ORIGINAL RESEARCH

High Burden of 30-Day Readmissions After Acute Venous Thromboembolism in the United States

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Background—Venous thromboembolism (VTE) is the third leading cause of vascular disease and accounts for $10 billion in annual US healthcare costs. The nationwide burden of 30-day readmissions after such events has not been comprehensively assessed.

Methods and Results—We analyzed adults ≥18 years of age with hospitalizations associated with acute VTE between January 1, 2010, and December 31, 2014, in the Nationwide Readmissions Database. *International Classification of Disease, Ninth Revision, Clinical Modification* (*ICD-9-CM*) codes were used to identify hospitalizations associated with acute pulmonary embolism or deep vein thrombosis. The primary outcome was the rate of unplanned 30-day readmission. Hierarchical logistic regression was used to calculate hospital-specific 30-day risk-standardized readmission rates, a marker of healthcare quality. Among 1 176 335 hospitalizations with acute VTE, in-hospital death occurred in 6.2%. VTE was associated with malignancy in 19.7%, recent surgery in 19.3%, recent trauma in 4.6%, hypercoagulability in 3.3%, and pregnancy in 1.0%. Among survivors to discharge, the 30-day readmission rate was 17.5%, with no significant difference in rates across study years (17.4%–17.7%; *P*=0.10 for trend). Major predictors of readmission were malignancy (relative risk, 1.49, 95% confidence interval 1.47-1.50), Medicaid insurance (relative risk, 1.48, 95% confidence interval 1.46-1.50), and nonelective index admission (relative risk, 1.31, 95% confidence interval 1.29-1.33). Top causes of readmission included sepsis (9.6%) and procedural complications (8.1%). Median rehospitalization costs were $9781.7 (interquartile range, $5430.7–$18 784.1), and 8.1% died during readmission. The interquartile range in risk-standardized readmission rates was 16.6% to 18.3%, suggesting modest interhospital heterogeneity in readmission risk.

Conclusions—Nearly 1 in 5 patients with acute VTE were readmitted within 30 days. Predictors and causes of readmission were primarily related to patient characteristics and complications from comorbid conditions, whereas healthcare quality had a moderate impact on readmission risk. **(*J Am Heart Assoc*. 2018;7:e009047. DOI: 10.1161/JAHA.118.009047.)**

Key Words: deep vein thrombosis • pulmonary embolism • readmission • venous thromboembolism

Venous thromboembolism (VTE), consisting of pulmonary embolism (PE) and deep vein thrombosis (DVT), constitutes a major global health issue. With nearly 10 million annual cases worldwide and an individual lifetime risk of >8%, VTE represents the third leading cause of vascular disease.[1–3] VTE is associated with significant morbidity and mortality, accounting for >200 000 deaths in the United States annually.[4] The yearly economic burden of VTE is substantial, with estimated US healthcare costs totaling $10 billion.[5]

In September 2008, the US Surgeon General released a *Call to Action to Prevent Deep Vein Thrombosis and Pulmonary Embolism*,[6] urging a coordinated multifaceted plan to reduce

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Accompanying Data S1, Tables S1 through S10, and Figure S1 through S8 are available at http://jaha.ahajournals.org/content/7/13/e009047/DC1/embed/inline-supplementary-material-1.pdf

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Clinical Perspective

What Is New?

- Nearly 1 in 5 patients with acute venous thromboembolism in the United States are readmitted within 30 days.
- These readmissions are associated with high healthcare costs and mortality.
- Predictors and causes of readmission were primarily associated with patient characteristics and complications related to comorbid conditions, whereas a smaller proportion of readmissions were associated with recurrent venous thromboembolism or disease processes directly consequential to acute venous thromboembolism.
- After standardizing for hospital case mix, there was only modest heterogeneity in readmission rates between institutions, suggesting that healthcare quality had only a moderate impact on readmission risk.

What Are the Clinical Implications?

- Further research is needed to identify and validate effective interventions to reduce these frequent and costly readmissions that follow acute venous thromboembolism events.
- Because variations between risk-standardized readmission rates among studied institutions were only modest, programs designed to penalize institutional outliers, similar to the mandate of Centers for Medicare and Medicaid Services' Hospital Readmissions Reduction Program, may have less of an impact on improving outcomes for this disease process.

the number of VTE cases nationwide. At the same time, the Centers for Medicare and Medicaid Services discontinued reimbursing hospitals for the marginal cost of treating certain preventable hospital-acquired conditions, including VTE after joint arthroplasty surgeries.[7] More recently, the Centers for Medicare and Medicaid Services instituted the Hospital Readmissions Reduction Program,[8,9] penalizing hospitals for greater than expected 30-day readmission rates after certain conditions and procedures. These programs have to date been successful[10,11] and have motivated interest in expanding the Hospital Readmissions Reduction Program to other disorders.

Despite the commonality of VTE and its significant costs to the healthcare system, the burden of nationwide readmissions has not yet been comprehensively assessed. With these data, practitioners can identify areas for intervention and opportunities for prevention. Therefore, we examined nationwide hospital readmission data from 2010 through 2014 to determine the rate, predictors, and causes of 30-day readmission after acute VTE. In addition, we sought to examine whether variations in risk-standardized readmission rates (RSRRs), a measure of healthcare quality, exist between US hospitals.

Methods

Data Source

The data used in this analysis are available to other researchers for purposes of reproducing the results or replicating the procedure. The data set is publicly available for purchase online.[12] We examined data from the Nationwide Readmissions Database (NRD) between 2010 and 2014. The NRD is sponsored by the Agency for Healthcare Research and Quality as part of the Healthcare Cost and Utilization Project and collects discharge data from 22 geographically dispersed states. The NRD includes data from all payers and the uninsured and is composed of >100 clinical and nonclinical variables for each hospital stay. These data include *International Classification of Disease, Ninth Revision, Clinical Modification* (*ICD-9-CM*) diagnosis and procedure codes, Clinical Classification Software (CCS) diagnosis and procedure classifications, patient demographics, expected payment sources, and total charges and hospital costs based on cost/charge ratios. Weights are provided to calculate national estimates. Research using the NRD was deemed not to qualify as human subjects research by the Institutional Review Board at Beth Israel Deaconess Medical Center (Boston, MA) because of the deidentified nature of the data, and no informed consent was required.

Study Population

All adult hospitalizations (>18 years of age) between January 1, 2010, and December 31, 2014, associated with a diagnosis code for acute VTE were identified (N=1 431 552) (Figure S1). Acute VTE included PE and DVT. Diagnosis codes in any billing position were included to capture all admissions associated with acute VTE. These codes are shown in Table S1. Because the NRD does not track readmissions between years, data from December of each year did not contribute admissions (N=115 659), allowing 30 days of follow-up for every patient. All analyses were performed using unweighted data. Of 1 315 893 hospitalizations associated with acute VTE, admissions were excluded if the hospitalization occurred in a state outside the patient's primary residence (N=66 873), because any readmission in a state different from the index hospital's state would not be captured by the NRD. Multiple VTE hospitalizations involving the same patient were allowed as long as they occurred >30 days after any previously included VTE hospitalization or readmission. However, a second VTE hospitalization within 30 days of another by the same patient was counted only as a readmission (excluded N=72 685).

Patient, Hospitalization, and Institutional Characteristics

Chronic conditions were determined on the basis of the 29 Elixhauser comorbidities provided by the Agency for Healthcare Research and Quality.[13] Because tobacco use is not included in this list, we used *ICD-9-CM* diagnosis codes to define smoking status (Table S1). To ascertain comorbid conditions associated with acute VTE, we identified claims codes for surgical procedures, trauma, malignancy, hypercoagulability, and pregnancy charged during the same admission (Table S1). Acute VTE associated with recent surgery was defined by a surgical billing code charged during the same hospitalization as the VTE event. Surgical procedures were included if they met at least 2 of 3 criteria: (1) surgery that typically requires ≥1 night stay; (2) surgery that requires some period of immobility; and (3) surgery that is likely to require general anesthesia. Acute VTE associated with recent trauma was defined by a billing code for trauma charged during the same hospitalization as the VTE event. Characteristics of the index hospitalization included type of acute VTE, length of stay, discharge destination, and costs. Institutional characteristics included bed volume, ownership, and teaching status. In-hospital procedures included systemic thrombolysis, pulmonary endarterectomy, mechanical ventilation, extracorporeal circulation, and inferior vena cava filter placement. In-hospital adverse events included major bleeding, acute myocardial infarction or unstable angina, cardiogenic shock, cardiorespiratory arrest, and acute heart failure.

Study Outcomes

For the first objective, the outcome was unplanned all-cause 30-day readmission rate, defined as the occurrence of a hospitalization for any cause within 30 days of discharge after an index hospitalization. Readmissions that were coded as "nonelective" within the NRD were considered unplanned. To further explore this outcome, we analyzed predictors and causes of unplanned 30-day readmission. Reasons for readmission were determined on the basis of CCS codes, a categorization scheme developed by the Agency for Healthcare Research and Quality based on *ICD-9-CM* coding[14] (Data S1). We used CCS categories 103 (pulmonary heart disease) and 118 (phlebitis; thrombophlebitis and thromboembolism) to categorize causes of readmission attributable to recurrent VTE or disease processes directly related to acute VTE. The CCS categorization of "pulmonary heart disease" includes diagnosis codes for recurrent PE; chronic pulmonary heart disease, including pulmonary hypertension; and other diseases of the pulmonary circulation. The CCS categorization of "thrombophlebitis" includes diagnosis codes for thrombophlebitis, recurrent DVT, and chronic DVT.

For the second objective, the primary outcome was hospital-specific 30-day RSRRs. To make these estimates, a hierarchical logistic regression model accounting for differences in hospital case mix was developed, as described later.

Statistical Analysis

Categorical variables were reported as counts and percentages, and continuous variables were reported as means with SDs. Between-group differences were assessed using Fisher's exact or χ^2 tests for categorical variables and Student *t* or Wilcoxon rank sum tests for continuous variables. The Mantel-Haenszel test for trend was used to assess for changes in readmission rates across study years.

To derive predictors of 30-day readmission, hierarchical modified Poisson models were developed. We estimated risk ratios directly using modified Poisson regression models with robust standard errors instead of odds ratios because of the high readmission rates.[15] These models were clustered by hospital per year, because the NRD does not track hospitals across years. Candidate variables for the models were determined on the basis of clinical experience and prior literature (Table S2). To establish parsimonious models, we used a backward selection process until 90% of the full model R^2 was retained.[16]

To estimate RSRRs across hospitals, we used hospital data from 2014, because the NRD does not track hospitals across years. For this analysis, we adapted a previously established approach.[17] First, we created a logistic regression model predicting 30-day readmission to identify variables for risk adjustment. Candidate variables for the model included patient factors, as reported in Table S3. We excluded covariates, such as in-hospital complications, certain patient demographics (eg, type of insurance), and discharge disposition, because these characteristics may be more related to hospital quality and resource availability. To inform variable selection, we used a modified stepwise logistic regression approach, which involved creating 500 bootstrap samples from the data set. For each sample, we ran a logistic stepwise regression, with both backward and forward selection. The *P* value to enter was set at 0.05, and the *P* value to exit was set at 0.01. We retained all risk-adjustment variables above a 70% cutoff because these demonstrated a strong association with readmission and were clinically relevant. The results of this model are displayed in Table S4. Next, we used hierarchical generalized linear models to estimate RSRRs.[17] This approach accounts for within-hospital correlation of the observed readmissions and assumes that, after adjusting for patient risk and sampling variability, the remaining heterogeneity is attributable to hospital quality.[18,19]

Analyses were stratified by type of acute VTE during the index hospitalization (PE versus DVT). For stratified analyses,

patients who had both types of VTE during the index admission only contributed data to the PE group. In addition, we examined hospitalizations in which acute VTE was the primary billing diagnosis.

Because of the inability to track out-of-hospital deaths, we performed a sensitivity analysis examining predictors and causes of readmission among those discharged to home. This was to ensure that discharge to a care facility, which may be associated with greater risk of short-term death, did not affect our primary findings.

A 2-sided $P<0.05$ was considered significant. Statistical analyses were performed using SAS software v9.3 (SAS Institute, Cary, NC).

Results

Readmissions After Acute VTE

During the study period, there were 1 176 335 hospitalizations associated with acute VTE. In-hospital death occurred in 6.2% (PE, 7.8%; DVT, 5.5%; both, 5.5%). Among 1 103 742 admissions in which patients survived to discharge, 193 632 were associated with nonelective readmissions at 30 days at a rate of 17.5% (PE, 15.8%; DVT, 19.4%; both, 14.3%). There were an additional 19 536 (1.8%) planned readmissions, which were excluded from the analysis. Weighted on a national level, there were 2 742 947 hospitalizations associated with acute VTE, with 2 577 387 involving patients who survived to discharge, and there were 441 562 readmissions at 30 days.

Between years, readmission rates did not significantly differ, ranging from a low of 17.4% in 2013 to a high of 17.7% in 2011 ($P=0.10$ for trend). Readmissions accrued throughout the follow-up period, with a readmission rate of 6.6% at 7 days, 8.7% at 10 days, and 14.0% at 20 days (Figure S2). Among cases with identifiable provoking factors associated with acute VTE present during admission, readmission rates were highest when associated with malignancy (23.7%), followed by recent surgery (19.9%), recent trauma (16.4%), hypercoagulability (16.4%), and pregnancy (10.7%). For those with acute DVT, readmission rates were similar among cases involving proximal and distal lower extremity vessels (16.7% versus 16.1%, respectively). During rehospitalization, an additional 8.1% of patients died.

Patient and Hospitalization Characteristics by Readmission Status

Of index hospitalizations associated with acute VTE, 54.6% were associated with DVT, 29.5% were associated with PE, and 15.9% were associated with both. Among cases with identifiable provoking factors associated with VTE present during admission, the plurality was related to malignancy (19.7%), followed by recent surgery (19.3%), recent trauma (4.6%), hypercoagulability (3.3%), and pregnancy (1.0%). Readmitted patients were older, were more often women, had more comorbid conditions, and were primarily insured by Medicare or Medicaid (Table 1). Readmissions occurred more frequently among index hospitalizations for nonelective indications, of longer durations, and in which patients were discharged to a subacute facility (Table 2). These hospitalizations more commonly involved mechanical ventilation and inferior vena cava filter placement, whereas use of systemic thrombolysis was associated with a lower frequency of readmission. Adverse events occurred with greater rates during hospitalizations associated with readmission, particularly major bleeds and acute heart failure.

