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Original Contributions

THE USE OF THROMBOLYSIS FOR ACUTE PULMONARY EMBOLISM IN THE UNITED STATES: NATIONAL TRENDS AND PATIENT CHARACTERISTICS FROM 2006 TO 2011

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☐ **Abstract—Background: Thrombolysis for the treatment of pulmonary embolism (PE) has received significant attention in the literature over the past 10 years. Objective: Our primary objective was to examine the trend in thrombolysis use in the United States from 2006 to 2011. Secondary objectives include examining patient and hospital characteristics associated with receiving thrombolysis and rates of complications associated with thrombolysis. Methods: In this retrospective cohort study, we used the Nationwide Inpatient Sample from 2006 to 2011 to identify patients with a diagnosis of PE who received or did not receive thrombolytic agents. Results: Examining the records of 47,911,414 hospital discharges identified a cohort of 1,317,329 patients with PE; of these patients, 10,617 received thrombolysis. During the study period, there was a 30% relative increase in the use of thrombolysis, from 0.68% (95% confidence interval [CI] 0.64–0.73%) to 0.89% (95% CI 0.83–0.95%; $p < 0.01$). After controlling for all factors in the model, factors associated with decreased access to thrombolysis were increasing age (odds ratio [OR] 0.981 [95% CI 0.980–0.982]; $p < 0.01$), female sex (OR 0.78 [95% CI 0.75–0.81]; $p < 0.01$), Black race (OR 0.86 [95% CI 0.81–0.91]; $p < 0.01$), Hispanic race (OR 0.78 [95% CI 0.71–0.86]; $p < 0.01$), other race (OR 0.72 [95% CI 0.59–0.88]; $p = 0.02$), and rural hospital location (OR 0.48 [95% CI 0.43–0.52]; $p < 0.01$). Conclusions: The use of thrombolysis increased between 2006 and 2011 in the United States. Patients who receive thrombolysis tend to be white men, live in higher-income ZIP codes, and receive the therapy at large academic teaching hospitals.** © 2016 Published by Elsevier Inc.

☐ **Keywords—epidemiology; pulmonary embolism; thrombolysis; United States**

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INTRODUCTION

Acute pulmonary embolism (PE) is responsible for approximately 100,000 deaths in the United States per year (1,2). Over the past 10 years, numerous studies have raised clinical awareness of thrombolysis as a potential therapy for acute massive PE (3,4). Compared to anticoagulation with unfractionated therapy alone, thrombolytic therapy accelerates pulmonary reperfusion but increases the risk of bleeding (5).

Current guidelines support thrombolysis for the treatment of massive PE, defined as PE with associated hemodynamic instability (i.e., systolic blood pressure <90 mm Hg or a drop in systolic blood pressure by >40 mm Hg for >15 min, if not caused by new-onset dysrhythmia, hypovolemia, or sepsis) (6,7). However, this therapy may be underused (8).

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In addition, there is presently no consensus on the use of thrombolytic agents for the treatment of submassive PE, defined as hemodynamically stable PE with signs of right ventricular dysfunction or myocardial injury (6). Recent trials suggest a potential role for some form of thrombolysis in subsets of this population (9–11). The results of the Pulmonary Embolism Thrombolysis trial noted improved hemodynamics with thrombolytic administration in intermediate risk PE; however, this finding was offset with increased hemorrhage and stroke (12).

Given the lack of clear consensus, the decision to use thrombolytic agents to treat PE is often left to physician discretion or institutional policy. To date, no group has used large-scale epidemiologic data to characterize thrombolysis use. The primary aim of our study was to examine the trend in thrombolysis use in the United States from 2006 to 2011. Secondary questions addressed were the patient and hospital characteristics associated with receiving thrombolysis, and rates of complications associated with thrombolysis.

MATERIALS AND METHODS

We report our study according to the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) statement (13). A waiver of consent was obtained from the University of British Columbia Institutional Review Board.

