The Association Between Group Identity and Advanced Therapies in a Cohort of Patients Hospitalized with Venous Thromboembolic Disease: The Medical Inpatient Thrombosis and Hemostasis (MITH) Study.

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Abstract

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Background: The mainstay therapy for venous thromboembolism (VTE) is anticoagulation but advanced therapies as systemic thrombolysis or catheter-directed thrombolysis (CDT), extracorporeal membrane oxygenation (ECMO), and surgical or catheter-guided thrombectomy, are used in eligible patients. There is a dearth of studies evaluating group identity-based disparities, driven by systemic discrimination, in the use of advanced therapies and clinical outcomes in patients with VTE.

Methods: We conducted a cohort study of patients hospitalized for ≥24 hours on a medical service and aged ≥18 years with a first hospitalization with a present-on-admission VTE diagnosis between 2016 and 2022 in 3 medical centers in the United States. Group identity was defined as Asian, Black, Hispanic or Latino, White, or Other identity. The primary outcome was the use of advanced therapies, defined as the use of systemic thrombolytics, CDT, surgical thrombectomy, catheter-guided thrombectomy, or ECMO. Our primary analysis evaluated the association between group identity and use of advanced therapies using multivariable logistic

regression to estimate adjusted odds ratios (OR) and 95% confidence intervals (CI), controlling for comorbidities and sociodemographic, clinical, and laboratory variables at baseline. Secondary exploratory analyses evaluated the association of group identity with inferior vena cava filter placement, with in-hospital mortality, and with length of hospital stay.

Results: A total of 7,809 patients were included with Asian (<1%), Black (30%), Hispanic or Latino (8%), Other (5%), and White (56%) identities. Overall, 615 (8%) patients were treated with advanced therapies. In the main analysis, Asian (OR = 0.69, 95% CI: 0.24, 1.96), Black (OR = 1.02, 95% CI: 0.83, 1.26), Hispanic or Latino (OR = 0.77, 95% CI: 0.55, 1.08), and Other (OR = 0.84, 95% CI: 0.56, 1.26) identities were not associated with use of advanced therapies compared with White identity after controlling for comorbidities and sociodemographic, clinical, and laboratory variables at baseline. In secondary exploratory analyses, Hispanic or Latino (OR = 1.69, 95% CI: 1.11, 2.58) identity was associated with placement of inferior vena cava filters compared with White identity. Furthermore, Asian (OR = 2.32, 95% CI: 1.06, 5.06) identity was associated with higher in-hospital mortality compared with White identity. We did not find an association between group identity and length of hospital stay.

Conclusions: We did not find evidence of group-identity based disparities in the use of advanced therapies for VTE. Additional well-powered studies evaluating disparities in the use of advanced therapies, inferior vena cava filters, and clinical outcomes in patients hospitalized with VTE are required.

Background

Venous thromboembolism (VTE), which includes both deep vein thrombosis (DVT) and pulmonary embolism (PE), is a major cause of morbidity and mortality worldwide.[1] In the United States (US), its annual incidence is 1-2 cases per 1,000 individuals and it is a leading cause of hospitalization.[1] The mainstay therapy for VTE is anticoagulation but advanced therapies such as systemic thrombolysis or catheter-directed thrombolysis (CDT), extracorporeal membrane oxygenation (ECMO), and surgical or catheter-guided thrombectomy,[2,3] as well as inferior vena cava filters, are used in eligible patients.[4] Guidelines recommend the use of advanced therapies based on the severity of VTE while placement of inferior vena cava filters is indicated when anticoagulant treatment must be delayed or witheld.[4] However, the use of advanced therapies is defined by individual case circumstances and the subjective judgement of the provider.[4]

Previous studies have highlighted the persistence of group identity-based disparities in patients with VTE in the United States.[2,5–7] Those who identify as non-Hispanic Black experience higher rates of VTE, present with more severe forms of PE, have longer hospitalizations, and incur higher costs of care than non-Hispanic White individuals.[3,5,8] Nonetheless, there is a dearth of studies evaluating group identity-based disparities in advanced therapies for VTE, and most studies have focused on patients with PE only.[2,3,6–10] In a 2021 study in the US, patients who identified as non-Hispanic Black were less likely to be treated with systemic thrombolytics and CDT despite presenting with more severe PE at admission on average.[9] Studies using the National (Nationwide) Inpatient Sample (NIS)[11] reported lower use of advanced therapies and higher in-hospital mortality,[2] lower use of CDT,[12] and lower use of CDT or thrombectomy[10] in patients who identified as non-Hispanic Black, Hispanic, and Asian or Pacific Islander compared with those who identified as non-Hispanic White after controlling for PE severity. Finally, patients who identify as non-Hispanic Black have also been reported to experience higher rates of inferior vena cava filter placement,[7,13] despite safety warnings about

an increased risk of complications related to their use.[14] Additional studies that evaluate disparities in the management and clinical outcomes of patients hospitalized with VTE remain a priority to tailor efforts to address them.[15]

