The Prevalence of Risk Factors for Venous Thromboembolism Among Hospital Patients

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• ***Background.***—**This study provides an estimate of the prevalence of risk factors for venous thromboembolism among hospital patients.**

Methods.—**The presence of risk factors for venous thromboembolism was determined from a retrospective review of the medical records of 1000 randomly selected patients in 16 acute care hospitals in central Massachusetts.**

Results.—**The most common risk factors for venous thromboembolism were age 40 years (59%) or more, obesity (28%), and major surgery (23%). The average number of risk factors increased with increasing age. One or more risk factors for venous thromboembolism were present in 78% of hospital patients, two or more in 48%, three or more in 19%, four or more in 6%, and five or more in 1%.**

Conclusion.—**Risk factors for venous thromboembolism are common among hospital patients, suggesting that prophylaxis should be widely employed. The cost-effectiveness and risk benefit of prophylaxis is well established in patients undergoing major surgery. Further studies are needed to confirm the benefit of prophylaxis in patients with nonsurgical risk factors for venous thromboembolism.**

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The ability of prophylaxis to prevent deep-vein thrombosis and to reduce the mortality of pulmonary embolism has been affirmed by a National Institutes of Health Consensus Conference[1] and by meta-analysis of controlled studies in surgical patients.[2,3] When low-dose heparin is used during the postoperative period, patients who undergo major abdominal or thoracic surgery experience a two-thirds reduction in deep-vein thrombosis and a similar reduction in fatal pulmonary emboli.[2,3] Currently available methods of prophylaxis, including subcutaneous injection of low-dose heparin and intermittent pneumatic calf compression, are both safe and cost-effective. Despite convincing evidence of the benefit of prophylaxis, US physicians do not prescribe prophylaxis for the majority of their high-risk patients.[4]

Most physicians prescribe prophylaxis selectively. Candidates for prophylaxis are usually identified from among hospital patients at least 40 years of age who have at least one additional risk factor such as major surgery, cancer, or stroke (Table 1). Several investigators have suggested that the incidence of venous thromboembolism increases in proportion to the number of risk factors present.[5-7] Other investigators have used logistic regression modeling to assign weights to individual risk factors, suggesting that some risk factors are more important than others[8-10]; however, this approach has proved cumbersome in routine practice and has not been widely adopted.

There is little information available about the number of patients who are at risk for venous thromboembolism. Such information would help to evaluate the potential costs and benefits of prophylaxis in reducing the incidence of this common disease. Our study measured the prevalence of risk factors for venous thromboembolism in hospital patients in a defined population setting. These data can be used to estimate the proportion of hospital patients who may be candidates for prophylaxis for venous thromboembolism.

PATIENTS AND METHODS

This research is based on data from the "Worcester DVT Study," a 5-year community-wide study of physician practices in the prevention and management of venous thrombosis and pulmonary embolism.[4,11] The study population comprised all discharges (excluding newborns) during two 1-month periods (December 1986 and December 1989) from 16 general hospitals that provide nearly all the acute care for central Massachusetts residents (1990 census population 709 705). The 16 study hospitals ranged from 78 to 578 acute care beds, and comprised 10 nonteaching hospitals and six teaching hospitals.

Patient Selection

To provide an estimate of the proportion of hospitalized patients at risk for venous thromboembolism, commonly accepted risk factors[1,6-11,12-14] were identified through a review of medical records (Table 1). Because of the number of hospital discharges (8440 during December 1986 and 8206 during December 1989), it was not feasible to review every medical record. There-

Table 1.—Risk Factors for Venous Thromboembolism

Risk Factors
Prior thromboembolism
Age, 40 y or more
Major surgery
Cancer
Obesity
Trauma
Myocardial infarction
Congestive heart failure
Stroke
Fracture (hip or leg)
Estrogen replacement therapy
Prolonged immobilization

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fore, two samples of hospital discharges were randomly selected for detailed review.

Discharge lists were obtained from each study hospital and patients were selected using a random sampling process. To determine the sample size for a given hospital, each hospital's discharges were expressed as a proportion of the entire study population.

Based on the normal approximation to the binomial distribution, each sample of 500 records was considered large enough to estimate the true proportion of all patients at risk for venous thromboembolism with a sampling error of at most 2.2%. The sampling error of estimates of proportions based on the combined population of 1000 records is at most 1.6%.