Overall, patient and hospitalization characteristics did not significantly differ from the overall group when stratified by PE and DVT (Tables S5 through S8).

Predictors of 30-Day Readmission

The strongest predictors of readmission included a diagnosis of malignancy (relative risk [RR], 1.49; 95% confidence interval [CI], 1.47–1.50), nonelective index admission (RR, 1.31; 95% CI, 1.29–1.33), and insurance status (Medicaid: RR, 1.48 [95% CI, 1.46–1.50]; Medicare: RR, 1.31 [95% CI, 1.29–1.33]) (Figure 1). Discharge to a subacute facility (RR, 1.25; 95% CI, 1.24–1.27) or home with additional care (RR, 1.19; 95% CI, 1.18–1.21) was also associated with increased readmission risk. Hospitalizations associated with acute DVT had a stronger relationship with need for readmission compared with those associated with acute PE (RR, 1.13; 95% CI, 1.11–1.14). Predictors of readmission did not significantly vary when stratified by PE and DVT (Figures S3 and S4), nor did they differ among those discharged to home (Figure S5).

Reasons for 30-Day Readmission

Sepsis was the primary indication for readmission (9.6%), followed by procedural complications (8.1%) and issues related to malignancy (6.9%) (Figure 2). Recurrent VTE and disease processes directly related to acute VTE, which are categorized as “recurrent DVT/thrombophlebitis” and “pulmonary heart disease,” composed 9.4% of all causes for readmission. The most frequent reason for rehospitalization among those with acute PE was directly related to the disease process (pulmonary heart disease, 7.9%), whereas for acute DVT, causes were more often related to complications from comorbid conditions (sepsis, 10.8%; procedural complications, 9.7%). Reasons for readmission were overall similar among those discharged to home (Figure S6).

Table 1. Patient Characteristics of Index Admissions Associated With Acute VTE, Stratified by 30-Day Readmission Status

Variable	All Index Admissions (N=1 103 742)	Nonelective 30-d Readmission		
		Yes (n=193 632)	No (n=910 110)	*P* Value
VTE				<0.001
Pulmonary embolism	325 850 (29.5)	51 417 (26.6)	274 433 (30.2)	<0.001
Deep vein thrombosis	602 126 (54.6)	117 107 (60.5)	485 019 (53.3)	<0.001
Both	175 766 (15.9)	25 108 (13.0)	150 658 (16.6)	<0.001
Saddle pulmonary embolus	10 901 (1.0)	1095 (0.6)	9806 (1.1)	<0.001
Acute cor pulmonale	1816 (0.2)	238 (0.1)	1578 (0.2)	<0.001
Thrombophlebitis	57 040 (5.2)	9726 (5.0)	47 314 (5.2)	0.001
Provoking factors associated with VTE present during admission				
Malignancy	217 402 (19.7)	51 565 (26.6)	165 837 (18.2)	<0.001
Recent surgery	213 163 (19.3)	42 454 (21.9)	170 709 (18.8)	<0.001
Recent trauma	50 474 (4.6)	8293 (4.3)	42 181 (4.6)	<0.001
Hypercoagulability	36 821 (3.3)	6046 (3.1)	30 775 (3.4)	<0.001
Pregnancy	11 043 (1.0)	1179 (0.6)	9864 (1.1)	<0.001
Age, mean±SD, y	64.0±17.3	64.8±16.9	63.9±17.3	<0.001
Female sex	580 632 (52.6)	102 849 (53.1)	477 783 (52.5)	<0.001
Primary insurance				<0.001
Medicare	627 703 (57.0)	119 763 (62.0)	507 940 (55.9)	<0.001
Medicaid	122 082 (11.1)	27 344 (14.1)	94 738 (10.4)	<0.001
Private	267 365 (24.3)	34 767 (18.0)	232 598 (25.6)	<0.001
Self-pay	40 725 (3.7)	5464 (2.8)	35 261 (3.9)	<0.001
Other	43 459 (3.9)	5966 (3.1)	37 493 (4.1)	<0.001
Median household income by residential zip code				<0.001
Lowest quartile	313 413 (28.8)	58 261 (30.5)	255 152 (28.5)	<0.001
Middle lowest quartile	265 269 (24.4)	46 036 (24.1)	219 233 (24.5)	0.001
Middle highest quartile	260 176 (23.9)	44 513 (23.3)	215 663 (24.1)	<0.001
Highest quartile	247 686 (22.8)	41 980 (22.0)	205 706 (23.0)	<0.001
Residence by county location				<0.001
Central counties in metropolitan areas with population ≥1 million	364 183 (33.0)	71 770 (37.1)	292 413 (32.2)	<0.001
Fringe counties in metropolitan areas with population ≥1 million	274 168 (24.9)	49 022 (25.4)	225 146 (24.8)	<0.001
Counties in metropolitan areas with population 250 000–999 999	222 597 (20.2)	36 264 (18.8)	186 333 (20.5)	<0.001
Counties in metropolitan areas with population 50 000–249 999	94 783 (8.6)	15 055 (7.8)	79 728 (8.8)	<0.001
Micropolitan counties	86 689 (7.9)	12 817 (6.6)	73 872 (8.1)	<0.001
Other	59 858 (5.4)	8338 (4.3)	51 520 (5.7)	<0.001
No. of chronic conditions, mean±SD	5.6±3.2	6.6±3.2	5.5±3.1	<0.001
Varicose veins	5950 (0.5)	662 (0.3)	5288 (0.6)	<0.001
Obesity	174 637 (15.8)	28 723 (14.8)	145 914 (16.0)	<0.001
Current or prior tobacco use	275 169 (24.9)	48 893 (25.3)	226 276 (24.9)	<0.001
Hypertension	640 841 (58.1)	116 883 (60.4)	523 958 (57.6)	<0.001
Congestive heart failure	138 558 (12.6)	33 563 (17.3)	104 995 (11.5)	<0.001
Diabetes mellitus	277 924 (25.2)	58 271 (30.1)	219 653 (24.1)	<0.001

Continued

Table 1. Continued

Variable	All Index Admissions (N=1 103 742)	Nonelective 30-d Readmission		
		Yes (n=193 632)	No (n=910 110)	*P* Value
Chronic pulmonary disease	238 531 (21.6)	50 018 (25.8)	188 513 (20.7)	<0.001
Pulmonary circulation disorders	216 282 (19.6)	39 899 (20.6)	176 383 (19.4)	<0.001
Renal disease	177 924 (16.1)	43 225 (22.3)	134 699 (14.8)	<0.001
Liver disease	32 656 (3.0)	7810 (4.0)	24 846 (2.7)	<0.001
Coagulopathy	99 598 (9.0)	21 530 (11.1)	78 068 (8.6)	<0.001
Anemia	303 960 (27.5)	67 349 (34.8)	236 611 (26.0)	<0.001
Fluid and electrolyte disorders	335 626 (30.4)	74 315 (38.4)	261 311 (28.7)	<0.001
Neurologic disorders/paralysis	143 567 (13.0)	28 597 (14.8)	114 970 (12.6)	<0.001
Alcohol abuse	40 838 (3.7)	7992 (4.1)	32 846 (3.6)	<0.001
Illicit drug abuse	35 702 (3.2)	8337 (4.3)	27 365 (3.0)	<0.001

Data are given as number (percentage) unless otherwise indicated. For most variables, 0% to 2.5% had missing values. VTE indicates venous thromboembolism.

Healthcare Costs Associated With VTE Readmissions

The median cost of a readmission after a hospitalization for acute VTE was $9782 (interquartile range, $5431–$18 784), with a nationally weighted annual cost totaling $1.44 billion. Including the median cost of the index admission ($14 739; interquartile range, $7917–$30 519), the median total inpatient healthcare cost associated with an acute VTE hospitalization that required a readmission was $24 521 (interquartile range, $13 348–$49 303).

Heterogeneity in Readmission Risk Between Hospitals

After standardizing for hospital case mix, the median RSRR for all institutions in 2014 was 17.4%. RSRRs ranged from 11.0% to 27.4% across hospitals, with an interquartile range of 16.6% to 18.3% (Figure 3). The fifth percentile was 14.9%, and the 95th percentile was 21.3%.

Hospitalizations With Acute VTE as Primary Billing Diagnosis

Of all hospitalizations, 49.7% (N=548 413) were associated with a primary diagnosis of acute VTE (Tables S9 and S10). The 30-day unplanned readmission rate among these patients was 13.3%. Predictors of 30-day nonelective readmission were similar to the overall study cohort (Figure S7), whereas the primary causes of readmission were more often related to VTE (recurrent DVT/thrombophlebitis, 8.8%; pulmonary heart disease, 8.1%) (Figure S8). Among patients readmitted, an additional 6.3% experienced an in-hospital death.

Discussion

Among >1.1 million US hospitalizations associated with acute VTE, the short-term readmission rate was substantial, with ≈1 in 5 rehospitalized within 30 days. These readmissions were costly, with ≈$10 000 in median additional healthcare expenditures per rehospitalization. Predictors and causes of readmission were primarily associated with patient characteristics and complications related to comorbid conditions. After standardizing for hospital case mix, there was only moderate heterogeneity in readmission rates between institutions.

Acute VTE is a major public health problem, with an incidence that is steadily increasing because of the aging population, increasing rates of comorbid conditions associated with VTE (eg, obesity and malignancy), and improved detection on imaging studies.[1,20] This disease process is also complex, involving the interaction between acquired and inherited predispositions for thrombosis. Many of these factors are related to external causes, such as hospitalization for surgery or trauma, pregnancy, prolonged immobilization, and active malignancy.[1] This heterogeneity in presentation and risk factors makes caring for these patients challenging and has prompted the development of formalized, multifaceted, team-based approaches.[21]

Beyond the direct costs accrued during the index hospitalization, our analysis demonstrates the substantial economic burden incurred by the US healthcare system because of short-term readmissions related to acute VTE. Readmissions were frequent (17.5% by 30 days), costly (median, ≈$10 000/rehospitalization), and often fatal (8% in-hospital death). Our findings complement a prior study, which found that the costs for VTE treatment are increasing faster than general inflation for medical care services.[22] Notably,

Table 2. Hospitalization and Institutional Characteristics of Index Admissions Associated With Acute VTE, Stratified by 30-Day Readmission Status

Variable	All Index Admissions (N=1 103 742)	Nonelective 30-d Readmission		
		Yes (n=193 632)	No (n=910 110)	*P* Value
Characteristics of index hospitalization				
Elective index admission	117 726 (10.7)	15 801 (8.2)	101 925 (11.2)	<0.001
Elective readmission	19 536 (1.8)	…	…	<0.001
Length of stay, mean±SD, d	9.4±13.0	11.5±14.6	8.9±12.5	<0.001
Disposition at discharge				<0.001
Home, no assistance	568 369 (51.5)	80 071 (41.4)	488 298 (53.7)	<0.001
Transfer to short-term hospital	14 514 (1.3)	2960 (1.5)	11 554 (1.3)	<0.001
Transfer to subacute nursing or intermediate-care facility	256 964 (23.3)	56 968 (29.4)	199 996 (22.0)	<0.001
Home with home health care	253 187 (22.9)	50 521 (26.1)	202 666 (22.3)	<0.001
Against medical advice	8704 (0.8)	2949 (1.5)	5755 (0.6)	<0.001
Cost of index hospitalization, median (IQR), $	11 208.4 (6127.2–23 529.9)	14 739.0 (7917.0–30 518.5)	10 573.3 (5851.9–22 043.2)	<0.001
Cost of rehospitalization, median (IQR), $	…	9781.7 (5430.7–18 784.1)	…	…
Characteristics of index hospital				
Bed size of hospital				<0.001
Small	112 428 (10.2)	17 033 (8.8)	95 395 (10.5)	<0.001
Medium	267 782 (24.3)	45 079 (23.3)	222 703 (24.5)	<0.001
Large	723 532 (65.6)	131 520 (67.9)	592 012 (65.0)	<0.001
Ownership of hospital				0.013
Government	157 440 (14.3)	28 116 (14.5)	129 324 (14.2)	<0.001
Private, nonprofit	769 314 (69.7)	134 513 (69.5)	634 801 (69.7)	0.014
Private, for profit	176 988 (16.0)	31 003 (16.0)	145 985 (16.0)	0.751
Teaching status				<0.001
Metropolitan, nonteaching	452 851 (41.0)	76 030 (39.3)	376 821 (41.4)	<0.001
Metropolitan, teaching	564 472 (51.1)	106 161 (54.8)	458 311 (50.4)	<0.001
Nonmetropolitan	86 419 (7.8)	11 441 (5.9)	74 978 (8.2)	<0.001
Procedures during index hospitalization				
Systemic thrombolysis	29 789 (2.7)	4231 (2.2)	25 558 (2.8)	<0.001
Pulmonary endarterectomy	131 (0.0)	17 (0.0)	114 (0.0)	0.169
Mechanical ventilation	69 239 (6.3)	15 395 (8.0)	53 844 (5.9)	<0.001
Extracorporeal circulation	408 (0.0)	82 (0.0)	326 (0.0)	0.174
Inferior vena cava filter placement	142 575 (12.9)	29 453 (15.2)	113 122 (12.4)	<0.001
Adverse events during index hospitalization				
Major bleed	239 633 (21.7)	54 587 (28.2)	185 046 (20.3)	<0.001
Gastrointestinal hemorrhage	47 628 (4.3)	11 580 (6.0)	36 048 (4.0)	<0.001
Intracranial hemorrhage	15 572 (1.4)	2999 (1.5)	12 573 (1.4)	<0.001
Other bleeding event (including RBC transfusion)	210 871 (19.1)	48 438 (25.0)	162 433 (17.8)	<0.001

Continued

Table 2. Continued

Variable	All Index Admissions (N=1 103 742)	Nonelective 30-d Readmission		
		Yes (n=193 632)	No (n=910 110)	*P* Value
Acute myocardial infarction/unstable angina	30 324 (2.7)	6565 (3.4)	23 759 (2.6)	<0.001
Cardiogenic shock	7686 (0.7)	1652 (0.9)	6034 (0.7)	<0.001
Cardiorespiratory arrest	9056 (0.8)	1925 (1.0)	7131 (0.8)	<0.001
Acute heart failure	174 146 (15.8)	42 328 (21.9)	131 818 (14.5)	<0.001

Data are given as number (percentage) unless otherwise indicated. For most variables, 0% to 2.5% had missing values. IQR indicates interquartile range; RBC, red blood cell; VTE, venous thromboembolism.

hospitalization costs were the primary cost driver in that analysis, with readmission-related expenses representing a large component.

