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Full Length Article

Trends in admission rates and in-hospital stay for venous thromboembolism☆

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ABSTRACT

Background: Acute venous thromboembolism leads to significant morbidity and mortality. Advances in pharmacotherapy facilitate outpatient care in low-risk acute venous thromboembolism. The proportion of hospitalized acute venous thromboembolism cases and the average length of stay are not known. We sought to identify predictors of hospitalization, changes in hospitalization rates and length of stay of acute venous thromboembolism over a decade in Alberta, Canada.

Methods: Using linked administrative health databases, we identified adult patients diagnosed primarily with acute venous thromboembolism between April 2002 and March 2012. We measured trends using Poisson regression, adjusted length of stay using analysis of covariance. We identified predictors of hospitalization using multivariate logistic regression.

Results: 8198 out of 31,656 acute venous thromboembolism cases were hospitalized. The overall venous thromboembolism admission rates ranged between 23.7% and 27.8% with no evident temporal trend ($P = 0.10$). The average admission rate was 51.9% for pulmonary embolism and 16.1% for deep vein thrombosis. The mean length of stay for deep vein thrombosis and pulmonary embolism remained unchanged with an adjusted mean for venous thromboembolism of 6.9 ± 1.0 days. Higher Charlson index, older age, male gender, pulmonary embolism at presentation and multiple comorbidities were associated with hospitalization. Hospitalization was associated with 30-day mortality (odds ratio:2.8, 95% CI: 2.2–3.5) whereas the length of stay was not (odds ratio:1.0, 95% CI: 0.99–1.0).

Conclusion: Hospitalization rates and mean length of stay for acute venous thromboembolism did not change significantly between 2002 and 2012. Advances in pharmacotherapy have not yet reduced hospitalization rates or length of stay for venous thromboembolism.

1. Introduction

Venous thromboembolism, commonly presenting as deep vein thrombosis and pulmonary embolism, has an annual incidence estimated at 1 to 2 per 1000 persons per year [1,2]. Venous thromboembolism leads to significant morbidity and mortality [3] and is associated with substantial medical costs [4]. Direct medical costs were estimated at $10,804 and $16,644 for primary diagnosis of DVT and PE respectively [5]. The main consequences of venous thromboembolism include disease recurrence and major bleeding during anticoagulation therapy. In the first 3 months of venous thromboembolism treatment, the rates of recurrent fatal venous thromboembolism and fatal major bleeding are 0.4% and 0.2% respectively with similar case fatality rates of recurrent venous thromboembolism and major bleeding at approximately 11.3% [6]. As the rate of recurrent venous thromboembolism without adequate anticoagulation is substantially higher than the rate of major bleeding on anticoagulation in these critical first 3 months, it is important to initiate appropriate treatment immediately.

With the transition from intravenous unfractionated heparin to low-molecular-weight heparin and vitamin K antagonists, and then more recently to direct oral anticoagulants with or without antecedent low-molecular-weight heparin, outpatient acute venous thromboembolism treatment has become a more viable option. Three recent systematic reviews concluded that outpatient treatment for patients with low-risk pulmonary embolism is safe [7–9], and the 2016 American College of Chest Physicians (ACCP) antithrombotic guidelines recommend outpatient management over in-hospital treatment for patients with acute deep vein thrombosis provided that they have adequate outpatient support. They also suggest that low-risk acute pulmonary embolism patients can be treated at home or discharged early when home

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conditions are suitable including good cardiorespiratory function, compliance to medication, no contraindication to treatment and the patient well-being [10]. Clinical tools, such as the pulmonary embolism severity index (PESI) score, can help determine which patients may be candidates for outpatient treatment [11,12].

Current data on hospitalization rates of venous thromboembolism and the length of stay in hospitals are very limited. The Worcester study determined an increase in outpatient treatment of venous thromboembolism from 22% in 1999 to 29% in 2003 [13]. We sought to measure temporal trends of admission to hospital as well as length of hospital stay for acute venous thromboembolism in a population-based sample using administrative health databases in the province of Alberta, Canada, to identify predictors of hospitalization, and to determine whether hospitalization was associated with 30-day mortality.

2. Methods

2.1. Study design

We conducted a retrospective cohort study using five linked provincial health administrative databases from April 1, 2002 to March 31, 2012 in Alberta, Canada to form the Alberta-Venous Thromboembolism (AB-VTE) database.

2.2. Data source

Previous publication has described the design of the AB-VTE database [14]. The database consists of the ambulatory care database which includes the emergency department and the outpatient clinic visits, the hospital inpatient discharge database, the physician claims database, the population registry and vital statistics. The ambulatory care database provides up to 10 diagnostic and 10 procedure codes, whereas the hospital inpatient database provides up to 25 diagnostic and 20 procedure codes. Alberta Vital Statistics data records information on deaths within Alberta.