Data Collection

A standard data abstraction form was developed for the review of medical records.[11] Identification of risk factors for venous thromboembolism was based on a careful review of each medical record, including the discharge summary, admission history, physical examination, and progress notes. Diagnostic classifications (eg, myocardial infarction, congestive heart failure) included conditions present on admission as well as those that developed during the hospital stay. The classification of obstetric surgery was limited to cesarean section. The classification of fracture was limited to patients who had a hip or leg fracture. Obesity was defined as 20% or more above the median recommended weight-for-height of the American Medical Association tables.[15] Where height and weight were not given (30% of patients), the physician's assessment of the patient as "obese" was accepted. Prolonged immobility was defined as 5 or more days of continuous bed rest. Surgery included major operations where general or epidural anesthesia lasted 30 minutes or more.

Data Analysis

Data were entered into portable computers using SAS-FSP and subsequently analyzed using SAS-PC.[16] Differences in the distribution of categorically defined risk factors were evaluated by χ^2 tests. Confidence intervals for proportions were obtained using the normal approximation to the binomial distribution. For continuous variables, such as age, comparisons were made using the two-sample t test.

Table 2.—Characteristics of a Randomly Selected Sample of Central Massachusetts Patients Hospitalized in 16 Acute Care Hospitals

Characteristic	Discharges (n=1000)
Age, y*	49.8±25.6
Race, %	
White	98.3
Sex, %	
Female	58.2
Length of stay, d*	7.2±15.7
No. of risk factors*	1.5±1.2
Percent	
Do-not-resuscitate order	5.5
In-hospital deaths	3.6
Suspicion of deep-vein thrombosis	1.9
Objectively proven deep-vein thrombosis	0.7
Suspicion of pulmonary embolism	1.3
Objectively proven pulmonary embolism	0.4

*Values are means±SDs.

RESULTS

Patient Characteristics

The sociodemographic characteristics of the patients in the 1986 and 1989 samples were similar. These data were therefore combined to provide a more precise estimate of the prevalence of risk factors for venous thromboembolism in hospital patients (Table 2). Based on the risk factors examined in Table 1, a typical hospital patient had an average of 1.5 risk factors for venous thromboembolism. There was a clinical suspicion of deep-vein thrombosis in 19 (1.9%) of 1000 patients, but this diagnosis was frequently ruled out by objective diagnostic tests (eg, impedance plethysmography or duplex ultrasound), and only seven of these patients (0.7%) had this diagnosis at discharge. Pulmonary embolism was suspected in 13 (1.3%) of 1000 patients, but only four of these patients (0.4%) still had this diagnosis at discharge. (Undoubtedly, other patients had clinically important venous thromboembolism that was silent and, consequently, unrecognized.[11,12]) No patient with confirmed venous thromboembolism had received prophylaxis. All 11 patients with confirmed venous thromboembolism had at least one risk factor. Thirty-six (3.6%) of 1000 patients died in the hospital; all of these patients had at least one risk factor for venous thromboembolism.

Table 3.—Prevalence of Risk Factors for Venous Thromboembolism Among 1000 Patients in 16 Acute Care Hospitals

	No. of Risk Factors*		Risk Factors,%*			
Risk Factor	Percent	Mean±SD	≥2	≥3	≥4	≥5
Age 40 y or more	59.1	2.1±1.0	73.3	29.8	9.0	1.7
Obesity	27.6	2.4±1.0	79.4	40.6	13.8	2.9
Major surgery	22.8	2.3±1.1	73.1	38.8	15.0	4.4
Prolonged immobilization	14.2	3.0±1.1	95.1	63.4	29.6	7.8
Cancer	9.3	2.8±1.0	96.8	55.9	20.4	5.4
Congestive heart failure	7.8	2.8±0.9	97.4	56.4	21.8	1.3
Myocardial infarction	2.9	3.3±0.9	100.0	86.2	34.5	6.9
Fracture (hip or leg)	2.2	3.7±1.3	95.5	86.4	54.6	27.3
History of venous thromboembolism	1.8	3.0±1.0	100.0	66.7	22.2	5.6
Trauma	1.6	2.1±1.5	50.0	25.0	25.0	6.3
Stroke	1.5	3.3±1.3	93.3	73.3	33.3	20.0
Estrogen replacement therapy	0.4	2.0±0.8	75.0	25.0	0.0	0.0

*Based on the risk factors listed in Table 1. Includes the risk factor that is the subject of each row.

