validated events, 477 (81%) were initial events yielding age-adjusted incidence and attack rates of 104 (95% confidence interval [CI] 95,114) and 128 (95% CI 118, 139) per 100,000 population, respectively. The occurrence of venous thromboembolism increased markedly with age. Overall, the incidence and attack rates of venous thromboembolism were slightly higher in women compared with men.

Medical Characteristics of Patients Developing Venous Thromboembolism

The 6 most prevalent preexisting medical characteristics for venous thromboembolism, in order of occurrence, included limited mobility >48 h in the last 30 days (defined as limited

Table 1. Incidence and Attack Rates of Venous Thromboembolism: The Worcester Venous Thromboembolism Study 1999*

# of events	VTE Attack Rate	VTE Incidence Rate	DVT Attack Rate	DVT Incidence Rate	PE Attack Rate	PE Incidence Rate
	N=587	N=477	N=516	N=422	N=142	N=134
Age adjusted rate (95% CI)	128 (118,139)	104 (95,114)	111 (102,121)	92 (84,101)	31 (26,37)	29 (25,35)
Age specific rate, (y)						
< 55	46	37	40	32	12	11
55 to 64	179	138	149	127	41	33
65 to 74	456	348	379	282	136	136
≥ 75	700	600	628	553	144	134
Sex specific rate						
Males	118	95	103	83	28	26
Females	135	111	116	99	33	31

*All rates are per 100,000 population.

VTE, venous thromboembolism; DVT, deep vein thrombosis; PE, pulmonary embolism.

ambulation – at most out of bed to chair or bathroom), recent hospitalization, recent surgical procedure, recent infection, active malignancy, and current hospitalization. Only 11% of patients had none of these characteristics, 36% had 1 to 2 characteristics, and 53% had ≥ 3 characteristics. All recorded medical characteristics with greater than 5% prevalence are listed in Table 2. Please note that where possible, findings for medical characteristics (VTE, diagnostic testing, and treatment characteristics) from the original Worcester DVT Study (1986 to 1989) are provided in Table 2. Given differences in study design

and population between these 2 studies no formal comparative analysis is attempted – these data are provided for descriptive purposes only.

Characterization of Venous Thromboembolism Events

Approximately 74% of patients presented to area hospitals with signs and symptoms suggestive of venous thromboembolism (“ambulatory”) (Table 2). Among patients with deep vein

Table 2. Clinical Characteristics of Patients with Venous Thromboembolism and Utilization of Diagnostic and Therapeutic Modalities: Comparison of the Worcester Venous Thromboembolism Study and the Worcester DVT Study*

Variable	Worcester Venous Thromboembolism Study 1999 (n=587)	Worcester DVT Study 1988/1989 (n=1,231)
Medical characteristics (%)**		
>48 h limited mobility in last month	45	NR
Recent [†] prior hospitalization	39	55
Recent surgery	34	18
Recent malignancy	34	22
Recent infection	34	NR
Admission with non-VTE-related diagnosis (immediately prior event)	26	19
Recent central venous catheter	18	NR
Prior VTE	19	26
Recent ICU discharge	16	NR
Recent intubation	16	NR
Recent hormonal therapy	12	NR
Recent fracture	10	10
Recent chemotherapy	9	NR
Recent heart failure	5	8
Recent cardiac procedures	5	NR
VTE characteristics		
Setting of VTE occurrence (%)		
Hospital acquired	26	19
Community acquired	74	81
Type of VTE event (%)		
DVT alone	76	72
PE alone	12	21
DVT and PE	12	7
Lower extremity DVT (% of total DVT)	84	100
Isolated calf DVT (% of total DVT)	13	NR
Upper extremity DVT (% of total DVT [‡])	16	0
Combined upper and lower extremity DVT (% of total DVT [‡])	1	0
Diagnostic testing		
Diagnostic tests for DVT (%) (in patients with DVT)		
Ultrasound	94 (97% positive)	46 (81% positive)
Venogram	2 (100 % positive)	53 (88% positive)
Impedance plethysomography	0	51 (74% positive)
Other test	5 (81% positive)	NR
One or more tests	93 (97% positive)	95 (95% positive)
Diagnostic tests for PE (%) (in patients with PE)		
Ventilation-perfusion scan	64	82
Pulmonary angiogram	2 (100 % positive)	10 (97% positive)
Spiral CT scan	28 (78 % positive)	0
One or more tests	83	87
Treatment		
Initial therapy (%)		
Intravenous heparin (in hospital)	61	91
Subcutaneous Enoxaparin	27	0
Other parenteral anticoagulant (in hospital)	1	NR
Warfarin (in hospital)	71	82
IVC filter	10	14
Length of hospital stay (mean, days)	9.4	15.0

*Data from Worcester DVT study (1988/1989) previously published.^{2,3} These data are provided for descriptive comparative reasons only. No formal comparison provided given baseline differences in the design and population of these 2 separate studies.

