

Direct Medical Costs of Venous Thromboembolism and Subsequent Hospital Readmission Rates: An Administrative Claims Analysis From 30 Managed Care Organizations

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ABSTRACT

BACKGROUND: Venous thromboembolism (VTE) is a common medical condition manifested as deep vein thrombosis (DVT) or pulmonary embolism (PE). Few data exist on the total economic burden of DVT and PE.

OBJECTIVE: To (1) quantify the economic burden of DVT and PE in direct medical costs and utilization and (2) determine the rates of hospital readmission for DVT and PE.

METHODS: Hospital claims containing DVT or PE as a primary or secondary discharge diagnosis during the period February 1998 through June 2004 were identified by retrospective analysis using the Integrated Health Care Information Services (IHGIS) National Managed Care Database. For the cost analysis, we included patients that had been enrolled in a health care plan for a minimum of 30 days prior to and 365 days following the DVT or PE hospitalization. For the readmission analysis, patients were required to have a minimum length of stay of 3 days and a preenrollment of 365 days. We quantified the cost burden to the health plan by examining annual DVT- and PE-related payments made by the health plan to providers for inpatient and outpatient care.

RESULTS: Of 5 million plus discharges in the database with dates of service between February 1, 1998, and June 30, 2004, 32,193 (0.64%) had DVT or PE as a primary discharge diagnosis, and 26,159 (0.52%) had DVT or PE as a secondary discharge diagnosis. After application of the inclusion and exclusion criteria, there were 5,348 patients with a primary discharge diagnosis of DVT and 4,593 patients with a secondary discharge diagnosis of DVT. For PE, 2,984 patients had a primary discharge diagnosis, and 1,119 had a secondary discharge diagnosis. The hospital readmission rates within 1 year for the combined diagnoses (DVT or PE) were 5.3% for primary and 14.3% for secondary diagnoses; 44.3% of the PE readmissions occurred within the first 30 days. Within 90 days, 50.7% of DVT readmissions and 58.6% of PE readmissions occurred. Regarding cost for a primary diagnosis, the average total annual provider payments made by a health plan were \$10,804 for DVT and \$16,644 for PE. For secondary diagnoses, the average total annual costs were \$7,594 for DVT and \$13,018 for PE. The mean hospital cost per readmission for a recurrent DVT (\$11,862) was higher than the mean cost for the initial hospitalization (\$9,805, $P=0.006$), but the mean cost per PE readmission (\$14,722) was similar to the mean cost for the initial hospitalization (\$14,146, $P=0.38$).

CONCLUSIONS: The economic burden of DVT and PE in direct medical cost is large, due not only to the initial hospitalization event, but also to the high rate of hospital readmission (5%-14%), over half of which occurs within 90 days.

KEYWORDS: Cost, Deep vein thrombosis, Pulmonary embolism, Venous thromboembolism, Recurrence, Managed care, Economic burden

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What is already known about this subject

- VTE is a common medical condition of particular importance in the hospital setting. In patients with major surgery, the diagnosis and treatment of an initial VTE event poses a significant economic burden to health care in the United States.
- The diagnosis and treatment of the initial VTE event incurs costs, but the VTE recurrences and long-term complications of VTE create additional costs. It was found previously that 1 in 4 patients who experienced a VTE event during the incident hospital stay had additional VTE-related events requiring hospitalization in the 21 months of follow-up. These events incurred an average health plan cost of \$14,957 per event, or \$2,101 per patient per year.

What this study adds

- The total annual health care cost for a VTE ranged from \$7,594 to \$16,644, depending on the type of event and whether it was a primary or secondary diagnosis. The hospital readmission rates of DVT or PE within 12 months were 5.3% for primary and 14.3% for secondary diagnoses.
- The recurrent DVT event was associated with 21% greater cost compared with the initial DVT event, but there was no difference in cost for the recurrent PE event compared with the initial PE event.
- The use of health plan total medical costs, including outpatient medical and pharmacy in this study, resulted in higher total costs compared with previous studies that used hospital inpatient costs.

Venous thromboembolism (VTE) is a common medical condition comprising deep vein thrombosis (DVT) and pulmonary embolism (PE). VTE is of particular importance in the hospital setting since more than half the cases of VTE are accounted for by institutionalization, with 24% of the cases attributable to hospitalization for surgery.¹ In the absence of prophylaxis, the incidence of objectively confirmed, hospital-acquired DVT ranges from 10% to 40% in the medical and general surgical population to as high as 40% to 60% in patients who have undergone orthopedic surgery.² Furthermore,

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in patients who have undergone major orthopedic surgery, the mortality rate due to VTE can be as high as 5%, underscoring the very high-risk nature of this population.² Recent estimates for the incidence of VTE in the United States suggest that VTE occurs, for the first time, in 100 to 120 of every 100,000 (~0.1%) of the population yearly.^{3,4}

Few data exist on the overall economic burden of VTE; however, Botteman et al.⁵ constructed a model to assess cost-effectiveness of DVT prophylaxis in total hip replacement (THR) in the United States. They estimated the cost of diagnosis and treatment of DVT at \$4,159 and PE at \$5,567. Other analyses have provided data on the economic burden of VTE via cost-effectiveness studies of prophylaxis versus no prophylaxis.⁶⁻⁸ A study of administrative claim records for January 1, 1997, through March 31, 2004, found that the median annualized medical costs of patients during and after the DVT or PE event were \$17,512 and \$18,901, respectively.⁹