Rate of Prophylaxis Use

One hundred sixty-seven (17%) of these 1000 patients received prophylaxis (low-dose heparin, intermittent calf compression, warfarin, or vena caval filter). Prophylaxis was used in 81 (43%) of 188 patients with three or more risk factors for venous thromboembolism. A detailed evaluation of the rate of use of prophylaxis by physicians practicing in these 16 hospitals has been published previously.[4] None of the 167 patients who received prophylaxis developed clinical venous thromboembolism during their hospital stay (the upper 95% confidence interval of this estimate suggests that there could be as much as a 2% incidence of clinically recognized venous thromboembolism following prophylaxis).

Prevalence of Risk Factors

Analysis of 1000 discharges from 1986 and 1989 provides an estimate of the prevalence of commonly cited risk factors for venous thromboembolism in hospital patients (Table 3). The average number of risk factors reported in Tables 3 and 4 are based on the risk factors listed in Table 1. They include the risk factor that is the subject of each row. For example, in Table 3 obesity is counted as a risk factor in the row entitled obesity. The three most common risk factors were age at least 40 years (59%), obesity (28%), and major surgery (23%); however, less than 4% of all hospital patients (16% of all patients with three or more risk factors) had this combination of the most common risks. Three or more risk factors were present in 30% of patients 40 years of age or older, but in only 3% of patients younger than 40 years.

The most common types of major surgery were orthopedic, abdominal, and obstetric (Table 5). Of 228 patients who had major surgery, 88 had three or more risk factors for venous thromboembolism (39%) and 126 were 40 years of age or older (56%). The proportion of hospital patients with from one or more to five or more risk factors for venous thromboembolism is shown in Fig 1. There was no significant difference in these proportions in 1986 compared with 1989.

There were 142 women (14% of 1000 patients) admitted for childbirth. One of these women had three risk factors for venous thromboembolism, 7% had two or more risks, and 43% had at least one risk factor. Despite evidence that pregnancy and childbirth entail an increased risk of venous thromboembolism,[17] none of these women received prophylaxis and none developed clinically recognized venous thromboembolism (the upper 95% confidence interval of this estimate suggests that there could be as much as a 2% incidence of clinically recognized venous thromboembolism following childbirth).

Table 4.—Estimate of Annual Hospital Cases in the United States at Risk for Acute Venous Thromboembolism*

Risk Group	Cases, 1000s	≥40 y, 1000s	≥3 Risk Factors, 1000s
Cancer	2880	2600	1600
Congestive heart failure	2420	2360	1360
Abdominal surgery	1640	1180	600
Orthopedic surgery	1640	680	800
Obstetric surgery	900	30	30
Myocardial infarction	900	900	775
Fracture (hip or leg)	680	500	590
History of venous thromboembolism	560	560	370
Trauma	500	90	125
Stroke	465	400	340

*Based on extrapolation of data from 1000 randomly selected central Massachusetts hospital discharges to the estimated 31 million acute care hospital discharges in the United States in 1989.[13]

Table 5.—Prevalence of Risk Factors by Type of Operation Among 228 Major Surgical Cases in 16 Acute Care Hospitals

Operation	No. (%)	No. of Risk Factors,* Mean±SD	≥3 Risk Factors,* No. (%)
Abdominal	53 (23)	2.3±1.0	19 (36)
Orthopedic	53 (23)	2.5±1.4	25 (48)
Obstetric	30 (13)	1.3±0.6	1 (3)
Gynecologic	14 (7)	2.1±0.7	4 (29)
Cardiac	11 (5)	3.1±0.9	8 (73)
Vascular	10 (4)	2.4±1.1	4 (40)
Urologic	6 (3)	3.3±1.5	4 (67)
Neurosurgery	4 (2)	3.0±1.4	2 (50)
All other	47 (21)	2.4±1.3	21 (45)

*The average number of risk factors are based on the risk factors listed in Table 1. They include the risk factor that is the subject of each row.

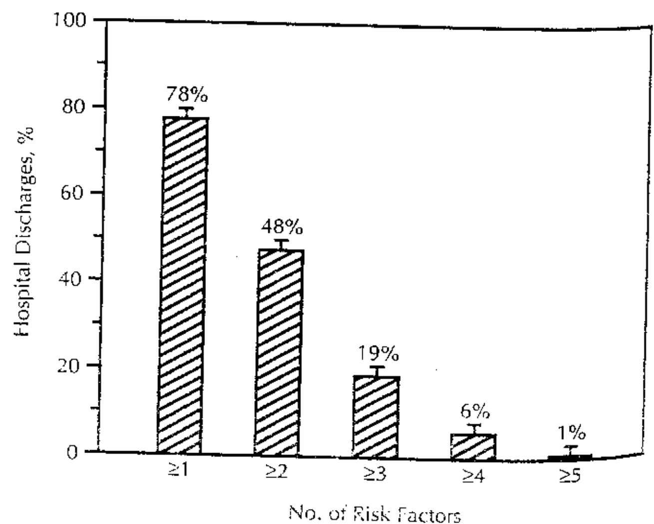

Fig 1.—*The cumulative prevalence of risk factors for venous thromboembolism in 1000 hospital discharges (mean±SEM).*