Study Population

We performed a retrospective cohort study using data from the Nationwide Inpatient Sample (NIS), a federal database that captures approximately 20% of all United States (US) hospital discharges (14). The NIS is a complex survey powered to estimate national trends and proportions. It is produced by the Agency for Healthcare Research and Quality via the Healthcare Cost and Utilization Project.

We included patients who were ≥18 years of age with a discharge diagnosis of PE (*International Classification of Diseases, 9th revision* [ICD9] codes 415.1, 415.11, 415.13, and 415.19) between the years 2006 and 2011. Patients who had an ICD9 procedure code for injection or infusion of a thrombolytic agent (ICD9 code 99.10) were segregated further (Figure 1). This latter code cannot differentiate between catheter-directed or systemic thrombolysis. Queried potential complications from thrombolysis included hematoma (ICD9 code 729.92), gastrointestinal bleeding (ICD9 code 578.xx), intracranial hemorrhage (ICD9 codes 430, 431, 4320, 4231, and 4329), and need for a blood transfusion (ICD9 code 99.04).

Patient variables, including age, sex, race (i.e., White, Black, Hispanic, and other), and insurance status (coverage vs. noncoverage) were determined from the database. Hospital characteristics were obtained including region (i.e., Northeast, Midwest, South, and West), size (i.e., small, medium, or large as defined by the Agency for Healthcare Research and Quality), teaching status (teaching hospital vs. nonteaching hospital), and rural vs. urban location (based on US Census Data) (14).

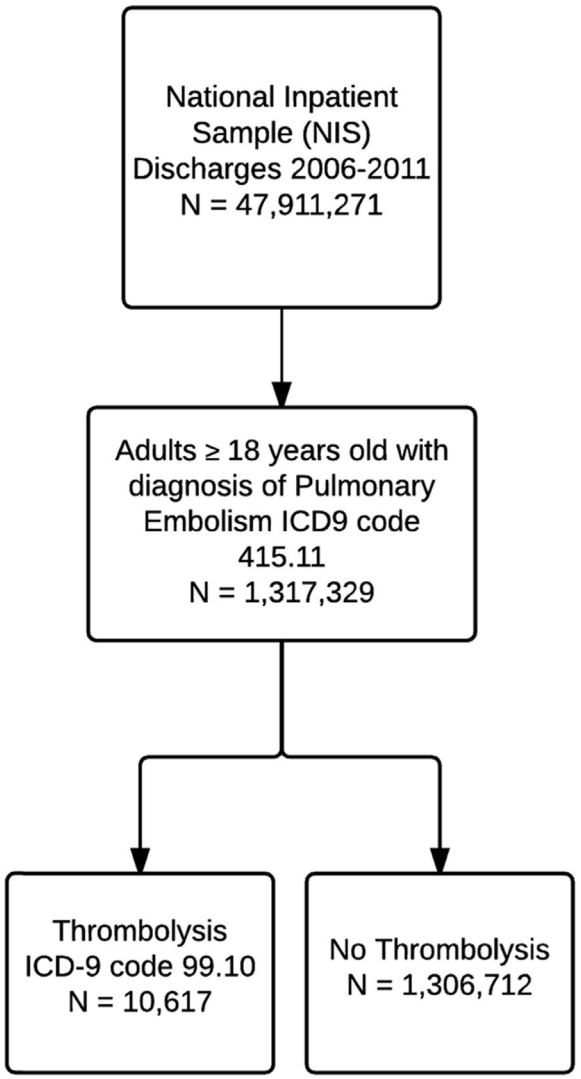

Figure 1. Patient selection flow diagram.

Statistical Analysis

Data were analyzed using complex survey procedures in SAS software (version 9.4; SAS Institute, Cary, NC); national estimates were obtained with appropriate national weights. Chi-squared tests were used for nominal or ordinal outcomes; independent *t*-tests were used for continuous data. Data are presented with 95% confidence intervals and standard deviations where appropriate.