To evaluate group identity-based differences in a provider's use of advanced therapies accounting for imbalances in sociodemographic factors, comorbidities and severity at baseline, we conducted a cohort study of medical inpatients from 3 medical centers in the US as part of the Medical Inpatient Hemostasis and Thrombosis (MITH) study.[16] In addition, we explored the placement of inferior vena cava filters, in-hospital death, and length of hospital stay based on group identity in secondary analyses. We hypothesized that Asian, non-Hispanic Black, Hispanic or Latino, and additional identities other than non-Hispanic White are associated with lower use of advanced therapies, higher use of inferior vena cava filters and in-hospital death, and longer hospital stay compared with non-Hispanic White identity. We considered group identity as a proxy for the exposure to structural forms of discrimination (e.g., implicit biases in patient care) rather than for the genetic or behavioral traits of individuals, representing differences in healthcare access driven by discrimination at the institutional and interpersonal level.[17]

Methods

Study Design and Setting

We conducted a cohort study including patients hospitalized with a present-on-admission VTE diagnosis at 3 medical centers in the US. We used individual-patient level data recorded in electronic health records at Harris Health (2 hospitals), University of Michigan (UM) Medical Center, and University of North Carolina (UNC) Health System Network (8 hospitals). UM medical center is a 550-bed tertiary care hospital in Ann Arbor, Michigan. Harris Health Hospitals includes 2 safety net hospitals with 850 beds in Houston, Texas. The UNC Health System Network encompasses 8 tertiary care hospitals with over 1,000 beds in North Carolina.

We used data from January 2018 to June 2022 at Harris Health, from January 2018 to December 2019 at UM, and from December 2017 to August 2022 at UNC. All centers used the International Classification of Diseases codes, 10th revision (ICD-10) codes in their electronic health records during the study period.

This study was conducted following the principles outlined by the amended Declaration of Helsinki.[18] This study was approved by Institutional Review Boards at each participating institution. Furthermore, participating institutions executed a data use agreement allowing UVM access to limited datasets as defined by the Health Insurance Portability and Accountability Act in the United States. The present manuscript follows the REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) statement.[19]

Study Participants

To be eligible for the cohort, individuals needed to be hospitalized for ≥24 hours on a medical service and aged ≥18 years with a first hospitalization with a present-on-admission VTE diagnosis. We defined admission to medical services as any hospitalization to internal medicine (including subspeciality services such as gastroenterology or infectious diseases), hematology, oncology, family medicine, cardiology, or critical care services. To identify present-on-admission VTE, we used a previously developed computable phenotype based on ICD-10 codes with present-on-admission flags and imaging studies.[20] The computable phenotype was developed by the MITH study researchers showing a positive predictive value of 89% and sensitivity of 99% for present-on-admission VTE diagnosis in medical patients admitted at University of Vermont Medical center for at least 24 hours.[20] We captured only the first VTE hospitalization per patient during the study period. Patients were followed from hospital admission until use of advanced therapies, hospital discharge or in-hospital death.

Data collection

Group Identity

The main variable of interest was group identity. Group identity was defined using categories entered in the electronic heath record for race and ethnicity, which could be self-reported, self-entered, or entered by a healthcare professional. Due to small sample sizes, we grouped patients as follows: Asian, non-Hispanic Black (hereinafter, Black), Hispanic or Latino, non-Hispanic White (hereinafter, White), or Other identity. Patients with Vietnamese, Korean, Chinese, and Other Asian identities were defined as "Asian"; those with Puerto Rican, Mexican, Chicano, or Other Hispanic identity were defined as "Hispanic or Latino"; and those with American Indian/Alaskan Native, Native Hawaiian or Other Pacific Islander, Filipino, Samoan, or Another identity were defined as "Other." If both race and ethnicity were recorded, ethnicity was first considered to define group identity. For instance, if a patient's data indicated White race and Hispanic or Latino ethnicity, they would be grouped as "Hispanic or Latino". If either race or ethnicity were missing in the electronic health records, only the recorded category was considered.

Other Covariates

We defined sex (male or female) and age (in years) using the category entered in the electronic heath records. We captured insurance types (Medicare/Medicare Advantage, Medicaid, Uninsured/self-pay, Commercial, or other), and neighborhood-level median income (in inflation-adjusted US dollars). We used billing information to identify insurance types and to retrieve zip codes. We used individual-patient level zip codes to estimate neighborhood median income using the American Community Survey 2018-2022 5-year income data.[21] In addition, we measured past medical history clinical variables recorded within 24 hours of admission (i.e., intracranial or gastrointestinal bleeding, gastrointestinal ulcers, prior VTE, atrial fibrillation, active cancer, malnutrition, chronic obstructive pulmonary disease, diabetes mellitus, stroke, prior

myocardial infarction, congestive heart failure, hypertension, hemodialysis treatment, and dementia; using ICD-10 codes, Table S1) and laboratory measures obtained within 24 hours of admission (i.e., D-dimer, B-type natriuretic peptide, cardiac troponin, serum creatinine, platelet count, and hemoglobin levels, Table S1).[22] For descriptive analysis, we report the proportion of patients with values above the upper limit of normal for D-dimer, B-type natriuretic peptide, and cardiac troponin (i.e., elevated values).[23] We identified the first measurement of clinical variables (i.e., respiratory dysfunction, systolic blood pressure, and heart rate) recorded within 36 hours prior (i.e., including emergency room visit records) or up to 12 hours after admission (i.e., when no vital signs measurements were recorded prior to admission). Further, we identified ICU admission within 24 hours of hospitalization using Current Procedural Terminology (CPT) codes and respiratory dysfunction was defined as use of oxygen therapy or oxygen saturation ≤90% at baseline (Table S1).