In this study, most readmissions were secondary to complications from an underlying illness or perioperative condition, whereas a smaller proportion was attributable to recurrent VTE or a directly related disease process (9.4%). This relationship was more pronounced among those with acute DVT, which tends to complicate acquired conditions more often than PE.[23] Predictors of 30-day readmission were primarily related to patient comorbidities (eg, malignancy and renal failure), socioeconomic status (eg, Medicaid insurance), and frailty (eg, Medicare insurance, longer index hospitalizations, and requiring discharge to subacute facilities). These results parallel a prior analysis of patients hospitalized with acute PE in the state of Pennsylvania.[24]

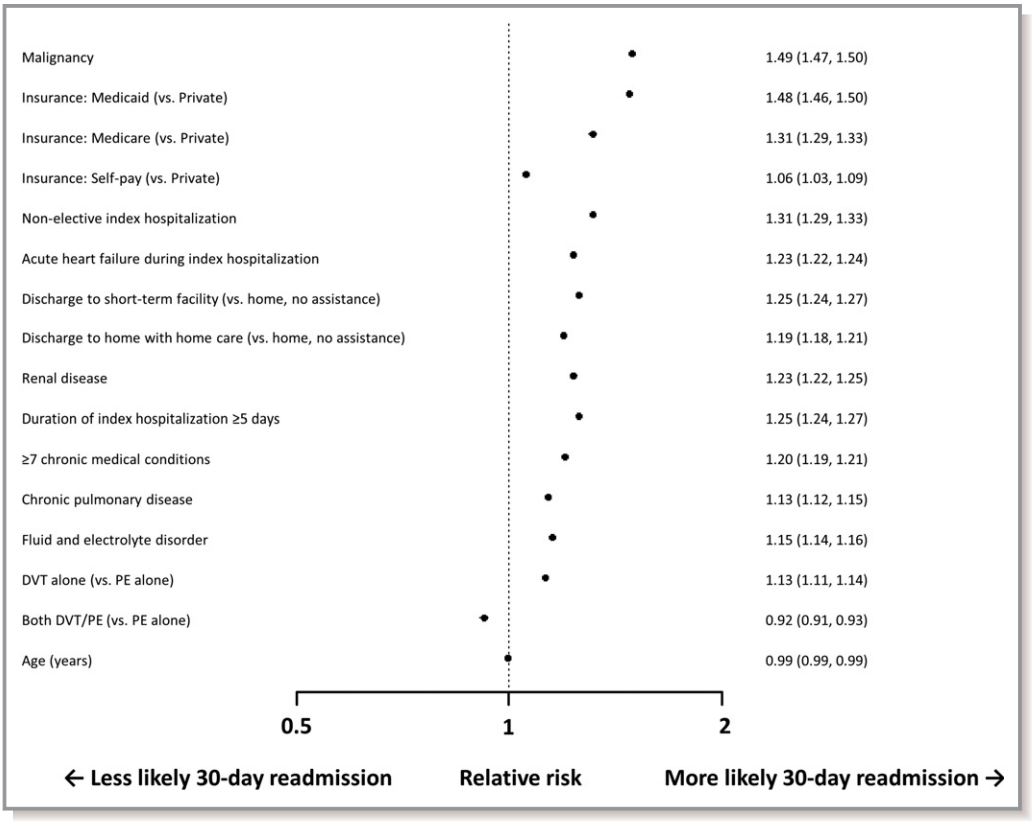

Figure 1. Displayed is a forest plot with predictors of nonelective 30-day readmission after acute venous thromboembolism. The strongest predictors included malignancy, nonelective index hospitalization, insurance type (Medicaid and Medicare), acute heart failure exacerbation, and discharge to a short-term facility. Risk estimates are relative risks with 95% confidence intervals. DVT indicates deep vein thrombosis; PE, pulmonary embolism.

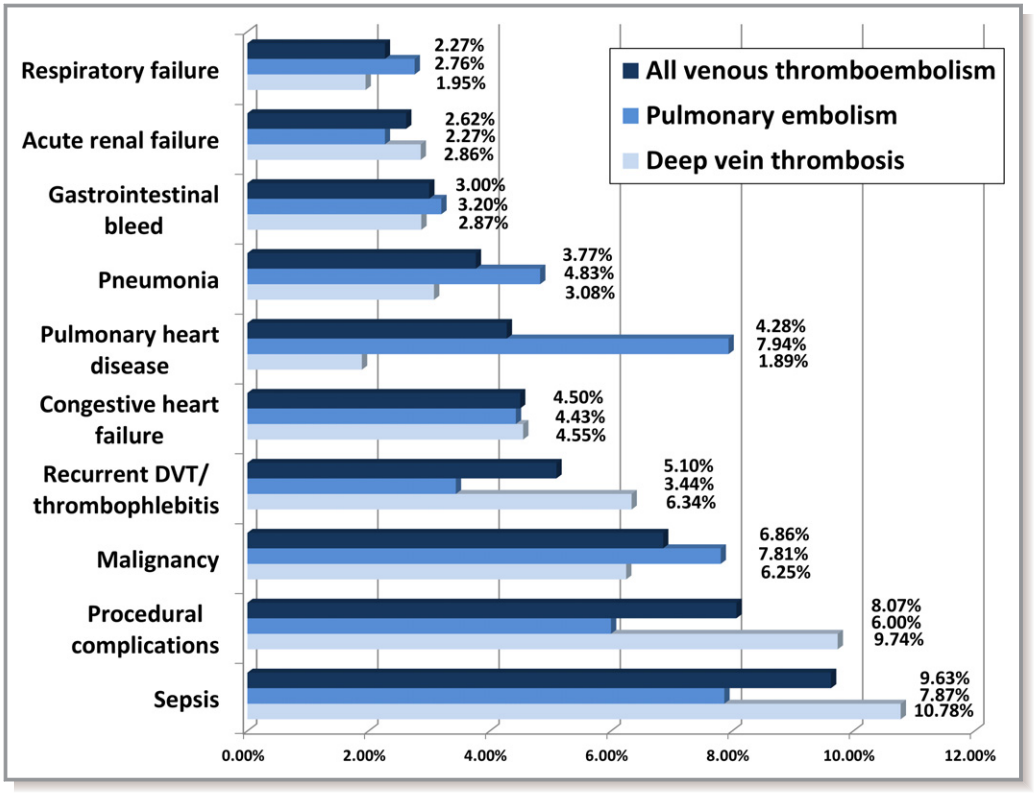

Figure 2. The figure displays the main reasons for 30-day readmission. The most common cause of readmission was sepsis, followed by procedural complications and issues related to malignancy. DVT indicates deep vein thrombosis.

More important, when examining patients admitted with a primary VTE diagnosis, the readmission rate was lower, but remained substantial (13.3%). In addition, predictors of readmission were similar to the overall cohort. Although there was a greater prevalence of readmissions for illnesses directly related to VTE (16.9%), this remained a minority of all causes.

Between studied institutions, there was modest heterogeneity in standardized readmission rates. In comparison, greater variation has been observed for currently penalized conditions, such as heart failure.[25] As such, programs designed to penalize institutional outliers, similar to the mandate of the Hospital Readmissions Reduction Program, may have less of an impact on improving outcomes for this disease process.

Taken together, the findings from this analysis should raise awareness to the large burden of readmissions that follow hospitalizations associated with acute VTE and the need to find effective strategies to reduce these events. Patient-oriented interventions, including early postdischarge follow-up, home health services, and confirmation of therapeutic anticoagulation, may be helpful for patients with high-risk comorbidities and complicated hospitalizations. Similar out-of-hospital initiatives have been effective for other conditions.[26] In addition, implementation of collaborative treatment teams for patients with acute VTE may be useful for coordinating in-hospital care, determining safe therapeutic strategies, and organizing treatment plans after discharge.[21]

This analysis must be interpreted in the context of the study design. First, acute VTE cases were identified through use of *ICD-9-CM* codes, which may result in the misclassification of acute VTE cases. For instance, *ICD-9-CM* codes are lacking for acute DVT, whereas there are *ICD-9-CM* codes to document chronic DVT. However, prior studies of VTE have demonstrated that in up to 96% of cases, *ICD-9-CM* codes corresponded with documented disease on medical record review.[23,24] Second, we lacked data on the incidence of out-of-hospital death after discharge. As such, our results may have been influenced by survivorship bias. To support that this effect was minimal, we performed a sensitivity analysis examining only hospitalizations in which patients underwent routine discharge home, a cohort who may have a lower risk of short-term death. These results did not vary significantly from our overall results (Figures S5 and S6). Third, we did not have data on the timing, type, and intensity of anticoagulation after the diagnosis of acute VTE, nor confirmatory testing among those with a diagnosis of primary

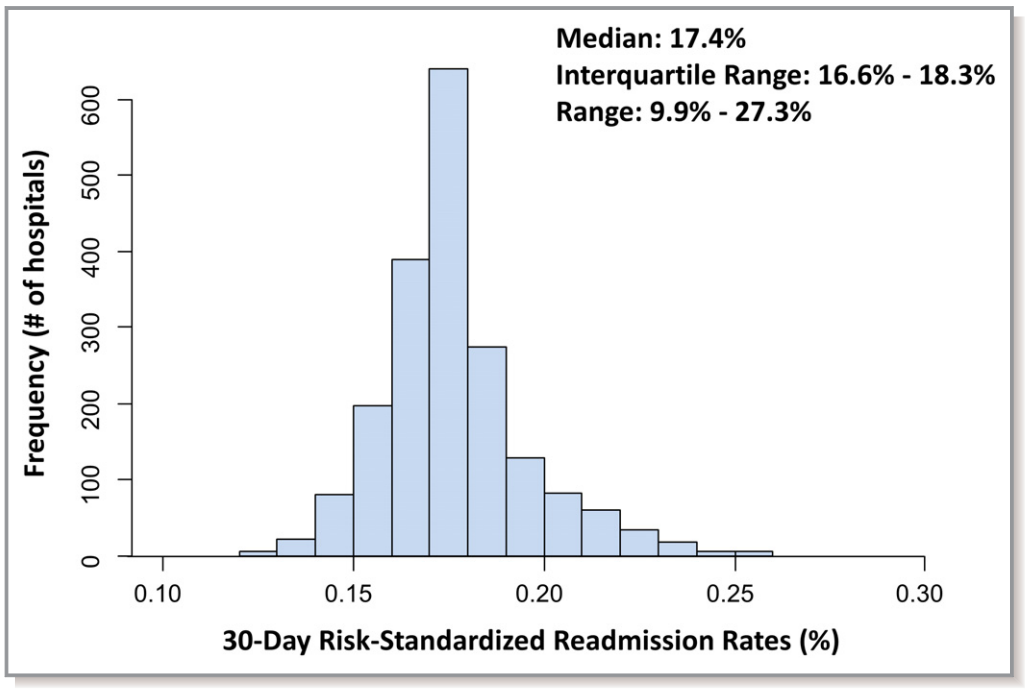

Figure 3. Frequency of 30-day risk-standardized readmission rates across institutions in 2014. Displayed on the X-axis are the hospital-specific 30-day risk-standardized readmission rates for each hospital included in the study. Displayed on the Y-axis are the frequencies of hospitals with the specific risk-standardized readmission rate.

hypercoagulability. Fourth, standardization of readmission rates for case mix using claims data may be subject to residual confounding. In addition, we chose to use risk standardization methods similar to those used by the Centers for Medicare and Medicaid Services that involve shrinkage of hospital estimates toward the mean. These methods may reduce the estimated variability in hospital readmission rates, particularly among lower-volume institutions. Fifth, among those with primary admissions for conditions other than VTE, such as for surgery, we are unable to determine the extent to which VTE caused the readmission above the risk secondary to the primary condition. Last, this analysis included data from a sample of US states and may not be generalizable to other populations, including those abroad.

Conclusions

Short-term readmission after acute VTE is common in the United States and associated with high healthcare costs and mortality. Readmissions are primarily related to patient characteristics and complications from comorbid conditions, whereas healthcare quality only modestly affects readmission risk. Further research is needed to identify and validate effective interventions to reduce these frequent and costly readmissions that follow acute VTE events.

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SUPPLEMENTAL MATERIAL

Data S1.

SUPPLEMENTAL METHODS

Agency for Healthcare Research and Quality (AHRQ) Clinical Classifications Software (CCS) for ICD-9-CM

The Clinical Classification Software (CCS) is a tool developed by the Agency for Healthcare Research and Quality that clusters patient diagnoses and procedures into a limited number of meaningful clinical categories[1]. The CCS collapses *International Classification of Diseases, 9th Revision, Clinical Modification* (ICD-9-CM) billing codes, which contain more than 14,000 diagnosis codes and 3,900 procedure codes, with the purpose of offering researchers the ability to use categorized conditions and procedures without having to sort through the thousands of ICD-9-CM codes. Without the CCS tool, the large number of ICD-9-CM codes would make statistical analysis and reporting difficult and time-consuming.

CCS consists of 2 related classification systems: 1) single-level and 2) multi-level. For this analysis, the single-level classification system of diagnoses was used to determine reasons for 30-day readmission, which is the most useful for ranking of diagnoses. CCS provides a listing of the ICD-9-CM codes included in each CCS diagnosis category, which can be found here: https://www.hcup-us.ahrq.gov/toolssoftware/ccs/ccs.jsp#download. The single-level CCS aggregates illnesses and conditions into 285 mutually exclusive categories. Examples of single-level CCS diagnosis categories are as follows:

98. Essential hypertension
99. Hypertension with complications and secondary hypertension
100. Acute myocardial infarction
101. Coronary atherosclerosis and other heart disease

For this analysis, we used CCS diagnosis categories **103 (Pulmonary heart disease)** and **118 (Phlebitis; thrombophlebitis and thromboembolism)** to identify patients with recurrent VTE or with disease processes directly related to or consequential of acute VTE.

The CCS diagnosis category "**Pulmonary heart disease**" consisted of the following ICD-9-CM codes: 415.0, 415.1, 415.12, 415.13, 415.19, 416.0, 416.1, 416.2, 416.8, 416.9, 417.0, 417.1, 417.8, 417.9, V12.55

The CCS diagnosis category "**Phlebitis; thrombophlebitis and thromboembolism**" consisted of the following ICD-9-CM codes: 451.0, 451.11, 451.19, 451.2, 451.81, 451.82, 451.83, 451.84, 451.89, 451.9, 452, 453.0, 453.1, 453.2, 453.3, 453.40, 453.41, 453.42, 453.50, 453.51, 453.52, 453.6, 453.71, 453.72, 453.73, 453.74, 453.75, 453.76, 453.77, 453.79, 453.8, 453.81, 453.82, 453.83, 453.84, 453.85, 453.86, 453.87, 453.89, 453.9, V12.51, V12.52

Table S1. Diagnosis and Procedure Billing Codes.