It is also important to note that the economic burden of VTE is not confined to the diagnosis and treatment of the initial event. Previous studies have demonstrated that a history of VTE is a strong independent risk factor for recurrent VTE in medical patients.^{10,11} Furthermore, 7% to 14% of patients with a VTE will have a recurrent event within 1 year,¹²⁻¹⁵ a figure that rises to approximately 30% at 10 years.^{15,16} It has been established that, in high-risk surgical patients, the majority of recurrent VTE occurs shortly after the initial event, most frequently in the first 3 months.¹³ These types of readmissions, especially within 30 days of the original hospital discharge, represent a major concern of quality patient care at hospitals. Moreover, the type of recurrent VTE episode appears to be strongly correlated to the initial VTE. For example, DVT accounted for 86% of recurrent VTE after an initial DVT, and PE accounted for 66% of recurrent VTE after an initial PE.¹⁷ In addition to recurrent VTE, other long-term complications include postthrombotic syndrome¹⁸ and pulmonary hypertension.¹⁹

The extended cost of long-term complications of VTE has been investigated in a small number of studies. In patients who had undergone THR, the average lifetime costs associated with long-term complications of VTE was \$3,069 per patient.²⁰ Similarly, in the study by Botteman et al.⁵, the annual cost of long-term events in patients with VTE after THR was \$3,798 for DVT and \$6,404 for PE. In an analysis of administrative claims from 2 large U.S. health care plans, Bullano et al. found during a 21-month follow-up of patients who experienced a VTE event that 13.4% of patients experienced an average of 1.26 recurrent VTE events that required hospitalization, with an average cost of \$5,736 per event.²¹

Although data exist to show that VTE and its sequelae pose a considerable medical problem, little data exist on the absolute cost burden of VTE. The present study therefore used actual health care plan reimbursement costs compiled in a large managed care database, containing records from across the

United States, to investigate the cost burden of not only initial but also hospital readmission for DVT and PE in the general population. The costs associated with a primary diagnosis of VTE are relatively clear as being all costs included during that hospitalization. Patients with VTE as a secondary diagnosis (and therefore with comorbidities) represent an interesting group to compare costs against patients with VTE as a primary diagnosis, since not all hospital costs of these patients are associated with the VTE event. Therefore, this study also investigated the costs associated with DVT and PE in patients with VTE as a secondary diagnosis.

Methods

Data Source

This study was a retrospective observational cohort analysis utilizing data from the Integrated Health Care Information Services (IHCIS) National Managed Care Database, which contains claim information from approximately 30 managed care organizations and comprises patient records for approximately 25 million patients across the United States, from 1998 to 2005.

Study Population

Overall Economic Burden of DVT and PE

For the analysis of the economic burden of DVT or PE, patients were included in the analysis if they had DVT and/or PE as the primary or secondary discharge diagnosis, and the hospitalization event occurred between February 1, 1998, and June 30, 2004. The first hospitalization for DVT or PE during the study period was defined as the index event. Patients were excluded if they did not have continuous health care plan enrollment and continuous pharmacy benefits for a minimum of 30 days prior to and 365 days following the hospitalization for DVT or PE. In addition, patients were excluded if they were aged older than 65 years and were not in the Medicare risk group (i.e., Medicare coverage with continuous pharmacy benefit from managed care organizations). Patient records that were not complete according to a prespecified list of required data fields, which included details of membership, hospitalization, outpatient medical, and outpatient pharmacy, were also excluded from the final analysis.

Comparison of Hospital Reimbursement of DVT/PE Readmissions

For the analysis of the economic burden of hospital readmission for DVT or PE, there were 2 additional criteria to ensure that these patients did have a true DVT or PE event and hospital readmission: (1) patients were required to have a minimum hospital length of stay of 3 days, and (2) patients were also required to have a minimum of 365 days where they did not have any DVT or PE hospitalization but had continuous health care plan enrollment prior to the index hospitalization (initial DVT or PE hospitalization).

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Data Collection and Analysis Recurrent DVT or PE Analysis

Demographic information was collected for all DVT and PE patients separately. To measure hospital readmission for DVT or PE, the following data were collected for primary or secondary diagnosis of DVT or PE: type of VTE event, time to first recurrent event, and time pattern of readmission (monthly percentages of readmission from the first month to 12 months after first discharge). Only reimbursed hospitalization costs were compared for both initial VTE admission and readmission. Outpatient medical and pharmacy costs were not measured and compared between the initial VTE admission and readmission, leading to patients being treated as outpatients in the emergency room not being included in the costs. In the evaluation of VTE hospital readmission rate, it was required that the initial DVT or PE hospital admission be followed by a DVT or PE hospital readmission within the required time period. In the evaluation of the time pattern of DVT or PE hospital readmission, only more specific readmission types are measured: an initial DVT admission followed by a DVT readmission or an initial PE admission followed by a PE readmission.

Total Economic Burden of DVT or PE Analysis

To measure the economic burden of VTE, the following data were collected separately for primary or secondary diagnosis of DVT or PE: type of VTE event, length of hospital stay, and average total annual reimbursement for DVT or PE-related inpatient costs, outpatient medical costs, outpatient procedure costs and outpatient pharmacy costs. In this analysis, VTE-related inpatient and outpatient pharmacy costs were defined as those incurred through use of a VTE treatment-related drug, namely unfractionated heparin (UFH), a low-molecular-weight heparin (LMWH: ardeparin, dalteparin, enoxaparin, or tinzaparin), or danaparoid, warfarin, or fondaparinux. VTE-related outpatient procedure costs were defined as those incurred through use of a VTE diagnosis and treatment-related procedures (Appendixes A and B).

Cost Calculations

Costs associated with various measures of resource utilization were reported in the IHCIS database on the basis of actual reimbursement by the participating health care plans, and as such, only costs that were reimbursed by health care plans are included in this analysis. For inpatient professional services and outpatient services, only the cost associated with a DVT or PE diagnosis was used in the calculation. For outpatient lab procedures and prescription cost, only procedures or drugs related to the diagnosis and management of VTE were used in the cost calculation (Appendixes A and B).