Clinical Outcomes

The primary composite clinical outcome of interest was the use of advanced therapies, defined as the use of systemic thrombolytics, CDT, surgical thrombectomy, catheter-guided thrombectomy, or ECMO. Additional outcomes included: (a) the placement of inferior vena cava filters, (b) length of hospital stay in days, and (c) in-hospital mortality. Systemic thrombolysis was considered present if thrombolytic medications were administered intravenously during hospitalization. All other advanced therapies and inferior vena cava filter placement were identified using CPT codes (Table S2). All-cause in-hospital mortality was identified using hospitalization's discharge disposition.

Statistical Analysis

We fitted multivariable logistic regression models for binary outcomes and multivariable linear regression models for continuous outcomes. To allow the contrast of our findings with previous studies, White identity was defined as referent for comparisons.[2,5–7,9] Covariates

included in the model were chosen *a priori.* Figure S1 depicts the relationships between sociodemographic factors and comorbidities for the association between group identity and use by the provider of advanced therapies.[24] We did not include insurance payer type and neighborhood median income in the models since they were considered mediators of the association between group identity, a proxy of systemic discrimination, and use of advanced therapies. However, inclusion in this study may oversample individuals with Asian, Black, Hispanic or Latino, and Other identities with a higher burden of comorbidities and severity at baseline (Figure S1).[5] Hence, we included such variables in our regression models (Table S3).[24] This approach accounts for imbalances in the distribution of comorbidities and severity variables but it may potentially attenuate the association between group-identity and use of advanced therapies.[24]

We handled missing data in all analyses using multiple imputation by chained equations. Data were missing on group identity (0.4%), heart rate at admission (0.9%), systolic blood pressure (0.6%), respiratory dysfunction (0.5%), hemoglobin (3.4%), platelet count (3.5%), and serum creatinine (3.5%). Characteristics of patients with and without missing data are displayed in Table S4. We used 10 imputed datasets[25] and calculated pooled estimates and confidence intervals following Rubin's rules.[26] We used data on age, sex, ICU admission, prior VTE, active cancer, atrial fibrillation, diabetes mellitus, chronic obstructive pulmonary disease, prior myocardial infarction, prior cardiac failure, stroke, hypertension, hemodialysis, dementia, and malnutrition to impute values on variables with missing information. We used multiple logistic regression, logistic regression, and predictive mean matching to impute nominal, binary, and continuous variables, respectively.

Our primary analysis evaluated the association between group identity and use of advanced therapies using multivariable logistic regression, adjusting for sociodemographic (i.e., age and sex), laboratory (i.e., hemoglobin, platelet count, and creatinine levels at baseline), and

clinical variables (i.e., treating site, ICU admission, respiratory failure, heart rate in beats per minute, and systolic blood pressure in mmHg) and comorbidities at baseline (i.e., prior VTE, active cancer, atrial fibrillation, diabetes mellitus, chronic obstructive pulmonary disease, prior myocardial infarction, prior cardiac failure, stroke, hypertension, gastrointestinal ulcers, hemodialysis, dementia, intracranial hemorrhage, gastrointestinal bleeding, and malnutrition) (Table S3). Hence, for example, the primary model estimates the odds of treatment with advanced therapies in patients with Black identity compared with those with White identity, keeping constant values of all other variables included in the model. We considered group identity as a proxy for systemic discrimination rather than for patients individual traits. Finally, we conducted exploratory analyses to evaluate the association between group identity and each advanced therapy considered separately using logistic regression adjusted for the same variables listed in the main analysis.

Secondary analyses were conducted adjusted for comorbidities, sociodemographic, laboratory, and clinical variables: (i) to estimate the association between group identity and inferior vena cava filter placement during hospitalization using logistic regression; (ii) to estimate the association between group identity and in-hospital mortality using logistic regression; (iii) to evaluate the association between group identity and length of hospital stay using linear regression. The complete list of variables included in each model is summarized in Table S3.

Sensitivity analyses

We conducted sensitivity analyses to test the robustness of our findings. Early in-hospital deaths may produce short lengths of hospital stay despite representing unfavorable clinical outcomes. To account for the impact of early in-hospital deaths on the association between group identity and length of hospital stay, we fitted an additional model for the linear association between group identity and length of hospital stay including only patients that were

hospitalized for ≥48 hours. Finally, to evaluate the robustness of our main analysis to the potential effect of COVID-19 onset on access to healthcare and management of patients,[27] we fitted the main model after excluding hospitalizations that occurred after December 31st, 2019.

A threshold for significance of 0.05 was set for the main model analysis. We considered secondary and sensitivity analysis as exploratory and hypothesis-generating, and p-values are provided for guidance. All analyses were conducted using R v4.3.3.