ICD-9-CM Diagnosis Codes for Acute Venous Thromboembolism	
Acute deep vein thrombosis	451.11, 451.19, 451.2, 451.81, 451.83, 451.84, 451.89, 451.9, 453.2, 453.3, 453.40, 453.41, 453.42, 453.82, 453.83, 453.84, 453.85, 453.86, 453.87, 453.89, 453.9, 671.30, 671.31, 671.33, 671.40, 671.42, 671.44
Phlebitis/thrombophlebitis	451.11, 451.19, 451.2, 451.81, 451.83, 451.84, 451.89, 451.9
Varicose veins	454.0, 454.1, 454.2, 454.8, 454.9, 671.00, 671.01, 671.02, 671.03, 671.04
Surgically-related	Any surgical or post-operative code with any code for acute deep vein thrombosis
Pregnancy-related	671.30, 671.31, 671.33, 671.40, 671.42, 671.44; or code V22.2 (pregnant state) with any code for acute deep vein thrombosis
Malignancy-related	Any code for malignancy with any code for acute deep vein thrombosis
Hypercoagulable-related	289.81 with any code for acute deep vein thrombosis
Trauma-related	Any code for trauma with any code for acute deep vein thrombosis
Acute pulmonary embolism	415.11, 415.13, 415.19, 673.20, 673.21, 673.22, 673.23, 673.24, 673.80, 673.81, 673.82, 673.83, 673.84
Saddle pulmonary embolism	415.13
Acute cor pulmonale	415.0 with any code for acute pulmonary embolism
Surgically-related	415.11; or any surgical or post-operative code with any code for acute pulmonary embolism
Pregnancy-related	673.20, 673.21, 673.22, 673.23, 673.24, 673.80, 673.81, 673.82, 673.83, 673.84; or code V22.2 (pregnant state) with any code for acute pulmonary embolism
Malignancy-related	Any code for malignancy with any code for acute pulmonary embolism

Hypercoagulable-related	289.81 with any code for acute pulmonary embolism
Trauma-related	Any code for trauma with any code for acute pulmonary embolism
Recent surgery	Diagnostic Codes: 415.11 Procedure Codes: 00.3, 00.7, 00.8, 00.91-00.93, 01, 02, 03.0, 03.1, 03.4-03.7, 03.97-03.99, 04.0, 04.2, 04.41, 04.42, 04.5-04.7, 06.12, 06.2-06.9, 07.0, 07.12, 07.2-07.9, 16.0, 16.3-16.7, 16.99, 17.1-17.4, 25.2-25.4, 30, 31.2, 31.3, 31.45, 31.5-31.7, 31.91, 31.92, 31.95, 31.98, 31.99, 32, 33.0, 33.1, 33.25, 33.3-33.6, 33.9, 34.0, 34.1, 34.26, 34.3-34.6, 34.72-34.74, 34.79, 34.8, 34.99, 35, 36.03, 36.1-36.9, 37.1, 37.3-37.6, 37.91, 37.99, 38.1, 38.3, 38.4, 38.6, 39.0-39.2, 39.4-39.7, 40.4-40.9, 41.0-41.2, 41.43, 41.5, 41.93, 41.94, 41.99, 42.0, 42.1, 42.3-42.9, 43, 44.2-44.6, 44.95-44.99, 45.0, 45.15, 45.26, 45.5-45.9, 46, 47, 48.0, 48.1, 48.25, 48.4-48.7, 48.92-48.99, 49.5, 49.6, 49.74-49.79, 49.95, 49.99, 50.0, 50.12, 50.3-50.6, 50.99, 51.0, 51.13, 51.2-51.7, 51.91-51.94, 51.99, 52.12, 52.5-52.8, 52.95, 52.96, 52.99, 53, 54.1-54.7, 54.92-54.96, 54.99, 55.3-55.9, 56, 57.34, 57.5-57.8, 57.91-57.93, 57.99, 58.3-58.9, 59.0-59.7, 59.91, 59.92, 59.99, 60.12, 60.14, 60.2-60.6, 60.73, 60.79, 60.93, 60.94, 60.99, 61.2-61.4, 61.92, 61.99, 62.2-62.7, 62.99, 63.4, 63.5, 63.8, 63.9, 64.3, 64.43-64.49, 64.5, 64.94-64.99, 65.0, 65.13, 65.2-65.9, 66.2-66.7, 66.99, 67.4, 67.5, 68.13, 68.14, 68.3-68.9, 69.2-69.4, 69.98, 69.99, 70.4, 70.6-70.8, 76.3-76.6, 76.91, 76.92, 77.2, 77.3, 77.7-77.9, 78.0-78.7, 80.0, 80.1, 80.4-80.7, 80.9, 81.0-81.8, 81.96, 81.97, 81.99, 82.5-82.8, 82.99, 83.1, 83.3-83.8, 83.99, 84.0-84.3, 84.40, 84.44, 84.48, 84.53, 84.54, 84.6-84.9, 85.2-85.4, 85.50, 85.53-85.55, 85.6-85.8, 85.93-85.99, 86.60-86.63, 86.65, 86.66, 86.69, 86.7-86.9
Hypercoagulable	289.81
Pregnancy	V22.2, 673.20, 673.21, 673.22, 673.23, 673.24, 673.80, 673.81, 673.82, 673.83, 673.84, 671.30, 671.31, 671.33, 671.40, 671.42, 671.44

Malignancy	V10; 140-209; 230-239
Recent trauma	800-829, 850-897, 925-929, 952, 958-959
Prior or current tobacco use	305.1, 649.00–649.04, V15.82
ICD-9-CM Procedure Codes	
Systemic thrombolysis	99.10
Pulmonary endarterectomy	38.15
Extracorporeal circulation	39.65, 39.66
Mechanical ventilation	96.04, 96.05, 96.70, 96.71, 96.72
Inferior vena cava filter placement	38.7
ICD-9-CM Diagnosis Codes for In-hospital Adverse Events	
Major bleed	
Gastrointestinal bleeding event	456.0, 456.20, 530.82, 531.0x, 531.2x, 531.4x, 531.6x, 532.0x, 532.2x, 532.4x, 532.6x, 533.0x, 533.2x, 533.4x, 533.6x, 534.0x, 534.2x, 534.4x, 534.6x, 535.01, 535.11, 535.21, 535.31, 535.41, 535.51, 535.61, 537.83, 562.02, 562.03, 562.12, 562.13, 568.81, 569.3, 569.85, 578.x Procedure Code: 44.43
Intracranial hemorrhage	430, 431, 432.0, 432.1, 432.9, 852.0x, 852.2x, 852.4x, 853.0x,
Other bleeding events (including red blood cell transfusion)	285.1, 360.43, 362.43, 362.81, 363.61, 363.62, 363.72, 364.41, 372.72, 374.81, 376.32, 377.42, 379.23, 423.0x, 596.7x, 599.7x, 602.1x, 620.1, 621.4, 626.2, 626.5, 626.7, 626.8, 626.9, 719.1x, 782.7, 784.7, 784.8, 786.3x, 958.2, 997.02, 998.11 Procedure codes: 99.00, 99.01, 99.02, 99.03, 99.04
Cardiorespiratory arrest	799.1, 427.5
Acute myocardial infarction/unstable angina	410.x1, 411.1

Cardiogenic shock	785.51
Acute heart failure	428.0, 428.1, 428.20, 428.21, 428.23, 428.30, 428.31, 428.33, 428.40, 428.41, 428.43, 428.9

Table S2. Candidate Variables for 30-day Readmission Prediction Models.

Variables
Age ≥median
Female
Primary insurance
Medicare (vs private)
Medicaid (vs private)
Self-pay (vs private)
Patient household income by residential zip code ≥median
Patient residence in large (≥1 million people) metropolitan counties (versus counties of <1 million people)
Number of chronic conditions ≥ mean
History of hypercoagulability
Recent surgery
Recent trauma
Pregnancy
Obesity
Current or prior tobacco use
Hypertension
Congestive heart failure
Valvular heart disease
Diabetes mellitus
Chronic pulmonary disease
Pulmonary circulation disorders
Renal disease
Liver disease
Coagulopathy
Chronic anemia
Fluid and electrolyte disorders
Neurologic disorders/paralysis

Variables
Malignancy
Rheumatoid arthritis/collagen vascular disease
Unintentional weight loss
Psychoses
Depression
Alcohol abuse
Illicit drug abuse
Venous thromboembolism
Deep vein thrombosis
Pulmonary embolus
Both
Saddle pulmonary embolism
Acute cor pulmonale
Phlebitis/thrombophlebitis
Length of stay ≥5 days (vs <5 days)
Disposition at discharge
Transfer to subacute nursing or intermediate care facility (vs home, no assistance)
Home with home health care (vs home, no assistance)
Non-elective index hospitalization (vs elective)
Large bed size of hospital (vs small/medium bed size)
Government or non-profit hospital (vs for-profit hospital)
Teaching hospital (vs non-teaching)
Systemic thrombolysis
Mechanical ventilation
Blood transfusion
Inferior vena cava filter placement
Major bleed
Acute myocardial infarction/unstable angina
Cardiogenic shock

Variables
Cardiorespiratory arrest
Acute heart failure

Table S3. Candidate Variables for 30-Day Risk Standardization Readmissions Model.

Variables
Age ≥median
Female
History of hypercoagulability
Recent surgery
Recent trauma
Pregnancy
Obesity
Current or prior tobacco use
Hypertension
Congestive heart failure
Valvular heart disease
Diabetes mellitus
Chronic pulmonary disease
Pulmonary circulation disorders
Renal disease
Liver disease
Coagulopathy
Chronic anemia
Fluid and electrolyte disorders
Neurologic disorders/paralysis
Malignancy
Rheumatoid arthritis/collagen vascular disease
Unintentional weight loss
Psychoses
Depression
Alcohol abuse
Illicit drug abuse

Table S4. 30-Day Readmission Logistic Regression Model.

Variable	Estimate	Standard Error	Odds Ratio	95% Confidence Interval
Intercept	-2.02	0.03	---	---
Age	-0.03	<0.01	0.97	(0.96, 0.98)
Rheumatoid arthritis/collagen vascular disease	0.17	0.03	1.19	(1.13, 1.26)
Congestive heart failure	0.33	0.02	1.39	(1.35, 1.44)
Chronic pulmonary disease	0.22	0.01	1.24	(1.21, 1.28)
Illicit drug abuse	0.32	0.03	1.37	(1.30, 1.45)
Liver disease	0.21	0.03	1.23	(1.16, 1.30)
Fluid and electrolyte disorders	0.26	0.01	1.29	(1.26, 1.32)
Obesity	-0.10	0.02	0.90	(0.88, 0.93)
Psychoses	0.21	0.02	1.24	(1.18, 1.30)
Renal disease	0.35	0.01	1.42	(1.38, 1.46)
Unintentional weight loss	0.23	0.02	1.26	(1.22, 1.31)
Neurologic disorders/paralysis	0.12	0.02	1.13	(1.10, 1.17)
Anemia	0.24	0.01	1.27	(1.24, 1.30)
Diabetes mellitus	0.19	0.01	1.21	(1.18, 1.24)
Malignancy	0.51	0.01	1.66	(1.62, 1.70)
Recent surgery	0.06	0.01	1.06	(1.03, 1.09)
Depression	0.10	0.02	1.10	(1.06, 1.14)
Pregnancy	-0.33	0.07	0.72	(0.63, 0.83)
Coagulopathy	0.07	0.02	1.07	(1.03, 1.11)
Recent trauma	-0.10	0.03	0.91	(0.86, 0.96)
Female sex	0.03	0.01	1.03	(1.01, 1.06)

* Between-hospital variance estimate when using the hierarchical model is 0.051 (standard error, 0.0041)

Table S5. Patient Characteristics of Index Admissions associated with Acute Pulmonary Embolism, Stratified by 30-day Readmission Status.

Variable, N (%)	All Index Admissions (N = 501,616)	Non-elective 30-day Readmission		
		Yes (N = 76,525)	No (N = 425,091)	P value
Patient Characteristics at Index Hospitalization				<0.001
PE alone	325,850 (65.0%)	51,417 (67.2%)	274,433 (64.6%)	<0.001
Both PE and DVT	175,766 (35.0%)	25,108 (32.8%)	150,658 (35.4%)	<0.001
Saddle pulmonary embolism	10,901 (2.2%)	1,095 (1.4%)	9,806 (2.3%)	<0.001
Acute cor pulmonale	1,816 (0.4%)	238 (0.3%)	1,578 (0.4%)	0.010
Provoking factors associated with PE present during admission				
Recent surgery	73,057 (14.6%)	12,713 (16.6%)	60,344 (14.2%)	<0.001
Malignancy	96,642 (19.3%)	22,100 (28.9%)	74,542 (17.5%)	<0.001
Recent trauma	19,202 (3.8%)	2,940 (3.8%)	16,262 (3.8%)	0.828
Hypercoagulability	18,733 (3.7%)	2,719 (3.6%)	16,014 (3.8%)	0.004
Pregnancy	4,893 (1.0%)	526 (0.7%)	4,367 (1.0%)	<0.001
Age, years (mean±SD)	63.1 ± 17.0	64.2 ± 16.5	62.9 ± 17.1	<0.001
Female	266,698 (53.2%)	41,398 (54.1%)	225,300 (53.0%)	<0.001
Primary insurance				<0.001
Medicare	266,598 (53.3%)	44,896 (58.8%)	22,1702 (52.3%)	<0.001
Medicaid	51,330 (10.3%)	10,625 (13.9%)	40,705 (9.6%)	<0.001
Private	142,064 (28.4%)	15,727 (20.6%)	126,337 (29.8%)	<0.001
Self-pay	19,818 (4.0%)	2,544 (3.3%)	17,274 (4.1%)	<0.001
Other	20,687 (4.1%)	2,591 (3.4%)	18,096 (4.3%)	<0.001
Median household income by residential zip code				<0.001
Lowest quartile	134,267 (27.2%)	22,323 (29.6%)	111,944 (26.8%)	<0.001
Middle lowest quartile	121,159 (24.5%)	18,434 (24.5%)	102,725 (24.6%)	0.533
Middle highest quartile	121,627 (24.6%)	17,938 (23.8%)	103,689 (24.8%)	<0.001
Highest quartile	116,596 (23.6%)	16,688 (22.1%)	99,908 (23.9%)	<0.001