Patients with DVT or PE as secondary discharge diagnoses were matched by primary diagnosis, and only the portion of hospital facility cost that was attributable to DVT or PE was

estimated and used for the total annualized health care cost. The DVT or PE attributable hospital facility cost is defined as the difference of hospital facility cost between the patient cohort with secondary diagnoses of DVT or PE and a control patient cohort. For each member in the DVT or PE patient cohort, up to 3 non-DVT or non-PE members were selected from the database to form the control cohort based on the following matching criteria: same sex and geographical census region, ≤ 5 -year age difference, and the same primary hospital discharge diagnosis (based on *International Classification of Diseases, Ninth Revision, Clinical Modification* [ICD-9-CM] codes).

Data and costs analysis were performed using SAS 8.2 software (SAS Institute Inc., Cary, NC). The Student's *t* test assuming unequal variances was carried out to test the statistical significance of the difference in the total hospitalization costs between DVT or PE readmission and the initial DVT or PE hospitalization. A *P* value below 0.05 was considered as statistically significant in this study.

Results

Patient Population

A total of 14,108 patients met the inclusion criteria of this study (Figure 1). Of these patients, 5,348 had a primary diagnosis of DVT in the index hospitalization, 2,984 had a primary diagnosis of PE, a further 5,776 patients had a secondary diagnosis of DVT and/or PE in the index hospitalization (4,593 DVT, 1,119 PE alone, and 64 DVT and PE).

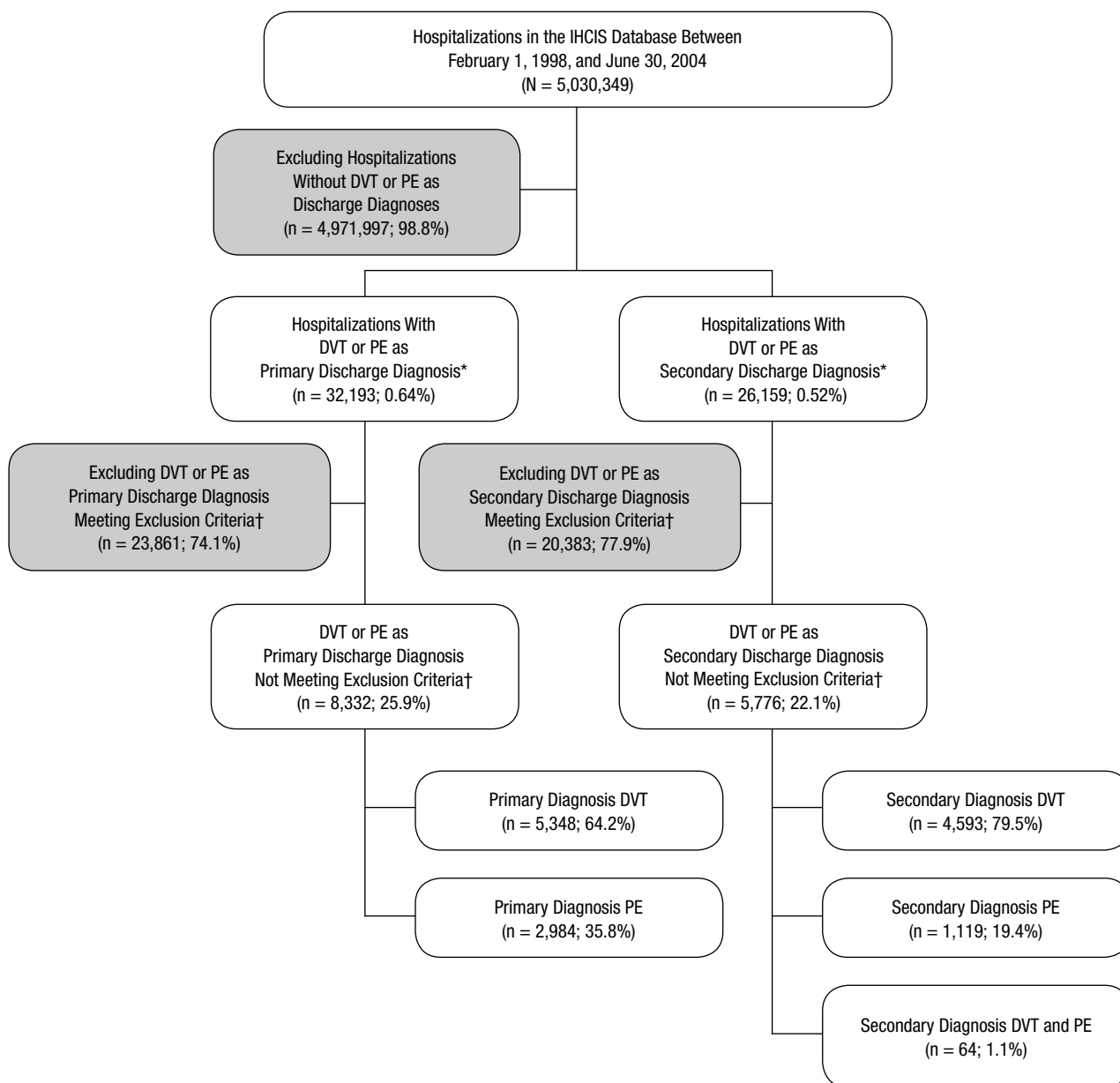
Patients with a primary diagnosis were younger (mean age 53.9 years for the DVT-alone group and 52.7 for the PE-alone group) compared with patients with DVT or PE as a secondary diagnosis (mean age 55.5 and 54.6 years, respectively). Patients were predominantly female and came from a number of different census regions (Table 1).