Six hundred forty (64%) of 1000 study patients were hospitalized in teaching hospitals. The proportion of patients who had three or more risk factors was significantly higher in teaching than in nonteaching hospitals, 20% vs 16% (P=.05). The average number of risk factors increased significantly with age (Fig 2) and was similar in men and women up to age 80 years; however, there were significantly more risk factors in women 80 years of age or older (P=.03).

COMMENT

Central Massachusetts is essentially similar to the general population of white residents of the United States in terms of socioeconomic and demographic characteristics. Possible limitations to generalizing the results of this study to the US population include the low proportion of nonwhites in the Worcester area; possible geographic variations in the prevalence of risk factors for venous thromboembolism; and variation in the manner of identifying and recording risk factors. For example, there was no way to assess physician diligence in identifying and/or recording a history of venous thromboembolism.

There are a number of databases, such as the National Hospital Discharge Survey,[18] which provide estimates of the annual number of hospital discharges according to discharge diagnoses and procedures; however, for several reasons these data cannot be used to estimate the number of patients at risk for venous thromboembolism. First, the prevalence of many important risk factors is not recorded, including obesity, prior thromboembolism, and duration of bed rest. Second, it is difficult to determine the proportion of discharges with multiple risk factors. Third, there are several potentially important sources of bias, including variations in coding practices, limitations in the number of secondary diagnoses coded, and inclusion of diagnoses that were ultimately ruled out. In addition, these databases do not allow analysis of time or severity-dependent risk factors. Although expensive and time-consuming, focused review and independent validation of patient charts is a systematic and accurate method for obtaining such data. Thus, the total number of patients who might benefit from prophylaxis in US hospitals each year is unknown and this question cannot be adequately addressed using currently available national databases. A similar approach was employed by Caprini et al[13] in a study of risk factors for venous thromboembolism in a community hospital.[14]

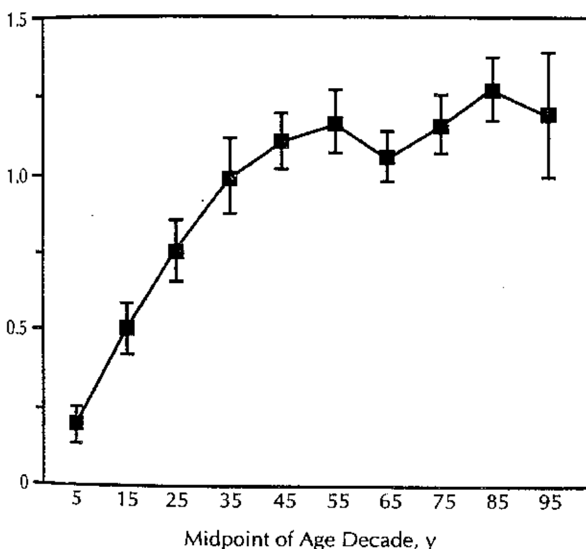

Fig 2.—*The number of risk factors for venous thromboembolism (mean±SEM), excluding age, is plotted vs 10-year intervals of age in 856 hospital patients (excluding newborns and 142 women admitted for childbirth).*

Table 6.—Estimated Cost of Providing Prophylaxis for Venous Thromboembolism in US Acute Care Hospitals

Patient Group	Cost of Prophylaxis,* $ Millions/y
Major surgery, age 40 y or more	59-118
All patients with risk factors	
≥1	1200-2400
≥2	750-1500
≥3	300-600
≥4	100-200

*Average cost estimated at $50 to $100 per patient per hospitalization.