Variable, N (%)	All Index Admissions (N = 501,616)	Non-elective 30-day Readmission		
		Yes (N = 76,525)	No (N = 425,091)	P value
Residence by county location				<0.001
Central counties in metro areas with population ≥1 million	148,701 (29.7%)	25,409 (33.3%)	123,292 (29.0%)	<0.001
Fringe counties in metro areas with population ≥1 million	126,680 (25.3%)	19,600 (25.7%)	107,080 (25.2%)	0.009
Counties in metro areas with population 250,000-999,999	106,961 (21.3%)	15,268 (20.0%)	91,693 (21.6%)	<0.001
Counties in metro areas with population 50,000-249,999	47,628 (9.5%)	6,727 (8.8%)	40,901 (9.6%)	<0.001
Micropolitan counties	42,854 (8.6%)	5,782 (7.6%)	37,072 (8.7%)	<0.001
Other	28,286 (5.6%)	3,614 (4.7%)	24,672 (5.8%)	<0.001
No. of chronic conditions (mean±SD)	5.4 ± 3.1	6.3 ± 3.1	5.2 ± 3.0	<0.001
Varicose veins	2,362 (0.5%)	224 (0.3%)	2,138 (0.5%)	<0.001
Obesity	94,621 (18.9%)	13,174 (17.2%)	81,447 (19.2%)	<0.001
Current or prior tobacco use	139,414 (27.8%)	22,505 (29.4%)	116,909 (27.5%)	<0.001
Hypertension	286,604 (57.1%)	45,603 (59.6%)	241,001 (56.7%)	<0.001
Congestive heart failure	64,153 (12.8%)	14,026 (18.3%)	50,127 (11.8%)	<0.001
Diabetes mellitus	112,167 (22.4%)	20,582 (26.9%)	91,585 (21.5%)	<0.001
Chronic pulmonary disease	122,081 (24.3%)	23,368 (30.5%)	98,713 (23.2%)	<0.001
Pulmonary circulation disorders	198,471 (39.6%)	35,510 (46.4%)	162,961 (38.3%)	<0.001
Renal disease	55,215 (11.0%)	11,391 (14.9%)	43,824 (10.3%)	<0.001
Liver disease	12,387 (2.5%)	2,489 (3.3%)	9,898 (2.3%)	<0.001
Coagulopathy	37,653 (7.5%)	6,993 (9.1%)	30,660 (7.2%)	<0.001
Anemia	116,733 (23.3%)	23,208 (30.3%)	93,525 (22.0%)	<0.001
Fluid and electrolyte disorders	131,145 (26.1%)	25,908 (33.9%)	105,237 (24.8%)	<0.001
Neurologic disorders/paralysis	53,581 (10.7%)	9,803 (12.8%)	43,778 (10.3%)	<0.001
Alcohol abuse	17,825 (3.6%)	3,286 (4.3%)	14,539 (3.4%)	<0.001

Variable, N (%)	All Index Admissions (N = 501,616)	Non-elective 30-day Readmission		
		Yes (N = 76,525)	No (N = 425,091)	P value
Illicit drug abuse	13,822 (2.8%)	3,074 (4.0%)	10,748 (2.5%)	<0.001

For most variables, 0 to 2.5% had missing values.

Abbreviations: DVT, deep vein thrombosis; PE, pulmonary embolism

Table S6. Hospitalization and Institutional Characteristics of Index Admissions associated with Acute Pulmonary Embolism, Stratified by 30-day Readmission Status.

Variable, N (%)	All Index Admissions (N = 501,616)	Non-elective 30-day Readmission		P value
		Yes (N = 76,525)	No (N = 425,091)	
Characteristics of Index Hospitalization				
Elective index admission	40,837 (8.1%)	5,088 (6.7%)	35,749 (8.4%)	<0.001
Elective readmission	6,755 (1.3%)	---	---	---
Length of stay, days (mean±SD)	7.9 ± 10.5	9.8 ± 12.4	7.5 ± 10.1	<0.001
Disposition at discharge				<0.001
Home, no assistance	288,496 (57.5%)	35,217 (46.0%)	253,279 (59.6%)	<0.001
Transfer to short term hospital	6,031 (1.2%)	1,188 (1.6%)	4,843 (1.1%)	<0.001
Transfer to subacute nursing or intermediate care facility	92,916 (18.5%)	18,839 (24.6%)	74,077 (17.4%)	<0.001
Home with home health care	110,021 (21.9%)	20,108 (26.3%)	89,913 (21.2%)	<0.001
Against medical advice	3,291 (0.7%)	1,122 (1.5%)	2,169 (0.5%)	<0.001
Cost of index hospitalization (median, IQR)	$10,418.4 (6,397.9, 19,279.4)	$13,301.3 (7,937.3, 25,073.9)	$9,992.0 (6,203.6, 18,281.3)	<0.001
Cost of rehospitalization (median, IQR)	---	$9,162.6 (5,172.0, 17,429.6)	---	---
Characteristics of Index Hospital				
Bed size of hospital				<0.001
Small	56,620 (11.3%)	7,464 (9.8%)	49,156 (11.6%)	<0.001
Medium	127,107 (25.3%)	18,570 (24.3%)	108,537 (25.5%)	<0.001
Large	317,889 (63.4%)	50,491 (66.0%)	267,398 (62.9%)	<0.001
Ownership of hospital				<0.001
Government	70,139 (14.0%)	11,211 (14.7%)	58,928 (13.9%)	<0.001
Private, non-profit	353,823 (70.5%)	53,350 (69.7%)	300,473 (70.7%)	<0.001
Private, for-profit	77,654 (15.5%)	11,964 (15.6%)	65,690 (15.5%)	0.202
Teaching status				<0.001
Metropolitan, non-teaching	210,983 (42.1%)	30,397 (39.7%)	180,586 (42.5%)	<0.001

Variable, N (%)	All Index Admissions (N = 501,616)	Non-elective 30-day Readmission		
		Yes (N = 76,525)	No (N = 425,091)	P value
Metropolitan, teaching	247,324 (49.3%)	40,744 (53.2%)	206,580 (48.6%)	<0.001
Non-metropolitan	43,309 (8.6%)	5,384 (7.0%)	37,925 (8.9%)	<0.001
Procedures during Index Hospitalization				
Systemic thrombolysis	11,693 (2.3%)	1,357 (1.8%)	10,336 (2.4%)	<0.001
Pulmonary endarterectomy	92 (0.0%)	11 (0.0%)	81 (0.0%)	0.378
Mechanical ventilation	24,076 (4.8%)	5,033 (6.6%)	19,043 (4.5%)	<0.001
Extracorporeal circulation	141 (0.0%)	18 (0.0%)	123 (0.0%)	0.410
Inferior vena cava filter placement	68,793 (13.7%)	13,325 (17.4%)	55,468 (13.0%)	<0.001
Adverse events during index hospitalization				
Major bleed	85,706 (17.1%)	17,593 (23.0%)	68,113 (16.0%)	<0.001
Gastrointestinal hemorrhage	15,759 (3.1%)	3,645 (4.8%)	12,114 (2.8%)	<0.001
Intracranial hemorrhage	4,206 (0.8%)	807 (1.1%)	3,399 (0.8%)	<0.001
Other bleeding event (including RBC transfusion)	76,010 (15.2%)	15,571 (20.3%)	60,439 (14.2%)	<0.001
Acute myocardial infarction/unstable angina	13,483 (2.7%)	2,480 (3.2%)	11,003 (2.6%)	<0.001
Cardiogenic shock	3,204 (0.6%)	549 (0.7%)	2,655 (0.6%)	0.003
Cardiorespiratory arrest	3,949 (0.8%)	718 (0.9%)	3,231 (0.8%)	<0.001
Acute heart failure	73,232 (14.6%)	16,045 (21.0%)	57,187 (13.5%)	<0.001

For most variables, 0 to 2.5% had missing values.

Abbreviations: RBC, red blood cell

Table S7. Patient Characteristics of Index Hospitalizations associated with Acute Deep Vein Thrombosis, Stratified by 30-day Readmission Status.

Variable, N (%)	All Index Admissions (N = 602,126)	Non-elective 30-day Readmission		
		Yes (N = 117,107)	No (N = 485,019)	P value
Patient Characteristics at Index Hospitalization				
Phlebitis/thrombophlebitis	53,821 (8.9%)	9,262 (7.9%)	44,559 (9.2%)	<0.001
Provoking factors associated with deep vein thrombosis present during admission				
Recent surgery	140,106 (23.3%)	29,741 (25.4%)	110,365 (22.8%)	<0.001
Malignancy	120,760 (20.1%)	29,465 (25.2%)	91,295 (18.8%)	<0.001
Recent trauma	31,272 (5.2%)	5,353 (4.6%)	25,919 (5.3%)	<0.001
Hypercoagulability	18,088 (3.0%)	3,327 (2.8%)	14,761 (3.0%)	<0.001
Pregnancy	6,150 (1.0%)	653 (0.6%)	5,497 (1.1%)	<0.001
Age, years (mean±SD)	64.8 ± 17.5	65.1 ± 17.1	64.7 ± 17.5	<0.001
Female	313,934 (52.1%)	61,451 (52.5%)	252,483 (52.1%)	0.010
Primary insurance				<0.001
Medicare	361,105 (60.1%)	74,867 (64.0%)	286,238 (59.2%)	<0.001
Medicaid	70,752 (11.8%)	16,719 (14.3%)	54,033 (11.2%)	<0.001
Private	125,301 (20.9%)	19,040 (16.3%)	106,261 (22.0%)	<0.001
Self-pay	20,907 (3.5%)	2,920 (2.5%)	17,987 (3.7%)	<0.001
Other	22,772 (3.8%)	3,375 (2.9%)	19,397 (4.0%)	<0.001
Median household income by residential zip code				<0.001
Lowest quartile	179,146 (30.2%)	35,938 (31.1%)	143,208 (30.0%)	<0.001
Middle lowest quartile	144,110 (24.3%)	27,602 (23.9%)	116,508 (24.4%)	<0.001
Middle highest quartile	138,549 (23.4%)	26,575 (23.0%)	111,974 (23.5%)	0.002
Highest quartile	131,090 (22.1%)	25,292 (21.9%)	105,798 (22.2%)	0.075
Residence by county location				<0.001

Variable, N (%)	All Index Admissions (N = 602,126)	Non-elective 30-day Readmission		
		Yes (N = 117,107)	No (N = 485,019)	P value
Central counties in metro areas with population ≥1 million	215,482 (35.8%)	46,361 (39.7%)	169,121 (34.9%)	<0.001
Fringe counties in metro areas with population ≥1 million	147,488 (24.5%)	29,422 (25.2%)	118,066 (24.4%)	<0.001
Counties in metro areas with population 250,000-999,999	115,636 (19.2%)	20,996 (18.0%)	94,640 (19.5%)	<0.001
Counties in metro areas with population 50,000-249,999	47,155 (7.8%)	8,328 (7.1%)	38,827 (8.0%)	<0.001
Micropolitan counties	43,835 (7.3%)	7,035 (6.0%)	36,800 (7.6%)	<0.001
Other	31,572 (5.3%)	4,724 (4.0%)	26,848 (5.5%)	<0.001
No. of chronic conditions (mean±SD)	5.9 ± 3.2	6.7 ± 3.2	5.7 ± 3.2	<0.001
Varicose veins	3,588 (0.6%)	438 (0.4%)	3,150 (0.6%)	<0.001
Obesity	80,016 (13.3%)	15,549 (13.3%)	64,467 (13.3%)	0.898
Current or prior tobacco use	130,620 (21.7%)	25,035 (21.4%)	105,585 (21.8%)	0.003
Hypertension	354,237 (58.8%)	71,280 (60.9%)	282,957 (58.3%)	<0.001
Congestive heart failure	74,405 (12.4%)	19,537 (16.7%)	54,868 (11.3%)	<0.001
Diabetes mellitus	165,757 (27.5%)	37,689 (32.2%)	128,068 (26.4%)	<0.001
Chronic pulmonary disease	116,450 (19.3%)	26,650 (22.8%)	89,800 (18.5%)	<0.001
Pulmonary circulation disorders	17,811 (3.0%)	4,389 (3.7%)	13,422 (2.8%)	<0.001
Renal disease	122,709 (20.4%)	31,834 (27.2%)	90,875 (18.7%)	<0.001
Liver disease	20,269 (3.4%)	5,321 (4.5%)	14,948 (3.1%)	<0.001
Coagulopathy	61,945 (10.3%)	14,537 (12.4%)	47,408 (9.8%)	<0.001
Anemia	187,227 (31.1%)	44,141 (37.7%)	143,086 (29.5%)	<0.001
Fluid and electrolyte disorders	204,481 (34.0%)	48,407 (41.3%)	156,074 (32.2%)	<0.001
Neurologic disorders/paralysis	89,986 (14.9%)	18,794 (16.0%)	71,192 (14.7%)	<0.001
Alcohol abuse	23,013 (3.8%)	4,706 (4.0%)	18,307 (3.8%)	<0.001
Illicit drug abuse	21,880 (3.6%)	5,263 (4.5%)	16,617 (3.4%)	<0.001

For most variables, 0 to 2.5% had missing values.

Table S8. Hospitalization and Institutional Characteristics of Index Admissions associated with Acute Deep Vein Thrombosis, Stratified by 30-day Readmission Status.