Hospital Readmission Rate for DVT or PE as Primary or Secondary Diagnosis

In patients with a DVT or PE as the primary diagnosis, the rate of hospital readmission for DVT or PE over 1 year was 5.3%, while readmission was much higher in patients with DVT or PE as a secondary diagnosis, reaching a rate of 14.3% by 1 year (Figure 2). A clear trend of early occurrence was observed in patients with either DVT or PE as the primary diagnosis, with 27.1% of hospital readmissions for DVT and 44.3% of hospital readmissions for PE occurring in the first 30 days after the initial event (Figure 3A). A total of 50.7% of all hospital readmissions for DVT, and 58.6% of all hospital readmissions for PE had occurred within 90 days of the initial event. Similar trends were observed in patients with DVT or PE as a secondary diagnosis, with 22.8% and 46.4% of all hospital readmission for DVT having occurred at 30 and 90 days respectively, and 32.8% and 51.6% of all hospital readmission for PE having occurred at the same time points (Figure 3B).

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FIGURE 1 Study Population for the Determination of Overall Economic Burden of DVT or PE



* Discharge diagnosis determined with ICD-9 codes 451.1, 451.11, 451.19, 451.2, 451.9, 453.8, 453.9, 453.4, 453.40, 453.41, 453.42, 444.21, 444.81, 451.0, or 997.2 for DVT, and 415.1, 415.11, or 415.19 for PE.

† Exclusion criteria:

- No continuous health care plan enrollment and continuous pharmacy benefit for a minimum of 30 days prior to, and 365 days following, the DVT or PE hospitalization.
- Age >65 years and not in the Medicare risk group.
- Incomplete patient records.

DVT=deep vein thrombosis; ICD-9=International Classification of Diseases, Ninth Revision; PE=pulmonary embolism.

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TABLE 1 Baseline Demographics for Patients With a DVT or PE

	DVT as Primary Diagnosis *	PE as Primary Diagnosis *	DVT as Secondary Diagnosis	PE as Secondary Diagnosis	DVT and PE as Secondary Diagnosis
No. of patients	5,348	2,984	4,593	1,119	64
Age (mean)	53.9	52.7	55.5	54.6	57.6
Female (%)	54	57	54	53	49
Census region (%)					
East North Central	2.6	3.2	1.9	2.7	2.9
East South Central	1.6	0.7	0.9	0.3	1.4
Middle Atlantic	30.4	20	25.8	23.9	20.0
Mountain	6	6.9	8.8	3.4	7.1
National†	24.5	32	34.2	42.8	51.4
New England	18.4	22.6	17.3	16.5	8.6
Other	0.1	0.1	0.2	0.1	0.0
Pacific	0.4	0.7	0.5	0.2	0.0
South Atlantic	5	5.3	3.6	4.4	2.9
West North Central	5.3	4.5	2.9	2.1	4.3
West South Central	5.6	3.9	4.1	3.6	1.4

* Primary DVT and primary PE are mutually exclusive; either DVT or PE was the primary diagnosis.

† Some health care plan members are grouped into a generic "National" region to protect their identities when the combination of their medical and demographic information is considered as "infrequent" and thus can be used to potentially identify the members from the combinations.

DVT=deep vein thrombosis; PE=pulmonary embolism.

The Economic Burden of Hospital Readmission for DVT or PE

In patients with hospital readmission for a DVT or PE as primary diagnosis, the costs associated with the readmission were higher than the initial hospitalization (Figure 4). For patients with a DVT, total hospitalization cost was significantly greater by \$2,057 (21%, from \$9,805 to \$11,862, $P = 0.006$), primarily due to a trend of increased length of hospital stay for the recurrent episode (from 7.7 to 8.7 days, $P = 0.17$ [Appendix C]). For patients who had hospital readmission for PE, the total hospitalization cost for the readmission was \$14,722 compared with \$14,146 for the initial hospitalization ($P = 0.38$). Length of hospital stay was 7.6 and 7.4 days, respectively ($P = 0.44$ [Appendix C]).

Resource Use and Economic Burden of VTE as the Primary Diagnosis

The average total annualized health care cost of a patient with a primary diagnosis of DVT or PE was \$10,804 and \$16,644, respectively (Table 2). The majority of the costs for both DVT and PE were hospitalization facility costs (\$8,228 and \$13,223 per patient, respectively), with hospitalization professional costs (\$898 and \$1,355 per patient) and outpatient procedure costs (\$821 and \$989 per patient) being the next most costly components. Resource utilization was also higher for PE patients than

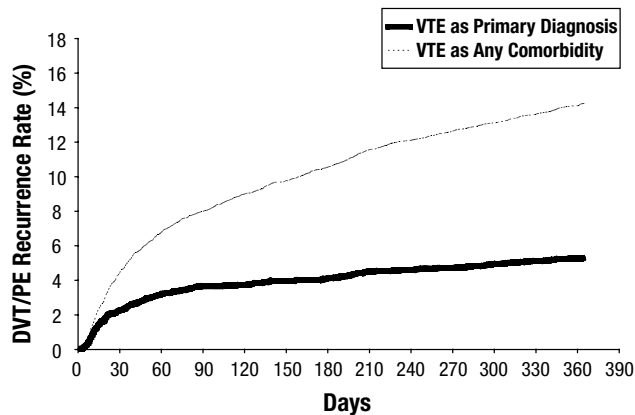
for DVT patients, with a longer average length of hospital stay (7.0 vs. 5.6 days), and higher numbers of outpatient prescriptions (7.5 vs. 6.4 prescriptions per patient), hospitalization professional service (10.7 vs. 7.6 services per patient), outpatient procedures (19.6 vs. 15.5 procedures per patient), and outpatient office visits (3.5 vs. 3.2 visits per patient) (Table 3). For patients with a primary diagnosis of DVT or PE, the secondary comorbidity is widely distributed among a large number of conditions (see Appendix D). Patients most frequently visited internal medicine physicians (37.2%), family physicians (20.7%), and pulmonologists (5.9%) for their outpatient DVT or PE care. The remaining 36.2% of patients visited a physician with other specialties or no specialty defined in the records.