If our results were generalizable to the population of all 31 million patients discharged in 1989 from US hospitals,[19] the prevalence of a variety of procedures and diagnoses that may place patients at risk for venous thromboembolism could be estimated for the 1989 US hospital population (Table 4). While there is close agreement with 1987 National Hospital Discharge Survey data[18] with respect to the number of discharges with myocardial infarction (872 000 vs 900 000) and cesarean section (959 000 vs 900 000), some of our estimates appear high compared with published figures, and others, such as prior thromboembolism, have no counterpart in national databases. Methodological issues may explain these differences. For example, we estimated that there were 2.4 million patients hospitalized with clinically recognized congestive heart failure in 1989; however, in 1987 there were an estimated 1.7 million discharges with an International Classification of Diseases code for this diagnosis (428.0).[18] This discrepancy may be at least partly explained by our anecdotal observation that many patients described as having congestive heart failure in their progress notes did not have this diagnosis coded on the face sheet of their medical record. Similarly, we estimated that there were 465 000 patients who had a stroke; National Hospital Discharge Survey data[18] indicate 330 000 such discharges. Some patient records in our sample were not coded as having a current diagnosis of stroke, yet these patients were included in our data because they remained symptomatic due to a stroke that occurred within the prior 6 months. Unfortunately, this remains a subjective judgment, since we are unaware of data defining the period of risk for venous thromboembolism following stroke.

While it is not certain that every patient with risk factors would benefit from prophylaxis, there are extensive data to support both the clinical benefit[1-3] and the cost-effectiveness[12,20-25] of prophylaxis in the subset of patients 40 years of age or older who underwent major general or orthopedic surgery. For example, data from more than 70 randomized trials, which included more than 16 000 patients, suggest that surgeons who prescribe low-dose heparin prophylaxis for their high-risk patients will prevent venous thrombosis in at least one of every 10 patients and will save the life of approximately one of every 200 patients.[2] Although less well documented, prophylaxis may also benefit patients hospitalized with serious medical conditions, including stroke, heart failure, and cancer.[12,26-28] The impor-

tance of preventing the postphlebitic syndrome is less well documented, but postphlebitic complications can be a source of serious long-term disability.

Current definitions of patients at risk for venous thromboembolism are less than ideal and the decision whether to give prophylaxis to an individual patient is frequently subjective. The low risk of prophylaxis suggests that it may be reasonable to adopt fairly broad guidelines in patient selection,[6] but in the current cost-conscious climate, it is important to justify any additional expense by clear evidence of improved patient outcome. For example, assuming per patient costs of prophylaxis of $50 to $100,[20-22,25] between $59 million and $118 million would be required annually to provide prophylaxis for an estimated 1 180 000 abdominal surgical procedures in patients 40 years of age or older. To protect the approximately 6 million US acute care hospital patients with three or more risk factors would require between $300 million and $600 million annually (Table 6).

Can this expense be justified in terms of treatment costs saved? If not, what is the cost per life saved or episode of deep-vein thrombosis prevented? The best available data from the medical literature, based on the use of low-dose heparin prophylaxis, demonstrate a reduction of 22.4% to 9.0% in deep-vein thrombosis and of 0.8% to 0.3% in deaths due to pulmonary embolism. These estimates were derived from studies of surgical patients 40 years of age or older.[2] Based on these figures, prophylaxis in all 1 180 000 major abdominal surgical patients 40 years of age or older would prevent 158 000 episodes of deep-vein thrombosis annually at a cost of between $375 and $750 per episode prevented. In addition, approximately 6000 deaths due to pulmonary embolism would be prevented at a cost of between $10 000 and $20 000 per death averted.

It is not known whether the incidence of deep-vein thrombosis and reduction in deaths due to pulmonary embolism documented in surgical patients can be applied to the broader population of 6 million patients with three or more risk factors for venous thromboembolism. However, recognized authorities have recommended prophylaxis in such patients.[1,6] If the data from surgical patients can be extrapolated to this larger group of patients, the general application of prophylaxis to these patients might prevent 700 000 to 900 000 episodes of deep-vein thrombosis and 25 000 to 33 000 deaths annually in the United States. These estimates are based on a 95% confidence interval estimate of 5.1 to 6.6 million discharges with three or more risk factors. Any errors in estimating the incidence rate of deep-vein thrombosis, deaths due to pulmonary embolism, or the benefits of prophylaxis, particularly in nonsurgical patients, will affect the validity of these estimates.

Prophylaxis is currently underused, even among postoperative patients in whom its benefit is firmly established.[4] Although many questions remain unanswered, the medical literature supports the use of prophylaxis in selected high-risk patients in terms of both cost and patient outcome. Individual hospitals should evaluate their use of prophylaxis and, where indicated, institute quality improvement programs to promote the use of prophylaxis in high-risk patients. Additional outcome and cost studies are needed to document the indications for and benefits of prophylaxis, particularly in nonsurgical patients.

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