Variable, N (%)	All Index Admissions (N = 602,126)	Non-elective 30-day Readmission		P value
		Yes (N = 117,107)	No (N = 485,019)	
Characteristics of Index Hospitalization				
Elective index admission	76,889 (12.8%)	10,713 (9.2%)	66,176 (13.7%)	<0.001
Elective readmission	12,781 (2.1%)	---	---	---
Length of stay, days (mean±SD)	10.6 ± 14.6	12.6 ± 15.9	10.1 ± 14.2	<0.001
Disposition at discharge				<0.001
Home, no assistance	279,873 (46.5%)	44,854 (38.3%)	235,019 (48.5%)	<0.001
Transfer to short term hospital	8,483 (1.4%)	17,72 (1.5%)	6,711 (1.4%)	<0.001
Transfer to subacute nursing or intermediate care facility	164,048 (27.3%)	38,129 (32.6%)	125,919 (26.0%)	<0.001
Home with home health care	143,166 (23.8%)	30,413 (26.0%)	112,753 (23.3%)	<0.001
Against medical advice	5,413 (0.9%)	1,827 (1.6%)	3,586 (0.7%)	<0.001
Cost of index hospitalization (median, IQR)	$12,216.7 (5,806.2, 27,962.2)	$16,039.6 (7,898.5, 34,592.1)	$11,373.6 (5,432.7, 26,302.2)	<0.001
Cost of rehospitalization (median, IQR)	---	$10,208.2 (5.614.9, 19.717.2)	---	---
Characteristics of Index Hospital				
Bed size of hospital				<0.001
Small	55,808 (9.3%)	9,569 (8.2%)	46,239 (9.5%)	<0.001
Medium	140,675 (23.4%)	26,509 (22.6%)	114,166 (23.5%)	<0.001
Large	405,643 (67.4%)	81,029 (69.2%)	324,614 (66.9%)	<0.001
Ownership of hospital				0.227
Government	87,301 (14.5%)	16,905 (14.4%)	70,396 (14.5%)	0.493
Private, non-profit	415,491 69.0%)	81,163 (69.3%)	334,328 (68.9%)	0.012
Private, for-profit	99,334 (16.5%)	19,039 (16.3%)	80,295 (16.6%)	0.013
Teaching status				<0.001
Metropolitan, non-teaching	241,868 (40.2%)	45,633 (39.0%)	196,235 (40.5%)	<0.001

Variable, N (%)	All Index Admissions (N = 602,126)	Non-elective 30-day Readmission		
		Yes (N = 117,107)	No (N = 485,019)	P value
Metropolitan, teaching	317,148 (52.7%)	65,417 (55.9%)	251,731 (51.9%)	<0.001
Non-metropolitan	43,110 (7.2%)	6,057 (5.2%)	37,053 (7.6%)	<0.001
Procedures during Index Hospitalization				
Systemic thrombolysis	18,096 (3.0%)	2,874 (2.5%)	15222 (3.1%)	<0.001
Inferior vena cava filter placement	73,782 (12.3%)	16,128 (13.8%)	57654 (11.9%)	<0.001
Adverse events during Index Hospitalization				
Major bleed	153,927 (25.6%)	36,994 (31.6%)	116,933 (24.1%)	<0.001
Gastrointestinal hemorrhage	31,869 (5.3%)	7,935 (6.8%)	23,934 (4.9%)	<0.001
Intracranial hemorrhage	11,366 (1.9%)	2,192 (1.9%)	9,174 (1.9%)	0.656
Other bleeding event (including RBC transfusion)	134,861 (22.4%)	32,867 (28.1%)	101,994 (21.0%)	<0.001
Acute myocardial infarction/unstable angina	16,841 (2.8%)	4,085 (3.5%)	12,756 (2.6%)	<0.001
Cardiogenic shock	4,482 (0.7%)	1,103 (0.9%)	3,379 (0.7%)	<0.001
Cardiorespiratory arrest	5,107 (0.8%)	1,207 (1.0%)	3,900 (0.8%)	<0.001
Acute heart failure	100,914 (16.8%)	26,283 (22.4%)	74,631 (15.4%)	<0.001

For most variables, 0 to 2.5% had missing values.
Abbreviations: RBC, red blood cell

Table S9. Patient Characteristics of Index Hospitalizations associated with a Primary Diagnosis Code for Venous Thromboembolism, Stratified by 30-day Readmission Status.

Variable, N (%)	All Index Admissions (N=548,413)	Non-elective 30-day Readmission		
		Yes (N = 72,803)	No (N = 475,610)	P value
Patient Characteristics at Index Hospitalization				
Venous thromboembolism				<0.001
Pulmonary embolism	299,117 (54.5%)	38,789 (53.3%)	260,328 (54.7%)	<0.001
Deep vein thrombosis	249,296 (45.5%)	34,014 (46.7%)	215,282 (45.3%)	<0.001
Saddle pulmonary embolus	9,461 (1.7%)	857 (1.2%)	8,604 (1.8%)	<0.001
Acute cor pulmonale	13,47 (0.2%)	150 (0.2%)	1,197 (0.3%)	0.020
Thrombophlebitis	9,806 (1.8%)	1,222 (1.7%)	8,584 (1.8%)	0.016
Provoking factors associated with VTE present during admission				
Recent surgery	33,812 (6.2%)	4,704 (6.5%)	29,108 (6.1%)	<0.001
Malignancy	81,652 (14.9%)	17,506 (24.0%)	64,146 (13.5%)	<0.001
Recent trauma	9,120 (1.7%)	1,338 (1.8%)	7,782 (1.6%)	<0.001
Hypercoagulability	23,976 (4.4%)	3,152 (4.3%)	20,824 (4.4%)	0.548
Pregnancy	7,131 (1.3%)	741 (1.0%)	6,390 (1.3%)	<0.001
Age, years (mean±SD)	63.0 ± 17.6	64.6 ± 17.3	62.8 ± 17.7	<0.001
Female	294,042 (53.6%)	40,443 (55.6%)	253,599 (53.3%)	<0.001
Primary insurance				<0.001
Medicare	293,251 (53.6%)	43,773 (60.2%)	249,478 (52.6%)	<0.001
Medicaid	55,569 (10.2%)	10,051 (13.8%)	45,518 (9.6%)	<0.001
Private	150,384 (27.5%)	13,523 (18.6%)	136,861 (28.8%)	<0.001
Self-pay	24,435 (4.5%)	2,682 (3.7%)	21,753 (4.6%)	<0.001
Other	23,542 (4.3%)	2,636 (3.6%)	20,906 (4.4%)	<0.001
Median household income by residential zip code				<0.001
Lowest quartile	155,422 (28.8%)	22,501 (31.4%)	132,921 (28.4%)	<0.001

Variable, N (%)	All Index Admissions (N=548,413)	Non-elective 30-day Readmission		
		Yes (N = 72,803)	No (N = 475,610)	P value
Middle lowest quartile	134,884 (25.0%)	17,723 (24.7%)	117,161 (25.0%)	0.062
Middle highest quartile	129,862 (24.1%)	16,683 (23.3%)	113,179 (24.2%)	<0.001
Highest quartile	119,592 (22.2%)	14,820 (20.7%)	104,772 (22.4%)	<0.001
Residence by county location				<0.001
Central counties in metro areas with population ≥1 million	161,324 (29.4%)	24,089 (33.2%)	137,235 (28.9%)	<0.001
Fringe counties in metro areas with population ≥1 million	138,399 (25.3%)	18,883 (26.0%)	119,516 (25.2%)	<0.001
Counties in metro areas with population 250,000-999,999	116,601 (21.3%)	14,375 (19.8%)	102,226 (21.5%)	<0.001
Counties in metro areas with population 50,000-249,999	51,712 (9.4%)	6,423 (8.8%)	45,289 (9.5%)	<0.001
Micropolitan counties	47,555 (8.7%)	5,457 (7.5%)	42,098 (8.9%)	<0.001
Other	32,204 (5.9%)	3,438 (4.7%)	28,766 (6.1%)	<0.001
No. of chronic conditions (mean±SD)	4.8 ± 3.0	5.8 ± 3.0	4.7 ± 2.9	<0.001
Varicose veins	3,797 (0.7%)	326 (0.4%)	3,471 (0.7%)	<0.001
Obesity	94,871 (17.3%)	11,694 (16.1%)	83,177 (17.5%)	<0.001
Current or prior tobacco use	144,725 (26.4%)	20,599 (28.3%)	124,126 (26.1%)	<0.001
Hypertension	317,524 (57.9%)	44,906 (61.7%)	272,618 (57.3%)	<0.001
Congestive heart failure	56,432 (10.3%)	11,846 (16.3%)	44,586 (9.4%)	<0.001
Valvular heart disease	25,608 (4.7%)	4,180 (5.7%)	21,428 (4.5%)	<0.001
Diabetes mellitus	122,415 (22.3%)	20,052 (27.5%)	102,363 (21.5%)	<0.001
Chronic pulmonary disease	115,300 (21.0%)	20,170 (27.7%)	95,130 (20.0%)	<0.001
Pulmonary circulation disorders	69,033 (12.6%)	8,760 (12.0%)	60,273 (12.7%)	<0.001
Renal disease	65,556 (12.0%)	12,405 (17.0%)	53,151 (11.2%)	<0.001
Liver disease	12,147 (2.2%)	2,329 (3.2%)	9,818 (2.1%)	<0.001
Coagulopathy	34,395 (6.3%)	5,719 (7.9%)	28,676 (6.0%)	<0.001

Variable, N (%)	All Index Admissions (N=548,413)	Non-elective 30-day Readmission		
		Yes (N = 72,803)	No (N = 475,610)	P value
Anemia	120,017 (21.9%)	22,009 (30.2%)	98,008 (20.6%)	<0.001
Fluid and electrolyte disorders	101,949 (18.6%)	18,568 (25.5%)	83,381 (17.5%)	<0.001
Neurologic disorders/paralysis	57,372 (10.5%)	9,367 (12.9%)	48,005 (10.1%)	<0.001
Alcohol abuse	16,608 (3.0%)	2,836 (3.9%)	13,772 (2.9%)	<0.001
Illicit drug abuse	13,842 (2.5%)	2,809 (3.9%)	11,033 (2.3%)	<0.001

For most variables, 0 to 2.5% had missing values.

Abbreviations: DVT, deep vein thrombosis; PE, pulmonary embolism; VTE, venous thromboembolism

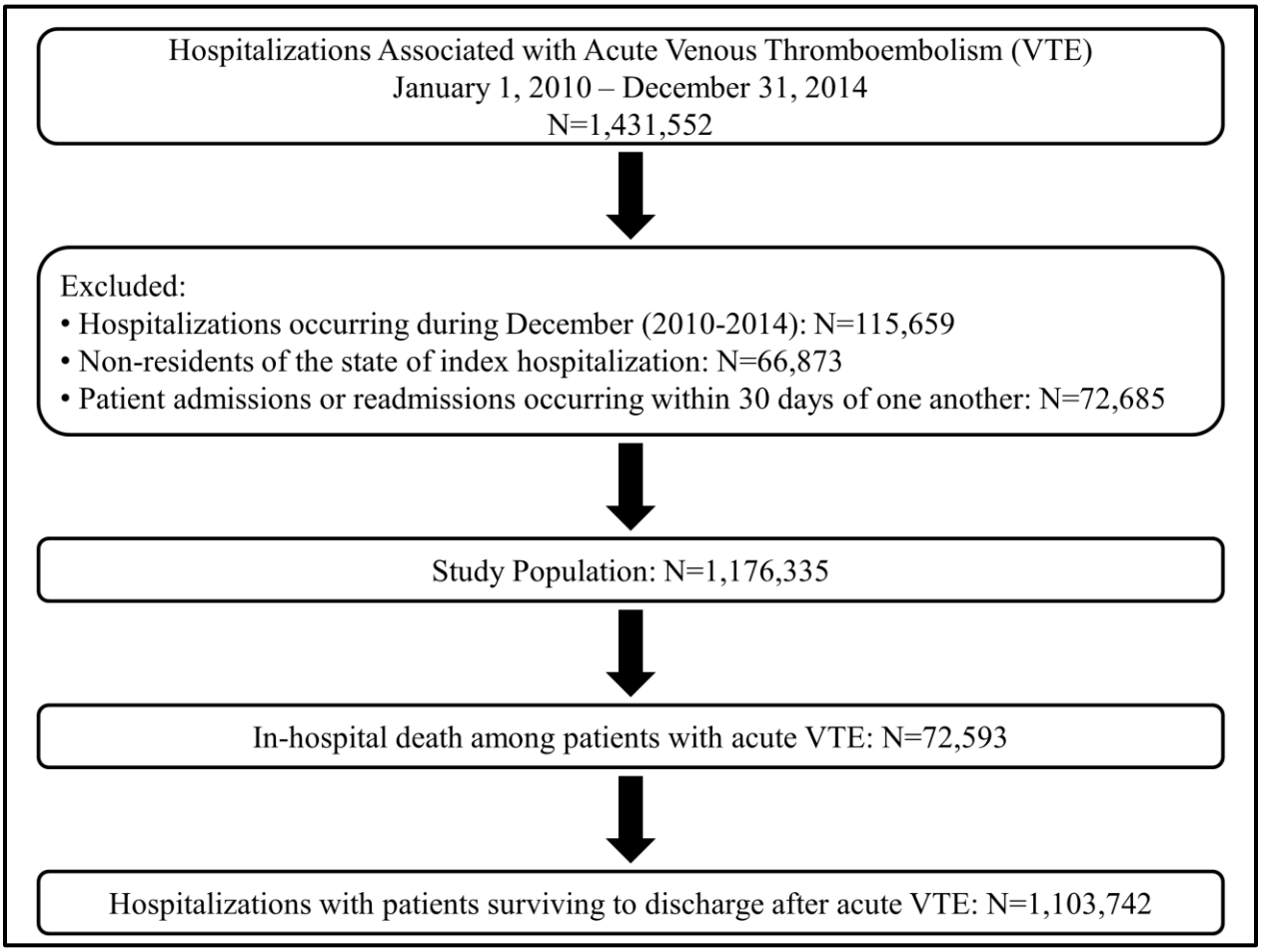
Table S10. Hospitalization and Institutional Characteristics of Index Admissions associated with a Primary Diagnosis Code for Venous Thromboembolism, Stratified by 30-day Readmission Status.

