Special Report

Surgical Thrombectomy for Pulmonary Embolism:

Updated Performance Rates and Outcomes

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Treatments for pulmonary embolism are numerous and often complex. Current data on surgical thrombectomy are important but are not readily available. We studied the National Inpatient Sample to evaluate trends in the performance rates and outcomes of surgical thrombectomy in the United States from 2003 through 2014. We think that our findings have meaningful application to the triage and risk stratification of patients who have hemodynamically significant pulmonary embolism. ***(Tex Heart Inst J 2019;46(3):172-4)***

Modern management of hemodynamically significant pulmonary embolism (PE) increasingly involves the triage of patients to various surgical and nonsurgical approaches, ranging from pulmonary thrombectomy to anticoagulation with or without systemic or catheter-directed thrombolysis. The usefulness of thrombolysis in patients with hemodynamically significant PE has been extensively studied; however, current data on surgical pulmonary thrombectomy are not readily available. The national data in widespread use are from older reports; in one, surgical thrombectomy is associated with a perioperative mortality rate of 27.2%.[1] Other single- or multicenter investigators have reported lower perioperative mortality rates; however, these studies had limitations related to reporting bias from selected centers of excellence.[2-5] We evaluated whether the national use and outcomes of surgical thrombectomy for acute hemodynamically significant PE changed from 2003 through 2014.

The National Inpatient Sample, the largest publicly available all-payer administrative claims database, contains information about patient discharges from approximately 1,000 non-Federal hospitals in 45 U.S. states.[6] Within the annual databases from 2003 through 2014, we identified adult patients (age, ≥18 yr) whose principal admission diagnosis was acute PE. The International Classification of Diseases, 9th Revision, Clinical Modification [ICD-9-CM] codes 415.1, 415.11, 415.12, and 415.19 have high diagnostic specificity and positive predictive value for that condition.[1] We excluded patients whose PE complicated pregnancy or childbirth (codes 634–639 with .6 suffixes, and 673.0–673.8). We identified pulmonary surgical thrombectomy from the ICD-9-CM code 38.05, systemic thrombolysis from code 99.10, and catheter-directed thrombolysis from code 88.43. The primary endpoint was in-hospital death. Secondary endpoints were rates of major complications, mean length of hospital stay, cost of hospitalization, and discharge to intermediate care or a skilled nursing facility. We compared baseline characteristics and outcomes between early (2003–2008) and later (2009–2014) patient cohorts. We determined predictors of in-hospital death by initially placing all baseline variables (Table I) in a univariate logistic regression model. We then entered variables associated with in-hospital death (P <0.1) into a multivariate logistic regression model to determine predictors of death. We computed temporal trends in the use of surgical thrombectomy and resultant death by using linear regression (weighted least squares). All statistical analyses were performed with use of SPSS version 24 (SPSS, an IBM company). P values ≤0.05 were considered statistically significant.

Of 1,916,793 patients who were admitted with acute PE from 2003 through 2014, 3,486 patients (0.2%) underwent surgical thrombectomy. During the study period, the use of surgical thrombectomy significantly increased (P=0.003), and the in-hospital mortality rate significantly decreased (P=0.014) (Fig. 1). Patients in the later cohort had a higher prevalence of comorbid conditions but a far lower mortality rate than did the early cohort (14% vs 23.1%; P=0.002) (Table I). Surgical intervention within 48 hours of admission was more prevalent in the later group (82% vs 71%; P

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TABLE I. Baseline Characteristics and Outcomes of Patients with Acute Pulmonary Embolism Undergoing Surgical Thrombectomy