Results

A total of 7,809 patients with present-on-admission VTE were included in this study (Figure 1). Overall, 3,687 (47%) patients were diagnosed with PE (with or without DVT), 3,496 (45%) with lower limb DVT, and 626 (8%) with upper arm DVT. Table 1 summarizes cohort characteristics of patients by Asian (<1%), Black (30%), Hispanic or Latino (8%), Other (5%), and White (56%) identities. Patients with Asian and White identities were on average older compared with patients with Black, Hispanic or Latino, and Other identities. There were marked differences in neighborhood annual median income across groups. Patients with Black (50%) and Hispanic or Latino (48%) identities had a larger proportion of individuals living in neighborhoods with an annual median income below $50,000 US dollars than those with Asian, Other, and White identities. Furthermore, patients with Asian (90%) or White (72%) identity were more likely to live in neighborhoods with a median annual income of 50,000 US dollars or more. Medicare/Medicare Advantage was the primary payer for those identifying as Black or White, and Medicaid was the most frequent for those identifying as Hispanic or Latino and for those with other identities. Patients identifying as Asian more frequently had commercial insurance. Hypertension, congestive heart failure, diabetes mellitus, active cancer, and malnutrition were the most prevalent comorbidities at baseline across all group identities. The percentage of individuals with elevated cardiac troponin and B-Type natriuretic peptide was higher in patients with Black and White identities compared with those with Asian, Hispanic or Latino, and Other

identities, but data was missing in a large proportion of patients. Detailed distribution of baseline characteristics by site is presented in Table S5.

Advanced Therapies

We identified 615 (8%) patients with VTE who were treated with advanced therapies during hospitalization (Table 2). The median time from hospital admission until use of advanced therapies was 1 (interquartile range, 1 to 6) day. Advanced therapies were used in a total of 251 (7%) patients with PE, 306 (9%) patients with lower limb DVT, and 58 (9%) patients with upper limb DVT. Advanced therapies were used in 5% of patients with Asian, 9% of those with Black, 9% of those with Hispanic or Latino, 10% of those with Other, and 7% of those with White identities (Table 2). Overall, 3/615 (<1%) patients were treated with ECMO, 1/615 (<1%) with surgical embolectomy for PE, 562/615 (91%) with thrombolytics (including both systemic and catheter-guided), and 127/615 (21%) with catheter-guided thrombectomy. Catheter-guided therapies (including both thrombectomy and CDT, or combinations of both) were used in 266/615 (43%) of patients treated with advanced therapies.

Results of the main model for the association between group identity and use of advanced therapies are displayed in Table 2. In the main analysis, Asian (adjusted OR = 0.69, 95% CI: 0.24, 1.96), Black (adjusted OR = 1.02, 95% CI: 0.83, 1.26), Hispanic or Latino (adjusted OR = 0.77, 95% CI: 0.55, 1.08), and Other (adjusted OR = 0.84, 95% CI: 0.56, 1.26) identities were not associated with use of advanced therapies compared with White identity after controlling for comorbidities and sociodemographic, clinical, and laboratory measures at baseline. Furthermore, models evaluating the association of group identity and CDT or systemic thrombolysis were consistent with these findings (Table S6). We could not fit models for other advanced therapies due to the low number of events.

Inferior vena cava filter placement

Inferior vena cava filters were placed in 252 (3%) patients, with a median time from hospital admission to placement of 2 (interquartile range, 1 to 5) days. Inferior vena cava filters were placed more frequently in patients with Asian (6%), Hispanic or Latino (6%), and White (3%) identities than others (Table 2). In multivariable logistic regression analysis, patients with Hispanic or Latino (adjusted OR = 1.69, 95% CI: 1.11, 2.58) identity had a higher odds of inferior vena cava filter placement compared with those with White identity (Table 2). Furthermore, Asian (adjusted OR = 1.69, 95% CI: 0.60, 4.77), Black (adjusted OR = 0.88, 95% CI: 0.63, 1.22), and Other (adjusted OR = 0.47, 95% CI: 0.19, 1.16) identities were not associated with inferior vena cava filter placement compared with White identity.

In-hospital mortality and length of hospital stay

The median length of hospital stay was 4 (interquartile range, 2 to 7) days and a total of 392 (5%) patients died during hospitalization. In multivariable logistic regression analysis, patients with Asian (adjusted OR = 2.32, 95% CI: 1.06, 5.06) identity had a higher odds of in-hospital mortality compared with those with White identity (Table 2). Furthermore, Black (adjusted OR = 0.87, 95% CI: 0.65, 1.15), Hispanic or Latino (adjusted OR = 1.50, 95% CI: 0.98, 2.30), and Other (adjusted OR = 1.28, 95% CI: 0.74, 2.22) identities were not associated with in-hospital mortality compared with White identity. Finally, in multivariable linear regression analysis, we did not find evidence of an association between group identity and mean length of hospital stay when comparing individuals with Asian, Black, Hispanic or Latino, or Other identities with those with White identity (Table 2).

Sensitivity analyses

Our models yielded similar results in sensitivity analyses. After excluding hospitalizations that occurred after December 1st, 2019, Asian (adjusted OR = 1.05, 95% CI: 0.27, 4.04), Black (adjusted OR = 1.01, 95% CI: 0.73, 1.40), Hispanic or Latino (adjusted OR = 0.65, 95% CI: 0.37, 1.14) and Other identities (adjusted OR = 1.00, 95% CI: 0.52, 1.92) were not associated with use of advanced therapies compared with White identity. Finally, after excluding patients with hospitalizations <48 hours, in multivariable linear analysis, we did not find evidence of an association between mean length of hospital stay and Asian (-0.86 days, 95% CI: -4.18 days, 2.45 days), Black (0.19 days, 95% CI: -0.57 days, 0.95 days), Hispanic or Latino (0.85 days, 95% CI: -0.41 days, 2.12 days), and Other (0.87 days, 95% CI: -0.72 days, 2.46 days) identities, compared with White identity.

