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Original research

What are the incidence and risk factors of in-hospital mortality after venous thromboembolism events in total hip and knee arthroplasty patients?

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ABSTRACT

Background: Pulmonary embolism and deep vein thrombosis, together referred to as venous thromboembolism (VTE), are serious and potentially preventable complications after total hip arthroplasty and total knee arthroplasty. The aim of this study was to investigate the incidence of mortality after VTE events and assess the risk factors that are associated with it.

Methods: The Nationwide Inpatient Sample was used to estimate the total number of total hip arthroplasty, total knee arthroplasty, VTE events, and mortality using the International Classification of Diseases, Ninth Revision procedure codes from 2003 to 2012. Patients' demographics, Elixhauser, and Charlson comorbidity indices were used to identify the risk factors associated with in-hospital VTEs and mortality.

Results: A total of 1,805,621 THAs and TKAs were included. The overall rate of VTE was 0.93%. The in-hospital mortality rate among patients with VTEs was 7.1% vs 0.30% in patients without VTEs (*P*-value < .0001). The risk factors for mortality after VTE events in descending order were as follows: hypercoagulable state (odds ratio [OR]: 5.3, 95% confidence interval [CI]: 3.6-5.8), metastatic cancer (OR: 5.2, 95% CI: 3.3-5.6), myocardial infarction (OR: 4.2, 95% CI: 2.3-4.7), peripheral vascular disease (OR: 3.6, 95% CI: 3.2-4.0), cardiac arrhythmias (OR: 3.2, 95% CI: 1.6-4.3), advanced age (OR: 3.1, 95% CI: 2.3-3.7), electrolyte disorders (OR: 3.1, 95% CI: 2.2-3.6), pulmonary circulation disorders (OR: 2.9, 95% CI: 2.6-3.3), depression (OR: 2.8, 95% CI: 1.6-3.4), complicated diabetes (OR: 2.7, 95% CI: 2.1-3.2), weight loss (OR: 2.6, 95% CI: 2.2-3.3), renal failure (OR: 2.6, 95% CI: 1.7-3.5), chronic pulmonary disease (OR: 2.5, 95% CI: 1.3-3.1), valvular disease (OR: 2.4, 95% CI: 1.8-2.7), liver disease (OR: 1.7, 95% CI: 1.2-1.9), and obesity (OR: 1.6, 95% CI: 1.5-1.9).

Conclusions: In-hospital VTE has a significant in-hospital mortality rate. Several of the identified risk factors in this study are modifiable preoperatively. We strongly urge the orthopaedic community to be cognizant of these risk factors and emphasize on optimizing patients' comorbidities before an elective arthroplasty.

Introduction

In the coming decade, the number of total hip and knee arthroplasties is projected to increase significantly in the United States and worldwide. Kurtz et al. [1] predicted that by 2030, number of primary total hip arthroplasties (THAs) increase by 174% and primary total knee arthroplasties (TKAs) by 672%. As with all medical procedures, total joint arthroplasty is often accompanied

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by complications. Pulmonary embolism (PE) and deep vein thrombosis (DVT), together referred to as venous thromboembolism (VTE), are of the most dreaded complications after total hip and knee arthroplasties [2–4]. It has been shown that the median incidence of only in-hospital VTE events during the initial hospitalization is 0.59% (0.55%-0.63%) for primary total hip arthroplasty (THA) and 1.01% (0.94%-1.08%) for primary TKAs in the Unites States. This rate is significantly higher in revision total joint arthroplasties (up to 2.5%) compared to primaries (1.6%, *P*-value < .0001) [5]. This not only has a huge economical burden on patients and the health-care system but also can increase the hospital stay and be associated with significant increase in the mortality rate in patients undergoing total hip and knee arthroplasties [4–6].

Mortality is one of the most worrisome concerns for both the patient and surgeon following any surgical procedure. Despite this concern, to our knowledge, the in-hospital mortality of patients who developed VTE after total knee arthroplasty (TKA) and THA has not been studied. Thus, the aim of this study was to utilize the National Inpatient Sample (NIS) database to (1) identify the risk factors of in-hospital VTEs after TKA and THA, (2) determine the rate of in-hospital mortality in patients who developed VTE, and (3) define the risk factors for mortality in these patients.

Material and methods

Study design

To conduct this study, the NIS data from the Agency for Healthcare Research and Quality were used to establish an 10-year retrospective cohort of patients who underwent primary and revision THA and TKA in the United States between 2003 and 2012 [7]. The NIS is the largest longitudinal, all-payer hospital database in the United States. This database consists of more than 1000 hospitals annually with 7-8 million medical records, which approximately represents 20% of all hospital discharges in the United States. The NIS database contains patients' demographics along with their comorbidities, duration of hospital stay, diagnostic codes based on the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM), patient disposition/discharge destination, and total amount of in-hospital charges. Because of the fact that the available information from the NIS database is deidentified, this study was exempted from institutional review board approval.

Patient selection

The database was queried with ICD-9-CM codes: 81.51 and 81.53, and 00.70-00.73 to identify patient who underwent THA, and 81.54-81.55 and 00.80-00.84 codes for patients who underwent TKA. A total of 1,805,621 THAs and TKAs were identified for analysis including 520,590 primary THAs, 88,162 revision THAs, 1,101,205 primary TKAs, and 95,664 revision TKAs (Table 1).