Breakdown of Annual Cost of DVT and PE to Health Care Plans

The average annualized health care costs of DVT or PE were higher in the patients in the Medicare group than in the general population. In Medicare patients, the average costs for patients with a primary diagnosis of DVT or PE were \$13,208 and \$20,728 per patient, respectively, representing cost increases of \$2,404 for DVT and \$4,084 for PE over the whole population. The differences in costs were driven by increased hospital length of stay for the Medicare group. The higher costs in the

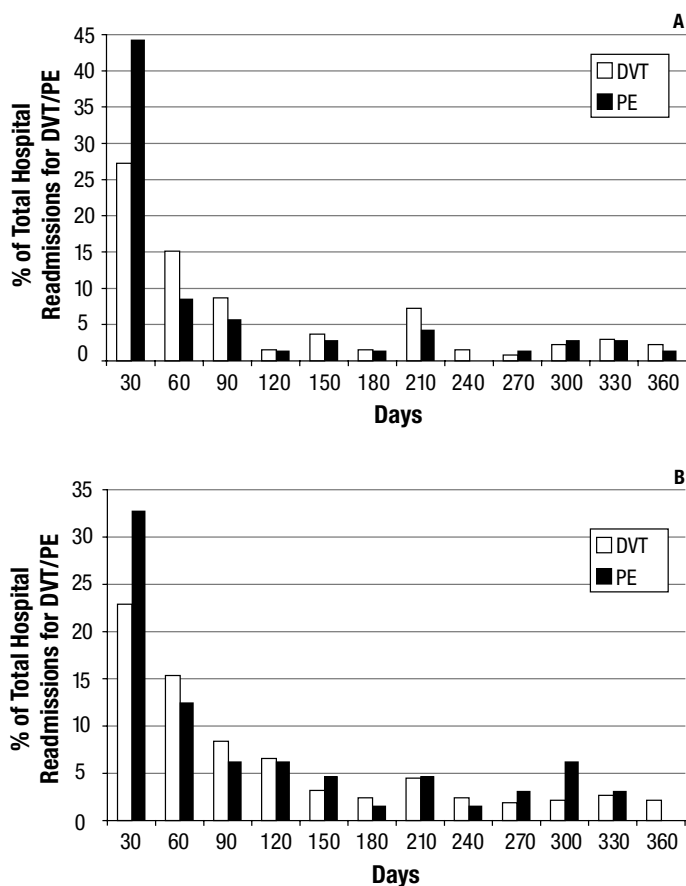
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FIGURE 2 Readmission Rate for DVT or PE as Primary or Secondary Diagnosis



* Readmissions with hospital stay less than 3 days were excluded.
DVT=deep vein thrombosis; PE=pulmonary embolism; VTE=venous thromboembolism.

FIGURE 3 Timing of Hospital Readmission for DVT or PE by Time Within 360 Days From Discharge in Patients With a Primary (A) (DVT, n=140; PE, n=70) or Secondary (B) (DVT, n=386; PE n=64) Diagnosis of DVT or PE



Total number of readmissions were 140 for primary DVT diagnosis, 386 for secondary DVT diagnosis, 70 for primary PE diagnosis, and 64 for secondary PE diagnosis.
DVT=deep vein thrombosis; PE=pulmonary embolism.

Medicare group could be related to higher costs in patients aged ≥ 70 years. Although average costs were similar for age groups up to 70 years, they were approximately 25% higher in patients aged ≥ 70 years compared with the whole population (Table 4).

Economic Burden of DVT and PE as Secondary Diagnosis

The proportion of the average total annualized health care cost of a patient that was associated with a secondary diagnosis of DVT or PE was lower than in patients with a primary diagnosis at \$7,594 and \$13,018, respectively (Table 2). The cost in both the DVT and PE groups was primarily driven by hospitalization facility costs (\$5,118 and \$9,906, respectively), followed by hospitalization professional costs, outpatient procedure costs, and outpatient prescription costs. The cost of a patient having both DVT and PE in the secondary diagnosis was extremely high at \$27,909. However, this result must be treated with caution since it was based on a low number of patients.

Discussion

In this study, utilizing actual health care plans reimbursement costs from approximately 25 million patients from across the United States. in a large managed care database to estimate the costs associated with VTE, it was found that the annualized total health care costs of admission for a primary diagnosis of DVT or PE were \$10,804 and \$16,644, respectively. Furthermore, hospital readmission for DVT or PE occurred predominantly in the first 90 days following the initial event, with a high proportion of the readmissions occurring in the first 30 days following

the initial event. DVT or PE readmissions were associated with an average total hospitalization cost per event of \$11,862 for DVT and \$14,722 for PE. The cost of hospital readmission for DVT was 21% greater than the cost for the initial DVT event, a difference driven by a trend toward an increased length of hospital stay (an average of 7.7 days for the initial admission vs. 8.7 days for the readmission [$P=0.17$]). A similar trend was not observed for patients who had an initial PE hospitalization.

The high rate of hospital readmission for DVT or PE found in the present study within the first 30 days or first 90 days is a point of concern for the quality of VTE care in hospitals, and is

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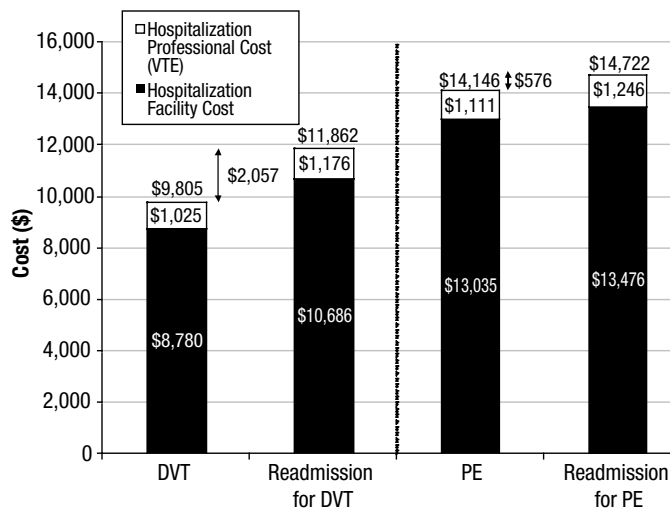
in line with previous estimates.^{12,13,15} In a population-based cohort study of 1,719 patients with a first episode of DVT or PE, the cumulative percentage of patients with recurrent VTE was 5.2% at 30 days and 8.3% at 90 days.¹⁵ The cost per event of readmission for DVT and PE observed in our study was also similar to that seen in previous smaller study populations. In the cohort study of Bullano et al.,²¹ a recurrent DVT or PE was associated with a total hospital cost of \$11,419 and \$11,014, respectively. These results highlight the importance of preventing a first episode of DVT or PE, in order to also reduce the cost burden associated with subsequent long-term complications.