Discussion

In this cohort study of adult patients hospitalized with VTE in the US, we did not find a lower use by the provider of advanced therapies in patients with Asian, Black, Hispanic or Latino, and Other identity compared with those with White identity. Moreover, we found a higher odds of inferior vena cava filter placement in patients with Hispanic or Latino identity and a higher odds of in-hospital mortality in patients with Asian identity compared with those with White identity. Confidence intervals for these associations were wide and results should be interpreted with caution.

Several studies reported disparities in the use of advanced therapies in patients with PE using the NIS database. Farmakis et al. observed a 13% lower odds of advanced therapies use in PE admissions of patients who identified as Black compared with White between 2016 and 2018.[2] Sathianathan et al. evaluated PE hospitalizations between 2016 and 2019, and found a lower CDT use in hospital admissions of patients who identified as female White, and male or female Asian, Black, and Hispanic individuals, compared with hospitalizations of males who

identified as White.[12] The largest gaps in CDT use were identified in female patients with Black (26% lower odds) and Hispanic (22% lower odds) identities. Finally, Rush et al. reported a lower odds of treatment with mechanical thrombectomy and CDT in PE admissions of patients with Black (10% lower) and Hispanic (22% lower) identity compared with those with White identity between 2016 and 2020.[10] Overall, studies using the NIS database had larger sample size than the present study and observed a lower use of advanced therapies in patients with Asian, Black, Hispanic or Latino identities.[2,6,10,12] The magnitude of the reported disparities remained consistent, ranging from 10 to 20% lower use of advanced treatments despite heterogeneous outcome definitions.[2,6,10,12] Divergence with our results may be explained by several factors. First, our study used a dissimilar unit of analysis. NIS studies estimate differences in the use of therapies for PE hospitalizations rather than individual patients, who may be counted multiple times in the database.[28] Second, there are differences in the measurement of comorbidities. Diagnostic codes assessed at discharge in the NIS dataset cannot discern comorbidities from treatment complications,[28] which was not a limitation in the present study. For example, adjustment for anemia due to blood loss may include a complication of CDT treatment in models assessing CDT use.[10] Third, there are differences in the set of adjusting variables included in statistical models. Studies using the NIS adjusted for hospital characteristics (e.g., bed size) but not for individual hospitals in their models.[2,10,12] Previous research has suggested that disparities in health outcomes may be driven by treating sites performance,[29] and individuals with identities other than White are more likely to be treated at medical centers with lower quality of patient care.[30] Furthermore, our study included patients with adjustment of laboratory and clinical variables such as vital signs at admission. Finally, studies using data sources other than the NIS are scarce. In a cohort study conducted within a single healthcare network in Pennsylvania between 2012 and 2019, Phillips et al. evaluate the use of advanced therapies in patients with Black identity compared with those with White identity.[9] They sequentially adjusted for sociodemographic factors and sociodemographic factors and comorbidities, and they report an

overall 28% lower odds of use of advanced therapies in patients with Black identity, without marked variations between models.[9] While our study also had extensive information on vital and laboratory measurements, sample size was lower and limited the precision of our estimates.

We evaluated inferior vena cava filter placement in secondary analyses. Use of inferior vena cava filters markedly increased between 2000 and 2009 and declined between 2010 and 2019 following a Food and Drug Administration (FDA) warning of long-term adverse clinical outcomes associated with their use.[14] Previous studies observed a higher use of inferior vena cava filters in patients with Black identity[5,7] yet lower use in patients with Hispanic or Latino identities compared with those with White identities.[7] In contrast, we observed a higher odds of inferior vena cava filter placement in patients with Hispanic or Latino identities in secondary analyses. Moreover, we evaluated the odds of in-hospital mortality and length of hospital stay based on group identities. We did not find longer lengths of hospital stay in patients with Asian and Pacific Islander identities reported by Farmakis et al,[2] but we did find a higher odds of in-hospital mortality in patients with Asian identity compared with those with White identity. The magnitude of the association was large, but these results should be interpreted with caution since the number of individuals with Asian identity in this study was low and confidence intervals were wide. Finally, data on indications for placement of inferior vena cava filters and causes of death for patients in this study were not available, and these preliminary findings from exploratory analyses should be evaluated in additional studies.

Structural discrimination and health outcomes

Identifying differences in patient care delivery remains a fundamental step in mitigating disparities,[15] yet understanding its underpinnings is required to develop measures to address them. It has been suggested that group identity-based discrimination impacts health through several pathways, including the institutional and interpersonal level.[17,31] Hence, measures intended to reduce disparities in the care of patients with VTE must act at several levels of the

public health structure to be successful.[32,33] To address interpersonal discrimination, for example, educational and healthcare institutions should acknowledge past discriminatory practices and commit to equity in patient care as part of their mission. Moreover, requirements for training in anti-racist and anti-oppressive frameworks for healthcare professionals are considered fundamental to promote equity in patient care.[17,31] Finally, policy-level interventions such as the Affordable Care Act, which have been reported to improve access to treatments in other cardiovascular diseases, must be considered.[33]

Strengths and limitations

This study has several strengths. First, we used a previously validated definition of VTE to capture present on admission events and identify patients eligible for advanced therapies.[20] Second, we used individual-patient level data from a three diverse healthcare networks to assess baseline and severity to account for vital signs and laboratory measurements at admission to calculate adjusted estimates of resource utilization based on group identity. Finally, this study expands current knowledge of disparities in the access to advanced therapies and clinical outcomes in patients with both DVT and PE, which remained limited to PE only in previous reports.