Outcome variables and statistical analysis

All THA and TKA patients who developed pulmonary embolism ([PE]: ICD-9 codes 415.11 or 415.19) or deep vein thrombosis ([DVT] ICD-9 codes 455.1, 451.2, 451.8, 451.9, 453.2, 453.4, 453.8, or 453.9) during their admission were identified. Mortality was used as the primary outcome measure; patients who developed VTE and expired during their admission were identified. Patients' demographics including, gender, age, body mass index, and comorbidities using Charlson and Elixhauser indices were taken into account as the predictors for VTE and mortality. A logistic regression model was created using all the predictors.

Standard statistics were used to present the descriptive data. Chi-squared tests were used to compare the incidences. An alpha level of 0.05 was used to determine statistical significance. All the analyses were performed using R 3.1 (R Foundation for Statistical Computing, Vienna, Austria). The “survey” package for R was used to derive estimates of means, medians, standard deviations, standard errors, rates, and confidence intervals (CIs).

Results

The overall rate of in-hospital VTE in the NIS database among the 1,805,621 patients undergoing THA and TKA was 0.93% (10,218 DVT, 6620 PE, and 1072 with both DVT and PE; 16,838 cases of VTE total) (Table 2). The risk factors for developing in-hospital VTEs in descending order were hypercoagulable state (odds ratio [OR]: 4.8, 95% CI: 3.9-5.8), metastatic cancer (OR: 4.2, 95% CI: 3.1-5.0), renal failure (OR: 3.5, 95% CI: 2.4-3.7), pulmonary circulation disorders (OR: 3.4, 95% CI: 2.9-4.1), cerebrovascular disease (OR: 3.3, 95% CI: 2.9-4.1), dementia (OR: 3.2, 95% CI: 2.7-3.6), chronic pulmonary disease (OR: 2.7, 95% CI: 2.1-3.2), cardiac arrhythmias (OR: 2.2, 95% CI: 2.0-2.7), valvular disease (OR: 2.2, 95% CI: 1.7-2.5), fluid and electrolyte disorders (OR: 2.1, 95% CI: 1.9-2.2), weight loss (OR: 2.0, 95% CI: 1.7-2.5), lymphoma (OR: 1.8, 95% CI: 1.1-2.4), myocardial infarction (OR: 1.8, 95% CI: 1.6-1.9), congestive heart failure (OR: 1.7, 95% CI: 1.1-1.9), revision THA (OR: 1.4, 95% CI: 1.1-1.7), peripheral vascular disorders (OR: 1.4, 95% CI: 1.1-1.6), solid tumor without metastasis (OR: 1.3, 95% CI: 1.1-1.6), deficiency anemia (OR: 1.3, 95% CI: 1.1-1.4), advanced age (greater than 70 years old) (OR: 1.3, 95% CI: 1.1-1.4), obesity (OR: 1.2, 95% CI: 1.1-1.5), and female gender (OR: 1.1, 95% CI: 1.0-1.3).

The overall in-hospital mortality rate for THA and TKA without VTEs was 0.30% (5441/1,788,783). The in-hospital mortality rate among patients with VTE was 7.1% (1203/16,838), which was significantly higher than those without VTE (*P*-value < .0001). The relative risk for mortality in patients with VTE was 23.5 (95% CI: 22.1-24.9) compared to those without VTEs. In-hospital PEs contributed the majority of mortalities in patients with VTE: 13.4% (887/6620) in PEs vs 3.1% (316/10,218) in patients with DVTs (*P*-value < .0001). Patients who developed in-hospital PEs had a 1.9 higher relative risk for mortality (95% CI: 1.7-2.0) compared to ones who just had DVTs. When THAs and TKAs were complicated with in-hospital PEs, the relative risk for mortality was 44.0 (95% CI: 41.2-47.1) compared to ones with no VTE events (number need to harm: 7.6). Furthermore, when adjusted for potential confounders and stratified by age, patients who developed VTEs had an odds ratio of 23.8 (95% CI: 21.5-26.8) for in-hospital mortality compared to those without VTEs.

Table 1
Demographics.

Procedure	Number of patients	Mean age (95% CI)	Female gender (95% CI)
Primary THA	520,590	67 (65-67)	57 (56-57)
Revision THA	88,162	67 (67-68)	58 (57-58)
Primary TKA	1,101,205	66 (66-67)	64 (63-64)
Revision TKA	95,664	66 (66-67)	58 (58-69)

Table 2
Overall median incidence between 2003 and 2012 in the United States.

Procedure	Pulmonary embolism (95% CI)	Deep venous thrombosis (95% CI)	Venous thromboembolism (95% CI)
Primary THA	0.41 (0.38-0.44)	0.24 (0.21-0.26)	0.60 (0.55-0.63)
Revision THA	1.12 (0.96-1.22)	0.37 (0.34-0.42)	1.36 (1.24-1.46)
Primary TKA	0.71 (0.57-0.77)	0.45 (0.42-0.48)	1.03 (0.94-1.09)
Revision TKA	0.93 (0.85-1.12)	0.35 (0.31-0.39)	1.17 (1.06-1.30)