Variable	All Patients (N=3,486)	Early Group (2003–2008) (n=1,395)	Later Group (2009–2014) (n=2,091)	*P* Value
Age (yr)	56 ± 16	57 ± 16	55 ± 16	0.809
Female	1,638 (47)	655 (47)	983 (47)	0.965
White	2,524 (72.4)	1,061 (76.1)	1,463 (70)	0.693
Hypertension	1,633 (46.8)	549 (39.4)	1,084 (51.8)	0.008
Diabetes mellitus	696 (20)	209 (15)	487 (23.3)	0.006
Smoking	387 (11.1)	118 (8.5)	269 (12.9)	0.075
Peripheral vascular disease	150 (4.3)	35 (2.5)	115 (5.5)	0.056
Chronic kidney disease	204 (5.9)	64 (4.6)	140 (6.7)	0.259
Coronary artery disease	327 (9.4)	114 (8.2)	213 (10.2)	0.362
Medicare/Medicaid insurance	1,636 (46.9)	645 (46.2)	991 (47.4)	0.298
Rural location	104 (3)	44 (3.2)	60 (2.9)	0.801
Teaching hospital	2,580 (74)	1,012 (72.5)	1,568 (75)	0.5
Given systemic thrombolysis	244 (7)	113 (8.1)	129 (6.2)	0.31
Given catheter-directed thrombolysis	279 (8)	99 (7.1)	180 (8.6)	0.487
Cardiac arrest	451 (13)	163 (11.7)	288 (13.8)	0.425
Operation <48 hr after admission	2,704 (77.6)	990 (71)	1,714 (82)	0.001
In-hospital outcomes				
Death	614 (17.6)	322 (23.1)	292 (14)	0.002
Acute kidney injury needing dialysis	80 (2.3)	34 (2.4)	44 (2.1)	0.762
Acute myocardial infarction	98 (2.8)	44 (3.2)	54 (2.6)	0.649
Stroke	70 (2)	14 (1)	54 (2.6)	0.15
Blood transfusion	1,119 (32.1)	442 (31.7)	677 (32.4)	0.844
Prolonged ventilation	179 (5.1)	89 (6.4)	90 (4.3)	0.213
Gastrostomy	75 (2.2)	35 (2.5)	40 (1.9)	0.599
Pneumonia	223 (6.4)	129 (9.2)	94 (4.5)	0.012
Discharge to healthcare facility	955 (27.4)	353 (25.3)	602 (29)	0.008
Length of hospital stay (d)	12 ± 14	13 ± 19	11 ± 10	0.001
Hospital charges ($US)	53,093 ± 50,683	50,365 ± 49,135	54,862 ± 51,646	0.745

Data are presented as mean ± SD or as number and percentage. $P \leq 0.05$ was considered statistically significant.

<0.001); rates of postoperative complications were similar between groups. Length of hospital stay was shorter in the later group; however, hospitalization cost was similar between groups (Table I). Upon multivariate logistic regression analysis, the most powerful predictors of in-hospital death in the overall cohort were systemic thrombolysis (odds ratio [OR]=3.38; 95% CI, 1.77–6.43) and catheter-directed thrombolysis (OR=2.08; 95% CI, 1.10–3.95).

As the study period progressed, surgical thrombectomy was performed more often and it improved outcomes significantly. Of note, the use of thrombolytic agents before surgical thrombectomy was associated with more than a 3-fold increase in the mortality rate (data not shown). This increase may be related to these patients' being more critically ill at baseline because of advanced disease and the consequent failure of thrombolytic therapy.

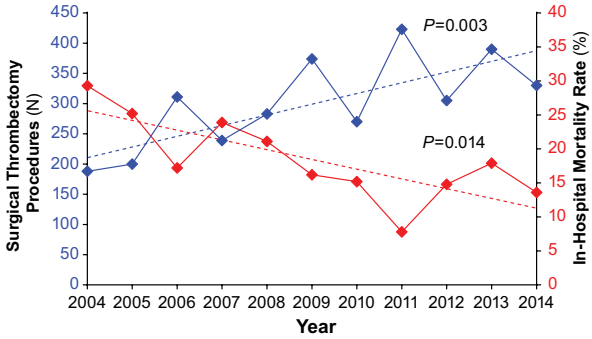

Fig. 1 *During the study period,* the number of surgical thrombectomy procedures (solid blue line) increased (P=0.003), and the in-hospital mortality rate (solid red line) decreased (P=0.014). Surgical thrombectomy trends increased (blue dashed line) and inpatient mortality trends (red dashed line) decreased over time. P ≤0.05 was considered statistically significant.*

**Data from 2003, available only from July through December, are not included.*

We think that our findings can be applied meaningfully to the triage and risk stratification of patients who have hemodynamically significant PE.

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