2.3. Study population

The cohort included adult patients, residents of Alberta, 18 years of age or older with any health care encounter coded as deep vein thrombosis and/or pulmonary embolism using a validated case-defining criteria [15] from the time of entry to the study until their death or the end of the study (March 31, 2012), whichever occurred first. Patients were definitely diagnosed with acute venous thromboembolism if they had a diagnostic event code within 7 days of a VTE-related imaging code. The date of imaging procedure was considered as the date of diagnosis if cases were identified from the ambulatory care and physician claim databases. The date of admission was used as the date of diagnosis for inpatient cases detected in the inpatient discharge database.

The diagnosis of deep vein thrombosis was made using the following codes: ICD-9 CM: 451.1. 451.2, 451.8, 451.9, 453.2, 453.8, or 453.9; ICD-10: I80.2, I80.3, I80.1, I82.8, I80.9, I82.9, I80.8, O22.3, O22.9, or O87.1. Pulmonary embolism was defined using ICD-9 CM: 415.0 and 415.1 and ICD-10: I26.9, I26.0. Patients coded with both events were analyzed with the pulmonary embolism group. Only the incident cases were considered using a 2-year washout period. The accuracy of our case finding algorithm to detect acute symptomatic venous thromboembolism has been previously validated against chart audit in Alberta [15], with a positive predictive value of 83.1%.

2.4. Study outcomes and covariates

The primary outcome was temporal trends in hospitalization rates after the diagnosis of venous thromboembolism. For hospitalized patients, we described crude and adjusted length of stay as well as predictors of hospitalization. We also examined the relationship between admission to hospital, length of stay and 30-day mortality. We recorded comorbidities if they were reported one year prior to the visit in the ambulatory care and inpatient databases. We defined the risk factors based on the period before the onset of venous thromboembolism. These factors include diagnosis of cancer 1 year before the event, major surgery, major trauma, hip fracture within the previous 3 months, ongoing or recent pregnancy (within 3 months from delivery) and hospitalization for other causes for >3 days in the last 3 months. In the absence of these risk factors, the event was classified as unprovoked. If cancer was present as a risk factor, the event was considered as cancer associated events. Otherwise, the presence of one or more of the other risk factors categorized the event as provoked.

2.5. Statistical analysis

To describe baseline characteristics, continuous variables were reported as means and standard deviations, and categorical variables were reported as frequencies and percentages. We calculated the rate of hospitalization for each year by dividing the number of patients admitted to the hospital by the total person-years at risk in the Alberta population covered by an Alberta health care insurance plan between April 1, 2004 and March 31, 2012 stratified by event type. Overall 30-day mortality rate was calculated by dividing the total number of all-cause mortality identified during the study period by the total number of venous thromboembolism cases, admitted and non-admitted. We used the likelihood ratio test of trend in the Poisson distribution to determine the statistical significance of change over time in the count outcomes; hospitalization and length of stay were transformed with a logarithmic link function and a log (population) offset term. Adjusted rates of length of stay were calculated using Analysis of Covariance for which all necessary assumptions have been met. To examine the predictors of hospitalization, the relationship between 30-day mortality and each of hospitalization and length of stay, we used purposefully selected multivariate logistic regression models. We adjusted models for age, sex, coexisting comorbidities, Charlson comorbidity index [16], provoking factor, year of diagnosis and type of index event.

A 2-sided P-value < 0.05 was considered statistically significant. Statistical analyses were performed using Stata (Stata Statistical Software: Release 13; StataCorp LP, College Station, TX).

3. Results

Overall, 8198 out of 31,656 patients (25.9%) diagnosed with venous thromboembolism were hospitalized during the study period. Of 8641 cases diagnosed with pulmonary embolism, 4489 cases (51.9%) were admitted to hospital compared to 3709 out of 23,015 cases diagnosed with deep vein thrombosis (16.1%). The overall mean age of patients admitted to hospital was 62.3 ± 18.4 years, compared to 55.7 ± 18.1 years for non-admitted patients (P < 0.001). Overall, inpatients had more comorbidities than outpatients. In inpatients versus outpatients, hypertension was the most common comorbidity among venous thromboembolism patients (32.5% versus 14.8%; P < 0.001) followed by malignancy (24.7% versus and 13.4%; P < 0.001) and chronic obstructive pulmonary disease (19.1% versus 8.3%; P < 0.001). Table 1 summarizes baseline characteristics and risk factors.

3.1. Temporal trends in hospitalization and length of stay

During the study period, the proportion of hospitalized patients for venous thromboembolism ranged between 23.7% and 27.8% with no evident temporal trend (P = 0.1 for adjusted trend) (Table 2, Fig. 1).

In addition, the crude and adjusted hospital length of stay for deep vein thrombosis and pulmonary embolism remained unchanged during the study period (P = 0.5 for trend). The overall crude mean length of stay of venous thromboembolism was 10.6 ± 22.0 days, however, after adjusting for age, sex, year of diagnosis, Charlson comorbidity