The level of readmissions for VTE represents the “worst offenders” in readmission, since the patients are coming back for exactly the same disease that they just left the hospitals for, with a high proportion of readmission occurring in the first 30 days or first 90 days. This represents significant issues for the quality of care. The Joint Committion is in the process of developing a VTE prevention and care performance measurement initiative that will come out in 2008. The goal for individual hospitals will be to reduce the incidence of first episode DVT and PE as well as the incidence of hospital readmissions for DVT or PE. The use of evidence-based, guideline-mandated prophylaxis and treatments may help to improve the continuum of care and reduce the economic burden of DVT and PE in these hospitals.

The costs of DVT and PE that were observed in patients with a primary diagnosis of DVT or PE were in line with the results seen in other smaller study populations. For example, in orthopedic surgery patients, the cost difference for the mean inpatient costs compared with patients without a VTE were \$7,769 for those patients with a DVT and \$9,176 with a PE.²² In a study comparing outpatient LMWH with inpatient unfractionated heparin for patients with confirmed DVT, the average inpatient cost of treating DVT was estimated to be \$4,696 per hospitalization compared with \$1,868 for outpatient treatment.²³ However, in a retrospective analysis in a health maintenance organization in New Mexico, the total average cost for patients treated for a DVT in hospital with unfractionated heparin was \$11,930.²⁴ A study from 2 managed care organizations, in the southeastern and western United States, reported the total costs for more than 2,000 patients admitted to the hospital with a DVT or PE. It showed that the average cost per DVT event was \$7,712 (median \$3,131) and \$9,566 (median \$6,424) for a PE event.²¹

Little data exists, however, on the total hospitalization cost of DVT or PE in large real-world studies that are representative of hospitals across the United States. The present study encompasses total annualized cost data from more than 12,000 patients with DVT or PE from across the United States, and the costs observed are higher than for many other studies. These higher costs compared with earlier studies may be a result of the data we used, including inpatient as well as outpatient payments to providers. Like

FIGURE 4 The Total Average Hospitalization Costs per Patient Associated With Initial Hospital Admission and Hospital Readmission* for DVT or PE as Primary Diagnosis



* Readmissions with hospital stay less than 3 days were excluded.
DVT=deep vein thrombosis; PE=pulmonary embolism; VTE=venous thromboembolism.

Bullano et al.²¹ we used net payer costs (i.e., after subtraction of member cost), but we used outpatient costs that included pharmacy as well as inpatient hospital costs. We also report the costs associated with a secondary diagnosis of DVT or PE, providing an estimate of the relative component that a VTE event has in the total health care cost of patients presenting with comorbidities. MacDougall et al., in a similar analysis of administrative claims data for 1997 through the first quarter of 2004, found median annualized medical costs of \$17,512 during and after the DVT event and \$18,901 during and after the PE event, representing median annualized incremental costs compared with a prevent baseline of \$10,285 for DVT patients and \$12,520 for PE patients.⁹ These median costs are higher than the mean costs that we found in the present study, which may be explained in part by the inclusion of recurrent VTE in the main cost calculations of the previous study reported by MacDougall and colleagues.

Limitations

Foremost among the study limitations is the difficulty in isolating the incremental medical costs associated with VTE since these patients typically have multiple comorbid conditions. For example, Bullano et al. found previously that disease severity is high in these patients, including 59% with a history of or

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TABLE 2 Economic Burden of DVT and PE as Primary and Secondary Diagnosis, Average cost per Discharge Including 12 Months of Follow-up Period

	Total Cost (\$)	Hospitalization Facility Cost (\$)	Hospitalization Professional Cost (\$) (VTE)	Outpatient Office Visit Cost (\$) (VTE)	Outpatient Procedure Cost (\$) (VTE)	Outpatient Prescription Cost (\$) (VTE)
DVT as primary diagnosis (n=5,348)	10,804	8,228 (76.2%)	898 (8.3%)	172 (1.6%)	821 (7.6%)	685 (6.3%)
DVT as secondary diagnosis (n=4,593)	7,594	5,118 (67.4%)	959 (12.6%)	107 (1.4%)	783 (10.3%)	628 (8.3%)
PE as primary diagnosis (n=2,984)	16,644	13,223 (79.4%)	1,355 (8.1%)	188 (1.1%)	989 (5.9%)	889 (5.3%)
PE as secondary diagnosis (n=1,119)	13,018	9,906 (76.1%)	1,276 (9.8%)	130 (1.0%)	900 (6.9%)	805 (6.2%)
DVT and PE as secondary diagnosis (n=64)	27,909	21,097 (75.6%)	2,538 (9.1%)	176 (0.6%)	1,823 (6.5%)	2,275 (8.2%)

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

active malignancy.²¹ Second, the index event for patients in this study was hospitalization for either a primary or secondary diagnosis of DVT or PE, and as such, this study excludes patients who were seen in the emergency room, treated, and sent home on an LMWH or other anticoagulation. Therefore, this study would tend to overestimate the per-patient costs for VTE. On the other hand, since some patients with VTE treated in a hospital outpatient department were excluded, the incidence and prevalence of VTE would be underestimated by our methods.