**Other factors with <5% prevalence (in descending order of frequency) include venous stasis/ulcer, family history of venous thromboembolism, varicose veins, superficial thrombophlebitis, prolonged air travel, recent lower extremity paresis, known hypercoagulable state, recent pregnancy or delivery, oral contraceptives, recent spinal cord injury.

[†]Recent defined as <6 months in initial Worcester DVT Study, <3 months in Worcester Venous Thromboembolism Study.

VTE, venous thromboembolism; DVT, deep vein thrombosis; PE, pulmonary embolism; IVC, inferior vena cava; NR, Not reported.

thrombosis, 96% were classified as definite and the remaining cases were classified as possible. Approximately 16% of cases of DVT were confined to the upper extremity; an additional 13% were confined to the calf veins. Of 142 cases of pulmonary embolism, 27% were classified as definite, 48% as probable, and 25% as possible.

History of Prophylaxis

We examined the utilization of prophylaxis for venous thromboembolism in 3 subsets of patients characterized by different risk scenarios: (1) patients in the first group were those who developed venous thromboembolism during hospitalization; venous thromboembolism prophylaxis during hospitalization but before to the index event was analyzed ($n=153$). (2) Patients in the second group had been hospitalized in the preceding 3 months, were discharged to home, but presented back to the hospital with venous thromboembolism; venous thromboembolism prophylaxis during the prior hospitalization was analyzed ($n=230$). Patients in the third group developed venous thromboembolism after recent (<3 months) surgery; venous thromboembolism prophylaxis perioperatively was analyzed ($n=171$). These patient subsets were not mutually exclusive – patients could have experienced ≥ 1 risk scenarios, but prophylaxis utilization during each possible scenario was analyzed separately. No prophylaxis was ordered during hospitalization in 25% of patients in group 1, mechanical prophylaxis alone was ordered in 28%, and anticoagulant prophylaxis (with or without mechanical prophylaxis) was ordered in 47%. No prophylaxis, mechanical prophylaxis alone, or anticoagulant prophylaxis during the prior hospitalization were ordered in 42%, 16%, and 42%, respectively, of patients in group 2. No prophylaxis, mechanical prophylaxis alone, or anticoagulant prophylaxis during the prior surgery were ordered in 40%, 17%, and 43%, respectively, of patients in group 3.

Diagnostic Modalities

Of patients diagnosed with deep vein thrombosis, the majority underwent a ultrasound, whereas venograms were rarely performed (Table 2). Approximately 3 of 5 patients diagnosed with pulmonary embolism underwent a ventilation-perfusion scan (Table 2). Of these, 2% of scans were indeterminate, 6% were of low probability, 28% were of intermediate probability, and 64% were high probability. Pulmonary angiography was rarely used, but almost 1/3 of patients underwent a spiral CT scan in 1999.

Therapies

Almost all patients received a heparin product for acute treatment of venous thromboembolism – the majority received unfractionated heparin but more than 1 in 4 received low-molecular weight heparin (LMWH) (Table 2). Of 106 patients never admitted for treatment – only 5.6% received unfractionated heparin during their short hospital encounter but 44.3% received enoxaparin. Acute treatment for the remaining patients either occurred entirely in the outpatient setting and/or was not recorded. In more than one quarter of patients, warfarin was not administered during their hospital encounter or was given entirely in an outpatient setting. Approximately 10% of patients underwent IVC filter placement. Approximately

13% of these patients had a prior history of VTE, 1% had recurrent VTE before filter placement, and 24% had major bleeding before filter placement.

Outcomes

Recurrent venous thromboembolism was diagnosed in 1.0% of patients during their index hospitalization and in a total of 4.8% in the first 30 days. In-hospital and 30-day major bleeding rates were 5.8% and 7.7%, respectively. In-hospital and 30-day death rates were 4.0% and 6.6%, respectively.

DISCUSSION

The Worcester Venous Thromboembolism study offers a unique opportunity to characterize recent attack and incidence rates of venous thromboembolism, as well as to characterize patients' demographic and clinical characteristics, management strategies, and outcomes of patients diagnosed with venous thromboembolism from a more generalizable population-based perspective.