This study also has several limitations. First, our study used electronic health records to capture group identity as a surrogate for disparities in resource utilization. This may misclassify how patients would self-identify but represents how the health care system interacts with them.[34] We aimed at measuring interpersonal and institutional discrimination in the use of advanced therapies for VTE yet information on providers who used these therapies was not available. Accounting for individual providers' use of therapies in VTE may identify biases in resource utilization and future studies may consider including them in their analytic approaches.

Second, while we captured extensive data on baseline variables reflecting burden of comorbidities and VTE severity at admission, information on other risk factors for VTE occurrence such as intravenous drug use was not available.[35,36] This may prove especially relevant in the context of the current opioid epidemic in the US.[37] Finally, we did not have extensive representation of patients with Asian and Other identities, and our estimates were imprecise for such groups. Future studies focusing on resource utilization in the setting of VTE in patients with such identities are warranted.

Conclusions

In conclusion, we did not find evidence of group-identity based disparities in the use of advanced therapies by the provider for the treatment of DVT and PE. Nonetheless, our study suggests a higher use by the provider of inferior vena cava filters in individuals with Hispanic or Latino identity and a higher odds of in-hospital mortality among those with Asian identity, compared with those with White identity. Additional well-powered studies evaluating disparities in the use by the provider of advanced therapies, inferior vena cava filters, and clinical outcomes in adult patients hospitalized with VTE are required.

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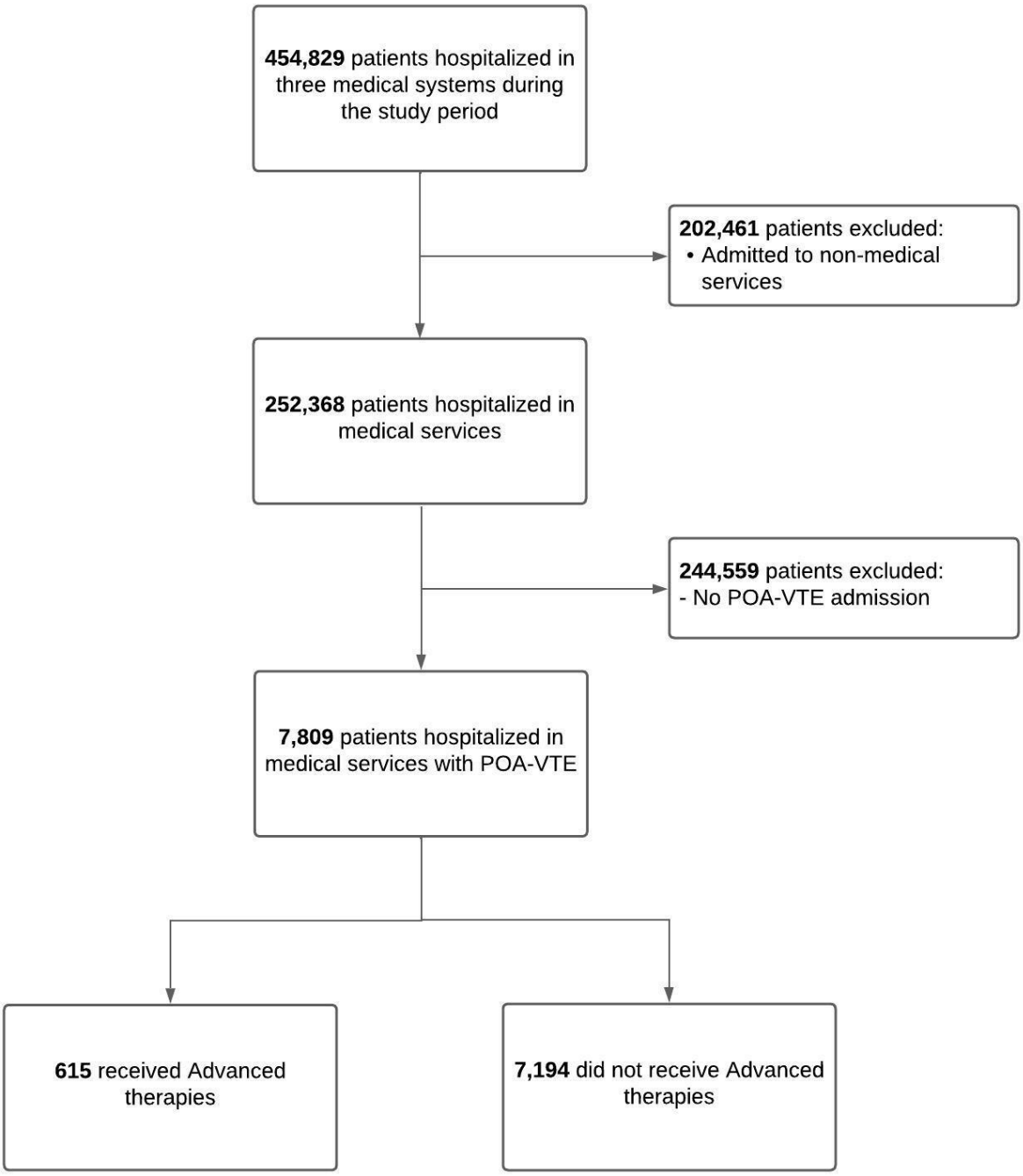
Tables and Figures

Figure 1. Flow chart of study participants.