Variable, N (%)	All Index Admissions (N = 548,413)	Non-elective 30-day Readmission		P value
		Yes (N =72,803)	No (N = 475,610)	
Characteristics of Index Hospitalization				
Elective index admission	39,151 (7.1%)	3,516 (4.8%)	35,635 (7.5%)	<0.001
Elective readmission	6,657 (1.2%)	---	---	---
Length of stay, days (mean±SD)	5.1 ± 4.9	6.1 ± 6.1	4.9 ± 4.7	<0.001
Disposition at discharge				<0.001
Home, no assistance	351,702 (64.2%)	37,854 (52.0%)	313,848 (66.0%)	<0.001
Transfer to short term hospital	3,829 (0.7%)	734 (1.0%)	3,095 (0.7%)	<0.001
Transfer to subacute nursing or intermediate care facility	77,374 (14.1%)	14,634 (20.1%)	62,740 (13.2%)	<0.001
Home with home health care	110,904 (20.2%)	18,274 (25.1%)	92,630 (19.5%)	<0.001
Against medical advice	4,138 (0.8%)	1,272 (1.7%)	2,866 (0.6%)	<0.001
Cost of index hospitalization (mdian, IQR)	$7,495.2 (4,689.1, 12,179.7)	$9,040.3 (5,614.3, 14,750.3)	$7,292.1 (4,576.0, 11,786.1)	<0.001
Cost of rehospitalization (median, IQR)	---	$8,392.0 (4,825.3, 15,600.9)	---	---
Characteristics of Index Hospital				
Bed size of hospital				<0.001
Small	62,522 (11.4%)	7,263 (10.0%)	55,259 (11.6%)	<0.001
Medium	143,702 (26.2%)	18,649 (25.6%)	125,053 (26.3%)	<0.001
Large	342,189 (62.4%)	46,891 (64.4%)	295,298 (62.1%)	<0.001
Ownership of hospital				0.035
Government	74,238 (13.5%)	10,073 (13.8%)	64,165 (13.5%)	0.011
Private, non-profit	378,083 (68.9%)	49,462 (67.9%)	328,621 (69.1%)	<0.001
Private, for-profit	96,092 (17.5%)	13,268 (18.2%)	82,824 (17.4%)	<0.001
Teaching status				<0.001

Variable, N (%)	All Index Admissions (N = 548,413)	Non-elective 30-day Readmission		
		Yes (N =72,803)	No (N = 475,610)	P value
Metropolitan, non-teaching	247,816 (45.2%)	32,207 (44.2%)	215,609 (45.3%)	<0.001
Metropolitan, teaching	245,072 (44.7%)	34,618 (47.6%)	210,454 (44.2%)	<0.001
Non-metropolitan	55,525 (10.1%)	5,978 (8.2%)	49,547 (10.4%)	<0.001
Procedures during Index Hospitalization				
Systemic thrombolysis	19,250 (3.5%)	2,003 (2.8%)	17,247 (3.6%)	<0.001
Pulmonary endarterectomy	69 (0.0%)	8 (0.0%)	61 (0.0%)	0.680
Mechanical ventilation	4,673 (0.9%)	936 (1.3%)	3,737 (0.8%)	<0.001
Extracorporeal circulation	50 (0.0%)	3 (0.0%)	47 (0.0%)	0.129
Inferior vena cava filter placement	68,088 (12.4%)	12,034 (16.5%)	56,054 (11.8%)	<0.001
Adverse events during Index Hospitalization				
Major bleed	55,545 (10.1%)	10,782 (14.8%)	44,763 (9.4%)	<0.001
Gastrointestinal hemorrhage	9,474 (1.7%)	2,040 (2.8%)	7,434 (1.6%)	<0.001
Intracranial hemorrhage	1,294 (0.2%)	273 (0.4%)	1,021 (0.2%)	<0.001
Other bleeding event (including RBC transfusion)	49,512 (9.0%)	9,577 (13.2%)	39,935 (8.4%)	<0.001
Acute myocardial infarction/unstable angina	4,840 (0.9%)	811 (1.1%)	4,029 (0.8%)	<0.001
Cardiogenic shock	1,329 (0.2%)	178 (0.2%)	1,151 (0.2%)	0.898
Cardiorespiratory arrest	1,349 (0.2%)	210 (0.3%)	1,139 (0.2%)	0.012
Acute heart failure	58,629 (10.7%)	12,377 (17.0%)	46,252 (9.7%)	<0.001

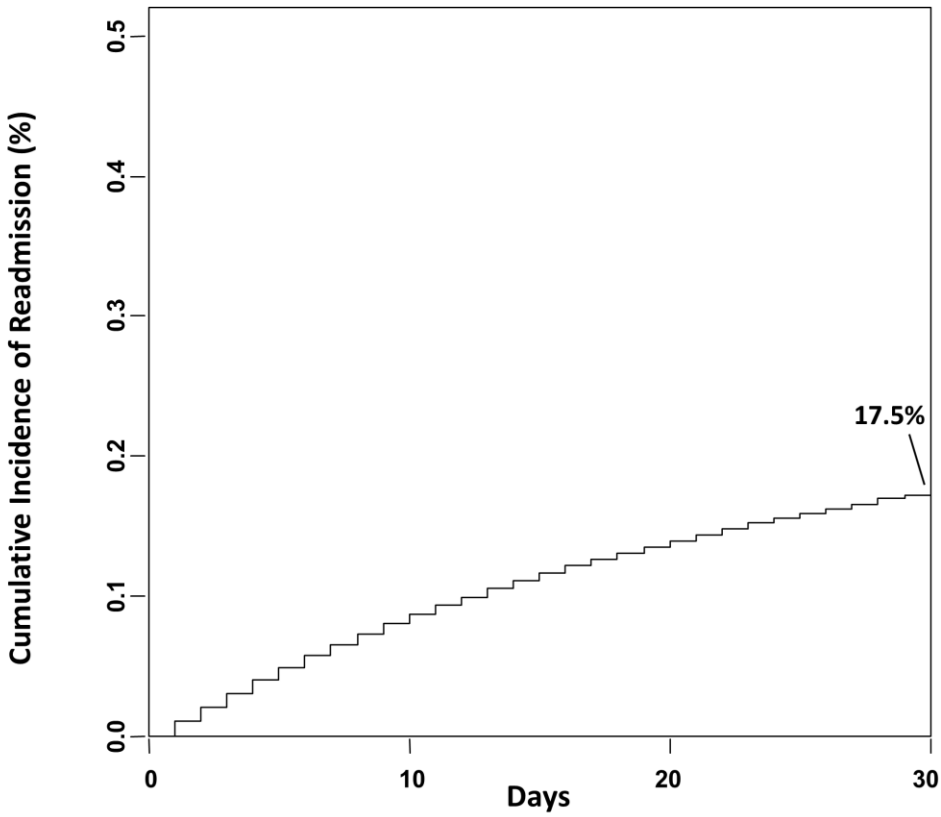
For most variables, 0 to 2.5% had missing values.
Abbreviations: RBC, red blood cell

Figure S1. Flow Diagram of Selection of Hospitalizations.



Flow diagram of hospitalization selection for the analysis. Hospitalization numbers are unweighted.

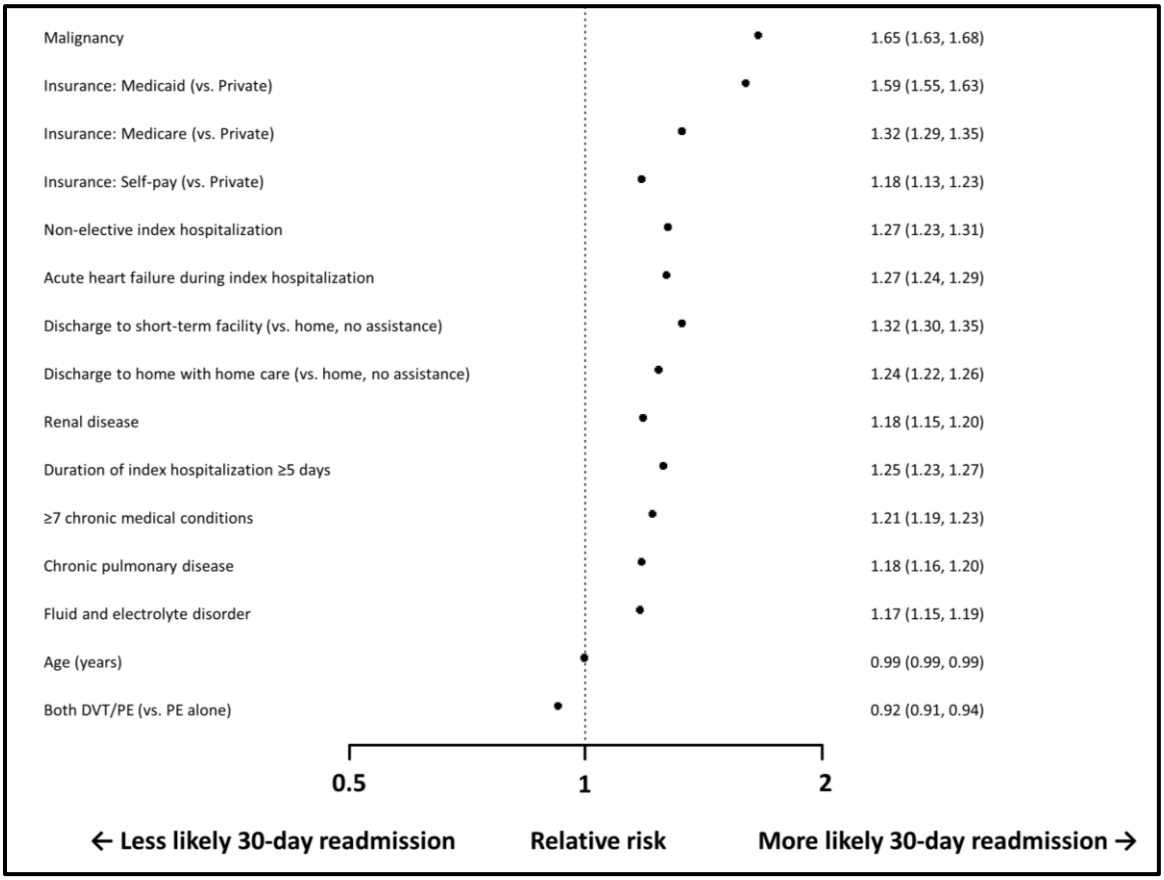
Figure S2. Cumulative Incidences of Readmission through 30 Days after Discharge following Hospitalizations associated with Acute Venous Thromboembolism.



No. at Risk	1,103,742	1,007,443	949,459	910,110
No. of Events	0	96,299	57,984	39,349
Cumulative Incidence	---	0.087	0.140	0.175

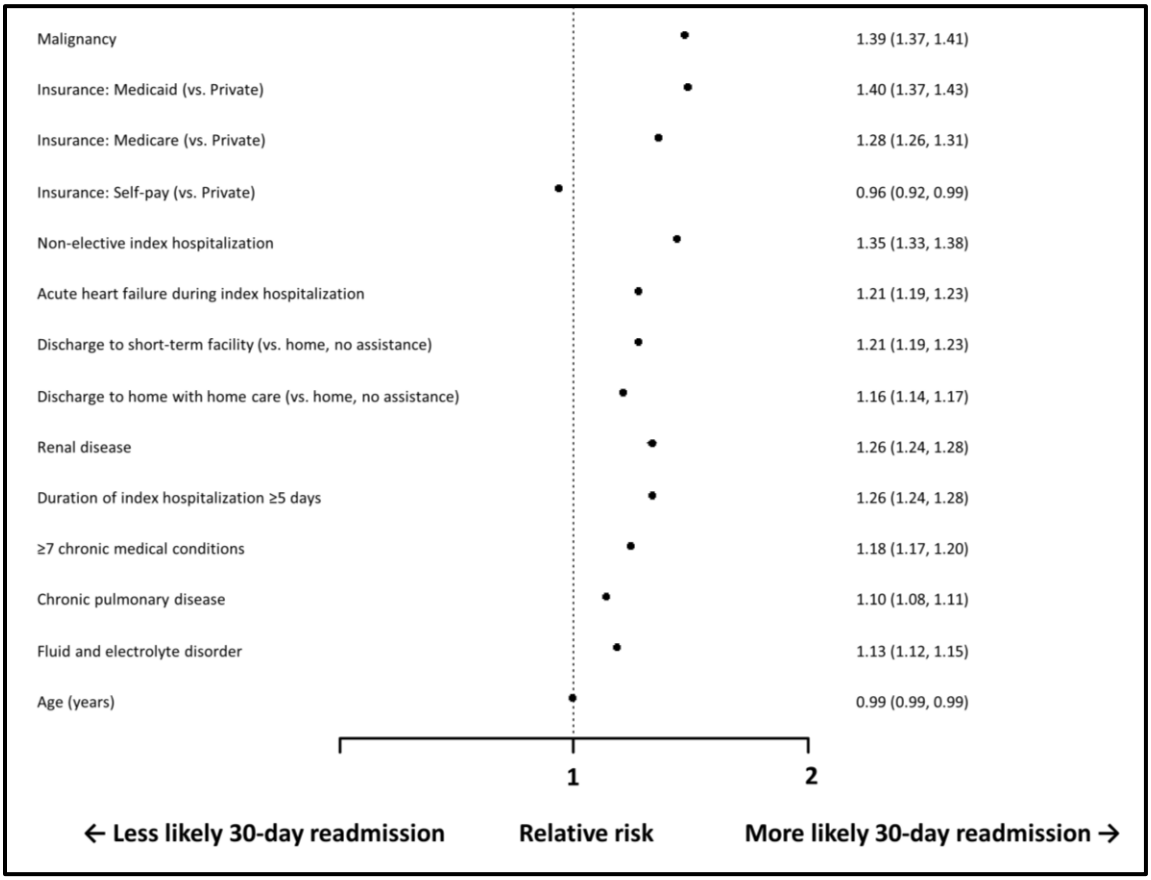
Displayed are the cumulative incidences of readmission through 30 days post-discharge. Readmissions accrued throughout the 30-day period. CI indicates confidence interval.

Figure S3. Predictors of 30-day Readmission following Hospitalizations associated with Acute Pulmonary Embolism.