Third, as with all retrospective administrative data analysis studies, there is the potential bias from missing data since some records are excluded from the analysis. However, since the sample size is large in the present study, and the missing data are not expected to be missing in a systematic manner, it is unlikely that this will have a large impact on the results. In the present study, we used a data source that did not disclose the plan names or detail information about the plans. There is, therefore, the chance that the results will not be representative of the national averages. We did however estimate the regional differences in the cost of primary DVT or PE (data not shown), and found that although differences did exist, they were not significant.

Fourth, in determining the inclusion and exclusion criteria of this study, a number of assumptions were made that may have impacted the results. We required patients to be enrolled in a health care plan before the DVT or PE event for a period of 30 days in the calculations of the total cost of DVT or PE, and for 365 days in the calculations of the hospitalization readmission costs.

Fifth, we also required that patients who were readmitted for DVT or PE had a minimum length of stay of 3 days in both the initial and readmission hospitalization. This was a conservative approach to ensure that during both the initial hospitalizations

and readmissions, a minimum length of DVT or PE treatments were administered. However, many legitimate DVT or PE patients, such as those who were admitted for only 1 to 2 days and then discharged for outpatient LMWH treatments would have been excluded due to this conservative approach, leading to an overestimation of average cost, but an underestimation of total readmissions.

There are also a number of additional complications of DVT that were not investigated in this article, but which contribute to the total cost burden of the disease, such as post thrombotic syndrome (PTS). PTS was not included due to the fact that there is not universal consensus on using ICD-9-CM code 459.1 (postphlebotic syndrome) to represent PTS. The costs reported here are therefore likely to be an underestimate of the total long-term costs associated with a first DVT.

Conclusion

This study has demonstrated the high cost burden of DVT and PE among a large national managed care population. Furthermore, it shows that readmission for DVT or PE occurs in up to 14.3% of patients, with 27.1% to 44.3% of readmissions within 30 days, and 50.7% to 57.8% occurring within 90 days. Furthermore, DVT readmissions incur a 21% greater cost than the initial episode. Hospitals have the potential to reduce the national cost burden of VTE and meet new quality initiatives by ensuring that VTE events are prevented via the use of evidence-based, guideline-mandated prophylaxis options in patients identified at risk of VTE.

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TABLE 3 Resource Utilization in 12 Months of Follow-up

	Total No. of Claims	Mean	SD	Median	IQR (Low)	IQR (High)
Hospital admissions (LOS in days)*						
DVT as primary diagnosis	6,101	5.6	6.0	4.0	3.0	6.0
DVT as secondary diagnosis	5,448	8.9	12.4	6.0	4.0	10.0
PE as primary diagnosis	3,369	7.0	13.9	6.0	4.0	8.0
PE as secondary diagnosis	1,357	10.8	10.3	8.0	5.0	14.0
DVT and PE as secondary diagnosis	185	16.8	16.9	12.0	8.0	18.0
Hospital inpatient professional service*						
DVT as primary diagnosis	40,656	7.6	8.8	5.0	3.0	9.0
DVT as secondary diagnosis	29,404	6.4	8.8	4.0	1.0	9.0
PE as primary diagnosis	32,008	10.7	10.3	8.0	5.0	13.0
PE as secondary diagnosis	10,123	9.0	12.7	5.0	2.0	12.0
DVT and PE as secondary diagnosis	1,194	18.7	14.4	15.5	8.0	27.0
Physician office visits*						
DVT as primary diagnosis	16,921	3.2	4.5	2.0	0.0	4.0
DVT as secondary diagnosis	10,076	2.2	4.2	0.0	0.0	3.0
PE as primary diagnosis	10,418	3.5	4.8	2.0	1.0	4.0
PE as secondary diagnosis	2,678	2.4	4.0	1.0	0.0	3.0
DVT and PE as secondary diagnosis	203	3.2	4.6	2.0	0.0	4.5
Outpatient procedures*						
DVT as primary diagnosis	82,831	15.5	24.1	7.0	1.0	21.0
DVT as secondary diagnosis	60,281	13.1	23.8	3.0	0.0	18.0
PE as primary diagnosis	58,407	19.6	22.8	12.0	3.0	29.0
PE as secondary diagnosis	18,536	16.6	36.0	7.0	0.0	21.0
DVT and PE as secondary diagnosis	1,335	20.9	25.3	12.0	3.0	31.0
Outpatient prescriptions*						
DVT as primary diagnosis	34,033	6.4	5.4	6.0	2.0	10.0
DVT as secondary diagnosis	23,324	5.1	5.6	4.0	0.0	8.0
PE as primary diagnosis	22,502	7.5	5.2	7.0	4.0	11.0
PE as secondary diagnosis	6,751	6.0	5.1	6.0	1.0	10.0
DVT and PE as secondary diagnosis	495	7.7	6.5	6.0	4.0	11.0

* Average use per patient, e.g., number of outpatient office visits per patient. Only resources and treatments used for treatment of a DVT or PE diagnosis are included (see Appendix B).

DVT=deep vein thrombosis; IQR=interquartile range; LOS=length of hospital stay; PE=pulmonary embolism.

DISCLOSURES

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TABLE 4 Average Cost per Discharge for DVT or PE as Primary Diagnosis With Breakdown by Age Groups

Age (Years)	DVT as Primary Diagnosis		PE as Primary Diagnosis	
	n (%)	Hospitalization Costs (\$)	n (%)	Hospitalization Costs (\$)
<40	919 (17.2)	10,291	513 (17.2)	17,415
40-49	1,170 (21.9)	10,422	734 (24.6)	14,656
50-59	1,611 (30.1)	10,219	951 (31.9)	16,417
60-69	911 (17.0)	10,747	491 (16.5)	16,701
≥70	737 (13.8)	13,403	295 (9.9)	20,883
Total/average	5,348	10,804	2,984	16,644

DVT=deep vein thrombosis; PE=pulmonary embolism.