Table 1. Baseline characteristics by group identity of patients with a first hospitalization for present on admission venous thromboembolism in 3 medical centers in the United States.

Table 2. Models for the association between group identity and use of advanced therapies, placement of inferior vena cava filters, length of hospital stay, and in-hospital mortality in three medical centers in the United States.

Figure 1. Flow chart of study participants.



POA: present on admission; VTE: venous thromboembolism.
A total of 3,914 hospitalizations occurred after January 1st, 2020 (COVID-19 onset).
A total of 5,504 hospitalizations had ≥2 days of length of hospital stay.

Table 1. Baseline characteristics by group identity of patients with a first hospitalization for present on admission venous thromboembolism in 3 medical centers in the United States.

Baseline characteristics	Asian (n = 78)		Black (n = 2342)		Hispanic or Latino (n = 633)		Other (n = 350)		White (n = 4376)	
Sociodemographic										
Age group, in years										
≥18 and <30	7	(9)	100	(4)	35	(6)	26	(7)	142	(3)
≥30 and <45	5	(6)	367	(16)	143	(23)	73	(21)	413	(9)
≥45 and <60	16	(21)	688	(29)	206	(33)	114	(33)	1009	(23)
≥60 and <70	14	(18)	572	(24)	132	(21)	67	(19)	1065	(24)
≥70 and <80	21	(27)	392	(17)	67	(11)	46	(13)	1020	(23)
≥80	15	(19)	223	(10)	50	(8)	24	(7)	727	(17)
Female	43	(55)	1137	(49)	334	(53)	182	(52)	1137	(49)
Neighborhood-level median income (US dollars)										
<35,000	0	(0)	292	(13)	53	(8)	44	(13)	95	(2)
>= 35,000 to <50,000	8	(10)	864	(37)	256	(40)	100	(29)	1088	(25)
>=50,000 to <100,000	57	(73)	1071	(46)	301	(48)	171	(49)	2753	(63)
>=100,000	13	(17)	82	(4)	21	(3)	21	(6)	382	(9)
Missing	0	(0)	33	(1)	2	(<1)	14	(4)	58	(1)
Insurance payer type										
Medicare / Advantage	28	(36)	1061	(45)	113	(18)	47	(13)	2335	(53)
Medicaid	8	(10)	386	(17)	178	(28)	114	(33)	293	(7)
Commercial	31	(40)	479	(21)	108	(17)	69	(20)	1410	(32)
Uninsured / self-pay	4	(5)	212	(9)	96	(15)	34	(10)	218	(5)
Other	7	(9)	204	(9)	138	(22)	86	(25)	120	(3)
Comorbidities										
Malnutrition	11	(14)	292	(13)	62	(10)	38	(11)	560	(13)
Prior VTE	2	(3)	121	(5)	33	(5)	21	(6)	97	(2)
Atrial fibrillation	0	(0)	104	(4)	14	(2)	10	(3)	350	(8)
Stroke	2	(3)	101	(4)	18	(3)	12	(3)	120	(3)
Hypertension	32	(41)	908	(39)	226	(36)	97	(28)	1378	(32)
Congestive heart failure	19	(24)	709	(30)	95	(15)	49	(14)	1048	(24)
Coronary disease	2	(3)	155	(7)	32	(5)	16	(5)	302	(7)
Diabetes mellitus	10	(13)	468	(20)	150	(24)	73	(21)	618	(14)
Hemodialysis	0	(0)	67	(3)	27	(4)	9	(3)	29	(1)
GI ulcers	4	(5)	34	(2)	8	(1)	6	(2)	67	(2)
Intracranial or GI hemorrhage	7	(9)	109	(5)	34	(5)	22	(6)	177	(4)
Active cancer	32	(41)	575	(25)	234	(37)	136	(39)	1402	(32)
COPD	3	(4)	180	(8)	18	(3)	12	(3)	494	(11)
Dementia	6	(8)	136	(6)	22	(4)	12	(3)	265	(6)
Severity										
ICU admission	14	(18)	296	(13)	110	(17)	57	(16)	707	(16)
Respiratory dysfunction	10	(13)	331	(14)	80	(13)	40	(11)	711	(16)
Missing	0	(0)	6	(0)	0	(0)	0	(0)	36	(1)
Heart rate, median (IQR)	99	(84-110)	97	(82-112)	101	(85-119)	101	(85-116)	97	(82-112)
Missing	0	(0)	16	(1)	3	(0.5)	1	(0)	52	(1)
Systolic blood pressure, median (IQR)	131	(118-143)	135	(117-153)	129	(114-146)	128	(114-145)	131	(115- 148)
Missing	0	(0)	6	(0)	0	(0)	0	(0)	38	(1)
Hemoglobin, g/dl, median (IQR)	12	(10-14)	12	(10-13)	12	(10-14)	12	(10-14)	13	(11- 14)
Missing	5	(6)	75	(3)	29	(5)	21	(6)	131	(3)
Platelet count, 10^3 cells/ml, median (IQR)	239	(166-307)	239	(178-318)	256	(182-357)	265	(192-342)	231	(172-306)
Missing	5	(6)	78	(3)	29	(5)	21	(6)	142	(3)