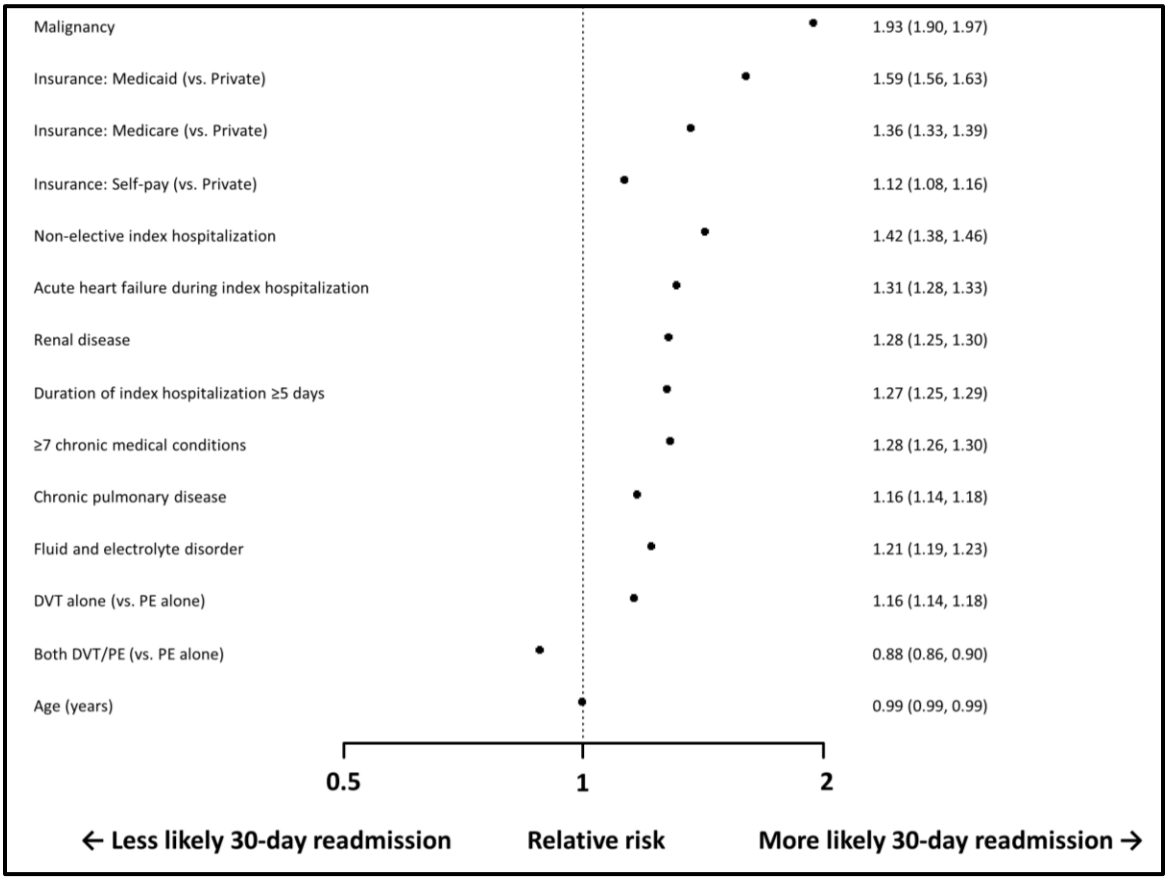
Predictors of readmission within 30 days following an index hospitalization associated with acute pulmonary embolism.

Figure S4. Predictors of 30-day Readmission following Hospitalizations associated with Acute Deep Vein Thrombosis.



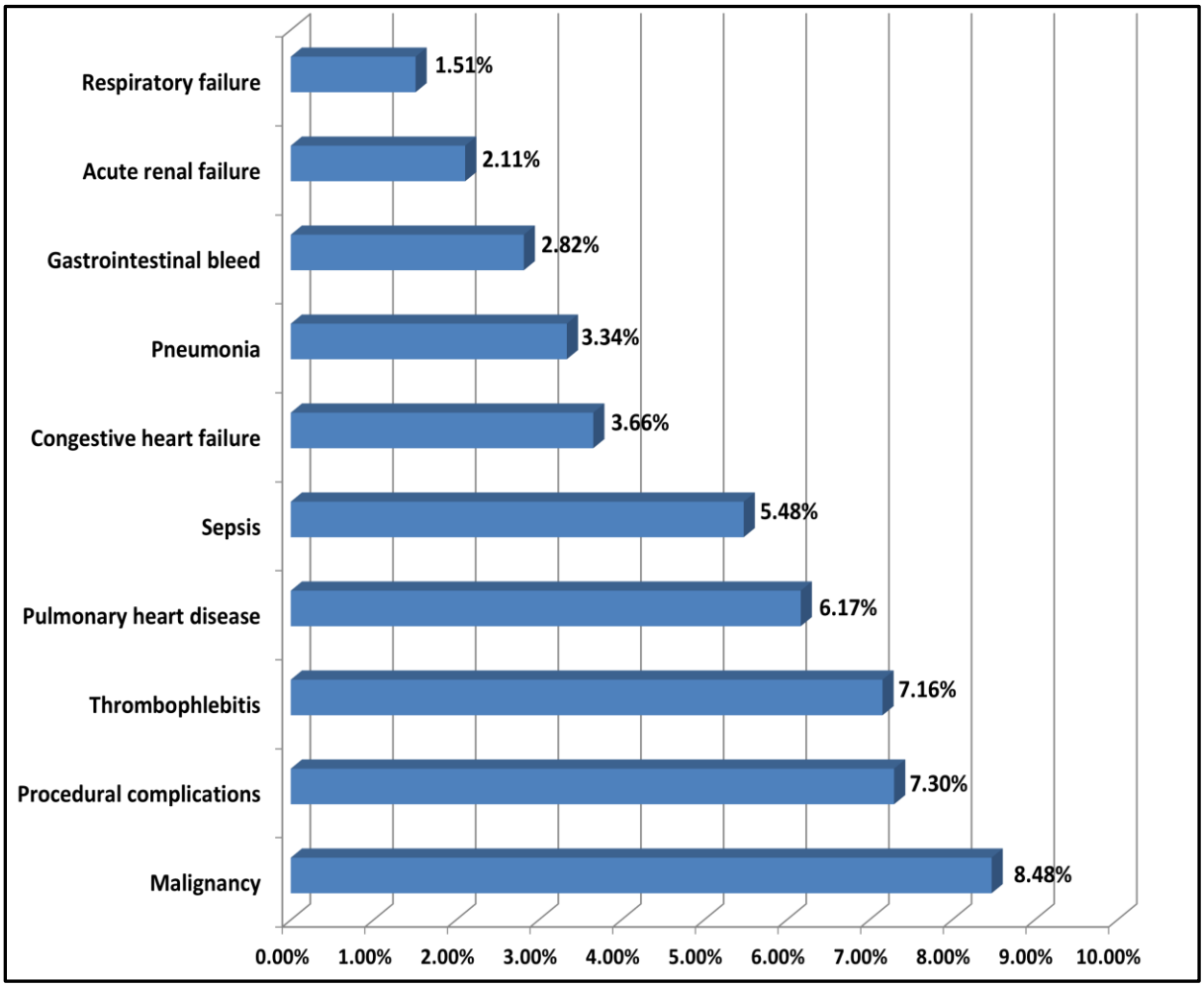
Predictors of readmission within 30 days following an index hospitalization associated with acute deep vein thrombosis.

Figure S5. Predictors of 30-day Readmission following Hospitalizations associated with Acute Venous Thromboembolism for Patients Discharged to Home.



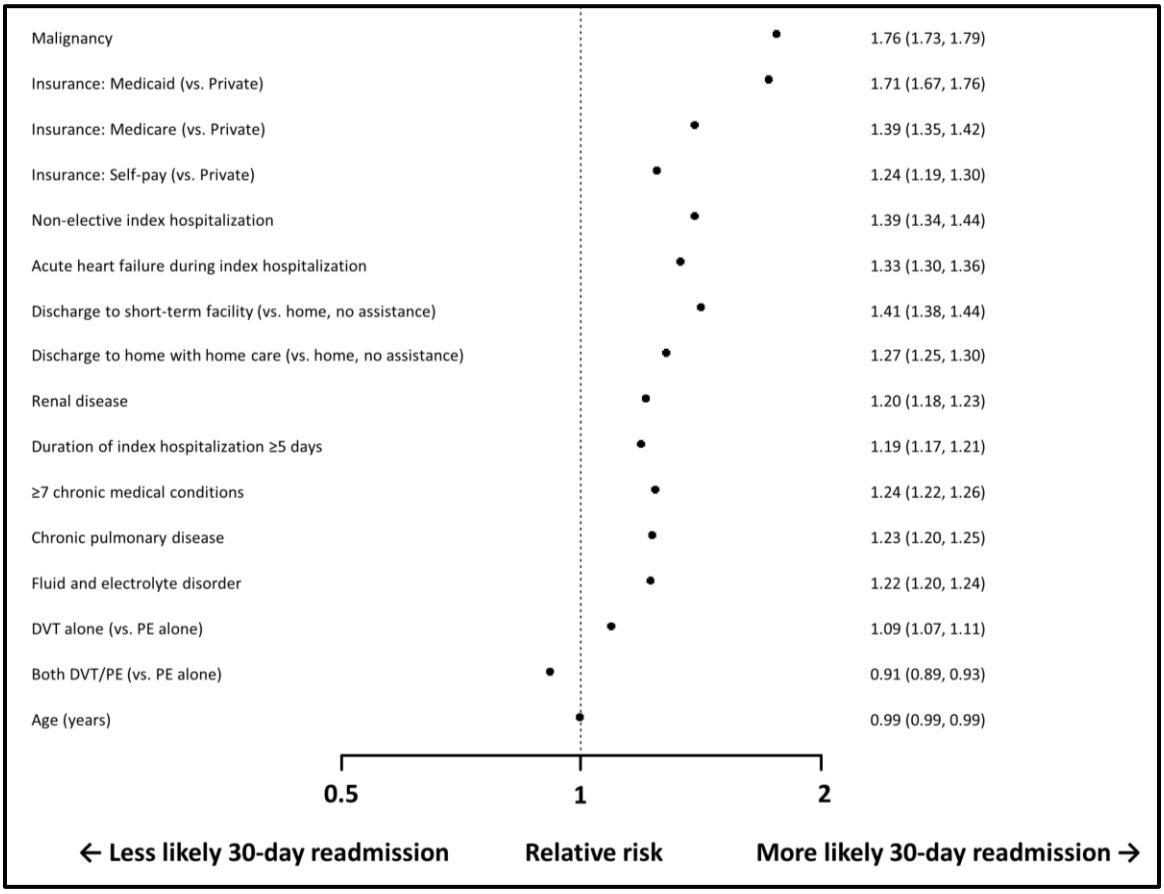
Predictors of readmission within 30 days following an index hospitalization associated with acute venous thromboembolism in which patients were discharged to home.

Figure S6. Top Causes of Non-Elective 30-Day Readmission following Hospitalizations associated with Acute Venous Thromboembolism for Patients Discharged to Home.



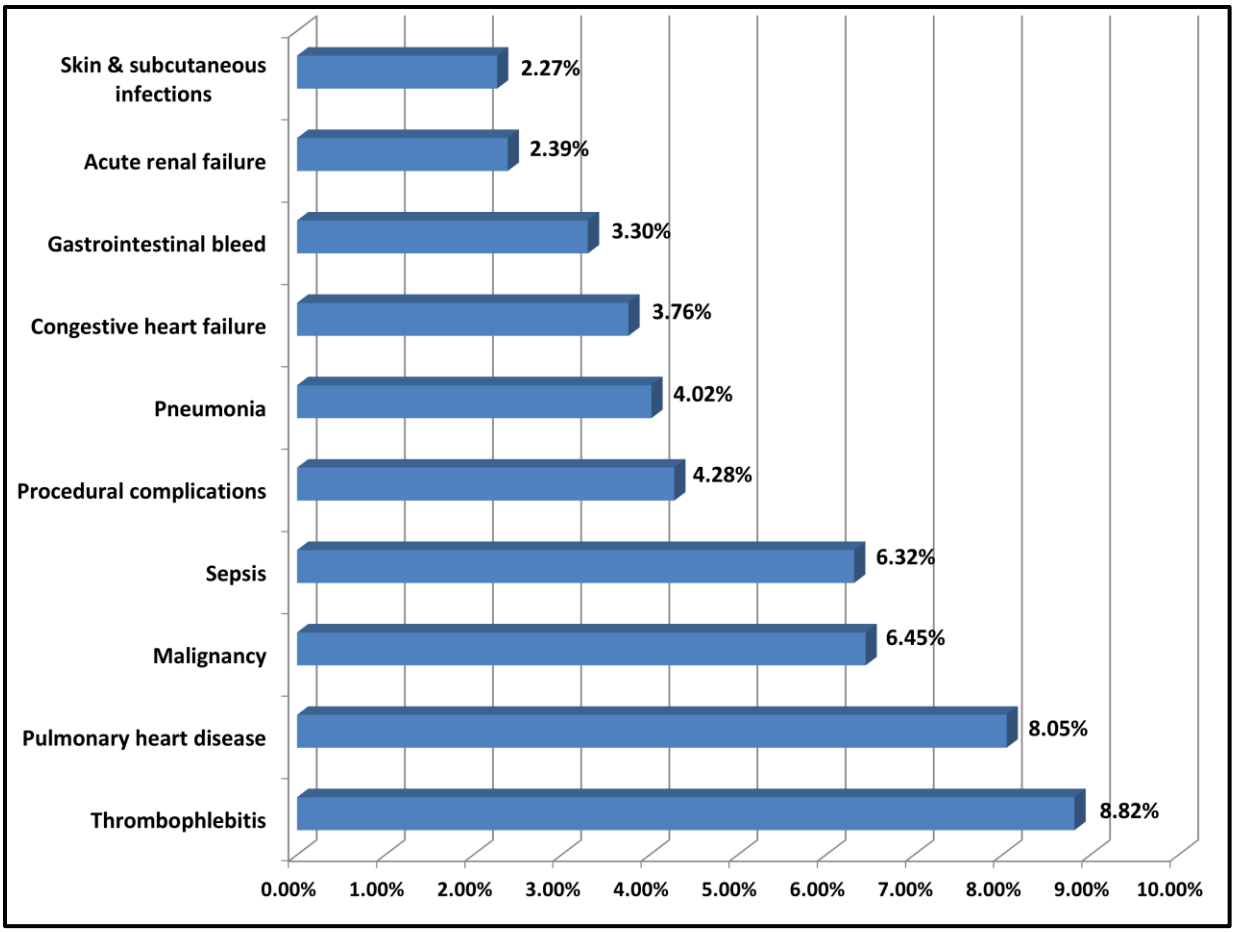
The figure displays the main reasons for 30-day readmission following hospitalizations associated with acute venous thromboembolism in which patients were discharged to home. The most common cause of readmission was related to malignancy, followed by procedural complications, and thrombophlebitis.

Figure S7. Predictors of 30-day Readmission following Hospitalizations associated with a Primary Diagnosis Code for Venous Thromboembolism.



Predictors of readmission within 30 days following an index hospitalization associated with a primary diagnosis code for venous thromboembolism.

Figure S8. Top Causes of Non-Elective 30-Day Readmission following Hospitalizations associated with a Primary Diagnosis Code for Venous Thromboembolism.



The figure displays the main reasons for 30-day readmission following hospitalizations associated with acute venous thromboembolism in which patients had a primary diagnosis code for venous thromboembolism. The most common cause of readmission was related to thrombophlebitis, followed by pulmonary heart disease and malignancy.

Supplemental Reference:

1. HCUP Clinical Classifications Software (CCS) for ICD-9-CM [Internet]. https://www.hcup-us.ahrq.gov/toolssoftware/ccs/ccs.jsp. Accessed March 31, 2017.