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APPENDIX A Imaging and Laboratory Procedures of Interest

CPT-4 Codes

Imaging Services	Description	Laboratory Services	Description
36488-36491, 36493	Central venous catheter (placement and repositioning)	85210	Factor II, activity*
		85220	Factor V, activity*
71010-71035	Chest radiography	85230	Factor VII, activity*
71040-71060	Bronchography	85240	Factor VIII, activity*
71275	Computed tomographic angiography, chest	85244	Factor VIII antigen*
71550-71555	Magnetic resonance imaging, chest	85245	Ristocetin cofactor*
75741-75746	Pulmonary angiography*	85246	Von Willebrand antigen*
76880, 76856-76857	Ultrasonography	85247	Von Willebrand factor multimers*
75820-75827	Venography, extremity, caval*	85250	Factor IX, activity*
75831-75872	Venography, renal, adrenal, neuro	85260	Factor X, activity*
78457, 78458	Venous thrombosis imaging*	85270	Factor XI, activity*
78580-78594	Ventilation/perfusion lung scan	85280	Factor XII, activity*
78596	Ventilation/perfusion study*	85290	Factor XIII, activity*
93875	Noninvasive study of extracranial arteries (bilateral)	85291	Factor XIII, solubility*
		85292	Prekallikrein assay*
93880-93882	Duplex/unilateral scan of extracranial arteries	85293	HMW kininogen*
		85300	Clotting inhibitors, antithrombin III, activity*
93886-93888	Transcranial Doppler study of intracranial arteries (limited or complete)	85301	Antithrombin III, antigen assay*
		85302	Protein C, antigen*
93922-93924	Noninvasive physiologic studies upper/lower extremity arteries including Doppler waveform analysis	85303	Protein C, activity*
		85305	Protein S, total*
93925-93931	Duplex scan of upper/lower extremities	85306	Protein S, free*
93965	Doppler Continuous-wave ultrasound; plethysmography*	85378-85380	Fibrin degradation products, D-dimer*
93970-93971	Compression ultrasound of extremity veins*	85420	Plasminogen (activity)*
		85610	Prothrombin time (PT)*
93990	Extremity arterial-venous studies; duplex scan of hemodialysis access	85730	Thromboplastin time, partial (PTT)*

* Events are included as outpatient disease-related resource utilization and costs.

CPT=Current Procedural Terminology.

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APPENDIX B ICD-9 Codes Used for
DVT or PE Diagnosis

DVT	
451.1	Phlebitis & thrombophlebitis deep veins lower extremity
451.11	Phlebitis and thrombophlebitis of femoral vein
451.19	Phlebitis & thrombophlebitis oth deep vessels lower extremity
451.2	Phlebitis & thrombophlebitis lower extremity unspecified
451.9	Phlebitis & thrombophlebitis of unspecified site
453.8	Embolism & thrombosis of other specified veins
453.9	Embolism & thrombosis of unspecified site
453.4	Venous embolism & thrombosis deep vessels lower extremity
453.40	Venous embolism & thrombosis uns deep vessels lower extremity
453.41	Venous embolism & thrombosis deep vessels prox lower extremity
453.42	Venous embolism & thrombosis deep vessels dist lower extremity
444.21	Embolism & thrombosis arteries upper extremity
444.81	Embolism & thrombosis of iliac artery
451.0	Phlebitis & thrombophlebitis sup vessels lower extremity
997.2	Peripheral vascular complications nec
PE	
415.1	Pulmonary embolism & infarction
415.11	Iatrogenic pulmonary embolism & infarction
415.19	Other pulmonary embolism & infarction

DVT=deep vein thrombosis; ICD-9=International Classification of Diseases, Ninth Revision; PE=pulmonary embolism.

APPENDIX C Hospital Length of Stay in
Discharges During Initial
Hospitalization or Readmission*
for DVT or PE

Discharge Group	Length of Stay (Days)	P Value
First DVT admission	7.7	
DVT readmission	8.7	0.17
First PE admission	7.4	
PE readmission	7.6	0.38

* Readmissions with hospital stay less than 3 days were excluded.
DVT=deep vein thrombosis; PE=pulmonary embolism.

APPENDIX D Comorbidities in Patients
With DVT and PE

Comorbidity Categories	1° DVT (%)	2° DVT (%)	1° PE (%)	2° PE (%)	2° DVT + PE (%)
Infectious and parasitic diseases	1.6	1.0	1.5	1.0	0.7
Neoplasms	6.4	4.1	5.0	3.4	4.9
Endocrine, nutritional, metabolic, immunity	13.9	8.8	12.0	8.2	7.3
Blood and blood-forming organs	5.9	3.7	4.5	3.0	4.8
Mental disorders	5.5	3.5	4.5	3.0	2.9
Nervous system and sense organs	2.5	1.6	1.9	1.3	1.6
Circulatory system	31.2	53.6	34.1	55.2	56.6
Respiratory system	5.6	3.5	13.0	8.8	6.2
Digestive system	5.0	3.2	4.9	3.3	2.7
Genitourinary system	4.1	2.6	3.8	2.6	3.3
Complications of pregnancy, childbirth, puerperium	0.1	0.1	0.2	0.1	0.0
Skin and subcutaneous tissue	4.0	2.5	1.1	0.7	1.0
Musculoskeletal system and connective tissue	5.0	3.2	3.2	2.2	2.6
Congenital anomalies	0.4	0.3	0.4	0.3	0.1
Conditions in the perinatal period	0.0	0.0	0.0	0.0	0.0
Symptoms, signs, and ill-defined conditions	5.8	3.7	7.4	5.0	3.8
Injury and poisoning	2.8	4.6	2.6	1.8	1.6

DVT=deep vein thrombosis; PE=pulmonary embolism.