Incidence and Attack Rates of Venous Thromboembolism

The incidence and attack rates in this community-based study were approximately 46% and 20% higher, respectively, compared with those reported in the original Worcester DVT study, which was carried out from 1986 to 1989.² Extrapolating our data to the United States would yield approximately 360,000 total cases and 290,000 incident cases of venous thromboembolism annually (80,000 cases of pulmonary embolism and 210,000 cases of isolated deep vein thrombosis). The age-adjusted incidence and attack rates of 104/100,000 and 128/100,000 are higher than that reported by the Worcester DVT study of 1986/87 (71/100,000 and 107/100,000, respectively). Data from an ongoing observational study of venous thromboembolism in residents of Olmstead County, MN, also describe an increase in incidence rates over time (96/100,000 in 1986 to 1990 to 118/100,000 in 1991 to 1997).^{4,5} It is likely that increasing physician awareness with respect to the diagnosis of venous thromboembolism, increased utilization of noninvasive diagnostic imaging, and increased "screening" for venous thromboembolism have all played a role in the increase in incidence rates of venous thromboembolism in these community-based studies. It must also be noted that isolated upper extremity and isolated calf vein thromboses constituted 16% and 13%, respectively, of observed deep vein thromboses in our study. The clinical significance of thromboses in these locations is less clear and warrants further study.

These caveats aside, the continued high prevalence of this largely preventable condition are concerning. Despite previous interventions in the Worcester community designed to improve venous thromboembolism prophylaxis use,⁶ as well as dissemination of guidelines stressing the importance of such prophylaxis,^{7,8} we observed that utilization of anticoagulation prophylaxis during hospitalization in patients who subsequently had VTE was less than 50%. Similarly, anticoagulant prophylaxis was ordered less than 50% of the time during prior hospitalization or surgery in ambulatory patients who presented to the hospital with venous thromboembolism. While continued research into better forms of anticoagulant prophylaxis is important, even larger reductions in venous

thromboembolism occurrence may be realized by research initiatives designed to translate current prophylaxis strategies to actual delivery of care.

Diagnostic Modalities

Venography and pulmonary angiography were infrequently used in the diagnosis of patients with venous thromboembolism in 1999 and have largely been replaced by noninvasive modalities. These shifts in the selection of diagnostic testing likely impact any reported incidence rates of venous thromboembolism – physicians may be more likely to search for venous thromboembolism given the widespread availability of noninvasive modalities, which may, in turn, result in an increased yield of cases. This is particularly problematic given the increasing use of “screening” ultrasounds in surgical and/or medical wards to detect asymptomatic deep vein thromboses that are of unclear clinical significance. We expect to further explore these issues using more contemporary data from our population-based registry.

Treatment Practices

In the initial Worcester DVT study, unfractionated heparin was the initial treatment of choice; LMWH therapy was not yet available. In our 1999 cohort, while unfractionated heparin remained the most common initial therapy, approximately one quarter of patients were treated with LMWH, which allows for earlier outpatient management. This factor may have contributed to the shorter length of hospital stay observed in our study compared with the initial Worcester DVT Study. We anticipate that utilization of outpatient LMWHs will increase markedly in our subsequent cohorts (2001, 2003), given recent guidelines recommending this approach in uncomplicated patients.⁹ While clinical trials have clearly documented the safety and efficacy of such an approach,^{10,11} utilization patterns of outpatient LMWH and associated outcomes in the community have not been adequately assessed. These issues will be carefully examined in future analyses of our ongoing population-based registry.

In-hospital and 30-day outcomes

Despite advances in venous thromboembolism management and shortened lengths of hospital stay, in-hospital recurrence of venous thromboembolism and/or major bleeding rates have not changed significantly over the last decade. In addition, our data suggest that an additional 3.8% of patients will suffer a venous thromboembolism recurrence after hospital discharge, resulting in a cumulative 30-day recurrence rate of 4.8%. This is relatively high when one considers that recurrence rates in prior clinical trials of venous thromboembolism management have not approached 5% until 3 months of follow-up.^{10,11} The recurrence rate in our community-based study mirrors the 30-day recurrence rate (5.2%) reported for patients enrolled in the Olmsted County study from 1966 to 1990.¹² Approximately 8% of patients with VTE in 1999 had major bleeding within 30 days of diagnosis. These data reaffirm that recurrence and bleeding rates associated with VTE and its management are generally higher than those observed in randomized clinical trials. Further evaluation of immediate postdischarge management practices in the community is needed to identify potential

deficiencies in care and the impact of any identified deficiencies on postdischarge outcomes.

Study Limitations and Strengths

Similar to the design and conduct of any observational study, the present investigation has several limitations. Although we conducted a broad screening for cases of venous thromboembolism at all 12 Worcester hospitals using multiple databases, validated each potential case of venous thromboembolism, and performed regular audits of randomly selected charts, it is likely that we may have missed some cases of venous thromboembolism – in particular, cases of venous thromboembolism among Worcester residents who sought care at outside hospitals and cases of pulmonary embolism resulting in out-of-hospital death. It should also be recognized that the individually reported incidence and attack rates of deep vein thrombosis and pulmonary embolism may be underestimated. In many cases, patients may have both diagnoses, but further diagnostic testing is suspended after 1 condition is objectively confirmed. Another potential limitation is that while our data abstracters were provided with prespecified definitions of medical history variables of interest, they still had to rely on documentation of these conditions in the medical record. As such, the possibility of over or underestimation of the prevalence of specific risk factors cannot be excluded. Finally, it is important to recognize that incomplete data as well as our inability to address unmeasured factors that may impact a physician's decision to perform specific diagnostic testing or institute specific therapies limit our ability to draw definitive conclusions with respect to these management practices.

It should also be noted that we can only offer a descriptive comparison of our findings relative with those published from the initial Worcester DVT study more than a decade ago. Although many aspects of our study design were similar to the original study, there were some important differences. Most notably, validation of cases in the original Worcester DVT study was based on written documentation of the diagnosis at discharge; classification of cases based on diagnostic testing or clinical findings was not performed. Other differences of note include differing definitions of “recent” for potential risk factors – 6 months in the initial Worcester DVT study (as opposed to 3 months in the current study), failure to include cases of upper extremity DVT in the initial study, and limited ability to capture “outpatient” cases of DVT in the initial study (which, at that time, consisted primarily of nursing home patients).

CONCLUSIONS

Our findings from the initial patient cohort of the Worcester Venous Thromboembolism study provide insights into the current magnitude of venous thromboembolism, changing patient profiles, utilization patterns of diagnostic and therapeutic modalities, and short-term outcomes. In particular, the majority of patients with subsequent VTE (including outpatients) have a history of at least 1 hospital-related risk factor, but venous thromboembolism prophylaxis in high-risk situations remains underutilized. Diagnostic and treatment approaches to venous thromboembolism are also changing as well; an increased emphasis on noninvasive testing and LMWH therapy will result in a further shift to outpatient management of this

prevalent condition. Future analyses from subsequent cohorts of this ongoing study will allow for validation of our observations as well as a more in-depth analysis of specific questions raised by these data.

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Appendix A

Venous thrombosis ICD-9 codes

- 415.1 (1,9) – pulmonary embolism and infarction
 - 451 – phlebitis and thrombophlebitis
 - 451.11 – femoral vein
 - 451.19 – other deep vein
 - 451.2 – lower extremities, unspecified
 - 451.81 – iliac vein

- 451.83 – deep veins of upper extremities
- 451.83 – upper extremity, unspecified
- 451.89 – other (axillary, jugular, subclavian)
 - 451.9 – unspecified site
- 453.1 – thrombophlebitis migrans
- 453.2 – vena cava
- 453.8 – of other specified veins
- 453.9 – of unspecified site
- 671.3 (0,1, – deep phlebothrombosis, antepartum
 - 3)
- 671.4 (0, – deep phlebothrombosis, postpartum
 - 2, 4)
- 671.9 (0 to – unspecified venous complication of puerperium
 - 4)
- 673.2 (0 to – obstetrical blood clot embolism
 - 4)
- 996.73 – complication because of renal dialysis device, implant, and graft
- 996.74 – complication because of other vascular device, implant, and graft
- 997.2 – phlebitis or thrombophlebitis during or resulting from a procedure

Appendix B

Criteria for classification of VTE events*

Deep vein thrombosis:

Definite – if confirmed by venography, compression/Duplex ultrasound, CT scan, MRI scan, or at autopsy.

Probable – if the above tests were not performed, or were indeterminate, but impedance plethysomography, radionuclide venography, or radiolabelled fibrinogen scan test results were reported as positive.

Possible – if all of these confirmatory tests were not performed, or were indeterminate, and 2 of the following criteria were satisfied – medical record indicates that the physician made a diagnosis of DVT, signs and/or symptoms of DVT were documented, and the patient underwent therapy with anticoagulants, or an IVC filter was placed.

Pulmonary embolism:

Definite – if confirmed by pulmonary angiography, spiral CT scan, MRI scan, or pathology.

Probable – if the above tests were not performed, or were indeterminate, but ventilation-perfusion scan findings were of high probability.

Possible – if all of the above confirmatory tests were not performed, or were indeterminate, and 2 of the following criteria were satisfied – medical record indicates that the physician made a diagnosis of PE, signs and/or symptoms of PE were documented, and the patient underwent therapy with anticoagulants, or an IVC filter was placed.

*Modification of criteria previously used by Silverstein et al. in the Olmstead County study of venous thromboembolism.⁴ Given increasing acceptance over the last decade of compression/Duplex ultrasound as a single diagnostic modality for DVT, we have classified patients with DVT confirmed by compression/Duplex ultrasound as *definite*, whereas these patients would be classified as *probable* by Silverstein's criteria.