Creatinine, g/dl, median (IQR)	0.9	(0.7 – 1.1)	1.1	(0.8 – 1.5)	0.8	(0.6 – 1.1)	0.8	(0.6 – 1.1)	0.9	(0.7 – 1.2)
Missing	5	(6)	78	(3)	29	(5)	21	(6)	141	(3)
Elevated troponin	19	(24)	647	(28)	95	(15)	59	(17)	1171	(27)
Missing	25	(32)	997	(43)	261	(41)	141	(40)	1919	(44)
Elevated D-dimer	19	(24)	677	(29)	166	(26)	90	(26)	1066	(24)
Missing	57	(73)	1648	(80)	464	(73)	257	(73)	3274	(75)
Elevated B-type natriuretic peptide	22	(28)	822	(35)	123	(19)	77	(22)	1541	(35)
Missing	35	(45)	1037	(44)	382	(60)	202	(58)	1881	(43)

Numbers reflect absolute counts (%) unless otherwise specified. Sum of percentages may not equal 100 due to rounding. Median neighborhood income data reflects 2022 inflation-adjusted income in US dollars.

COPD: chronic obstructive pulmonary disease; dl: deciliter; g: gram; GI: gastrointestinal; ICU: intensive care unit; IQR: interquartile range; ml: milliliter; US: united states; VTE: venous thromboembolism.

Table 2. Models for the association between group identity and use of advanced therapies, placement of inferior vena cava filters, length of hospital stay, and in-hospital mortality in three medical centers in the United States.

Model	Number of events (%)	Adjusted Odds Ratio (95% CI)	p-value
Main analysis			
Use of any advanced therapy[1]			
Asian	4 (5.1)	0.69 (0.24, 1.96)	0.48
Black	205 (8.8)	1.02 (0.83, 1.26)	0.86
Hispanic or Latino	59 (9.3)	0.77 (0.55, 1.08)	0.13
Other group identity	36 (10.3)	0.84 (0.56, 1.26)	0.40
White	309 (7.1)	Ref.	-
Secondary analysis			
Inferior vena cava filter placement[2]			
Asian	5 (6.4)	1.69 (0.60, 4.77)	0.33
Black	59 (2.5)	0.88 (0.63, 1.22)	0.44
Hispanic or Latino	35 (5.5)	1.69 (1.11, 2.58)	0.01
Other group identity	6 (1.7)	0.47 (0.19, 1.16)	0.10
White	146 (3.3)	Ref.	-
In-hospital mortality[1]			
Asian	9 (11.5)	2.32 (1.06, 5.06)	0.04
Black	101 (4.3)	0.87 (0.65, 1.15)	0.32
Hispanic or Latino	42 (6.6)	1.50 (0.98, 2.30)	0.06
Other group identity	20 (5.7)	1.28 (0.74, 2.22)	0.38
White	216 (4.9)	Ref.	-
Length of hospital stay[1]	**LOS, median (IQR)**	**Difference in LOS, days (95% CI)**	**p-value**
Asian	4.0 (2.0 -8.0)	-1.03 (-2.14, 0.09)	0.07
Black	4.0 (2.0 – 8.0)	0.14 (-0.49, 0.78)	0.65
Hispanic or Latino	5.0 (3.0 – 9.0)	0.78 (-0.18, 1.75)	0.11
Other group identity	5.0 (3.0 – 9.0)	0.75 (-0.55, 2.04)	0.26
White	4.0 (2.0 – 7.0)	Ref.	-

CI: confidence interval; IQR: interquartile range; LOS: length of stay.

1. Multivariable model adjusted for age (linear term), sex, treating site (indicator variable coding), prior thromboembolism, active cancer, atrial fibrillation, diabetes, chronic obstructive pulmonary disease, prior myocardial infarction, prior cardiac failure, stroke, hypertension, gastrointestinal ulcers, hemodialysis, dementia, intracranial hemorrhage, gastrointestinal bleeding, malnutrition, hemoglobin (linear term), platelet count (linear term), creatinine (linear term), intensive care unit admission, respiratory failure, heart rate (linear term), and systolic blood pressure (linear term). Variables were included as binary unless otherwise specified.
2. Multivariable model adjusted for age (linear term), sex, treating site, prior thromboembolism, active cancer, atrial fibrillation, diabetes, chronic obstructive pulmonary disease, prior myocardial infarction, prior cardiac failure, stroke, hypertension, hemodialysis, dementia, intracranial hemorrhage, malnutrition, hemoglobin (linear term), platelet count (linear term), creatinine (linear term), intensive care unit admission, respiratory failure, heart rate (linear term), and systolic blood pressure (linear term). Variables were included as binary unless otherwise specified.

Appendix: Supplementary material

Figure S1. Directed acyclic graph for the association of group identity and use by the provider of advanced therapies.

Table S1. Data source and definition of clinical, laboratory, and sociodemographic factors.

Table S2. List of CPT codes and medication terminology used to identify the use of advanced therapies, inferior vena cava filter placement, and extracorporeal membrane oxygenation.

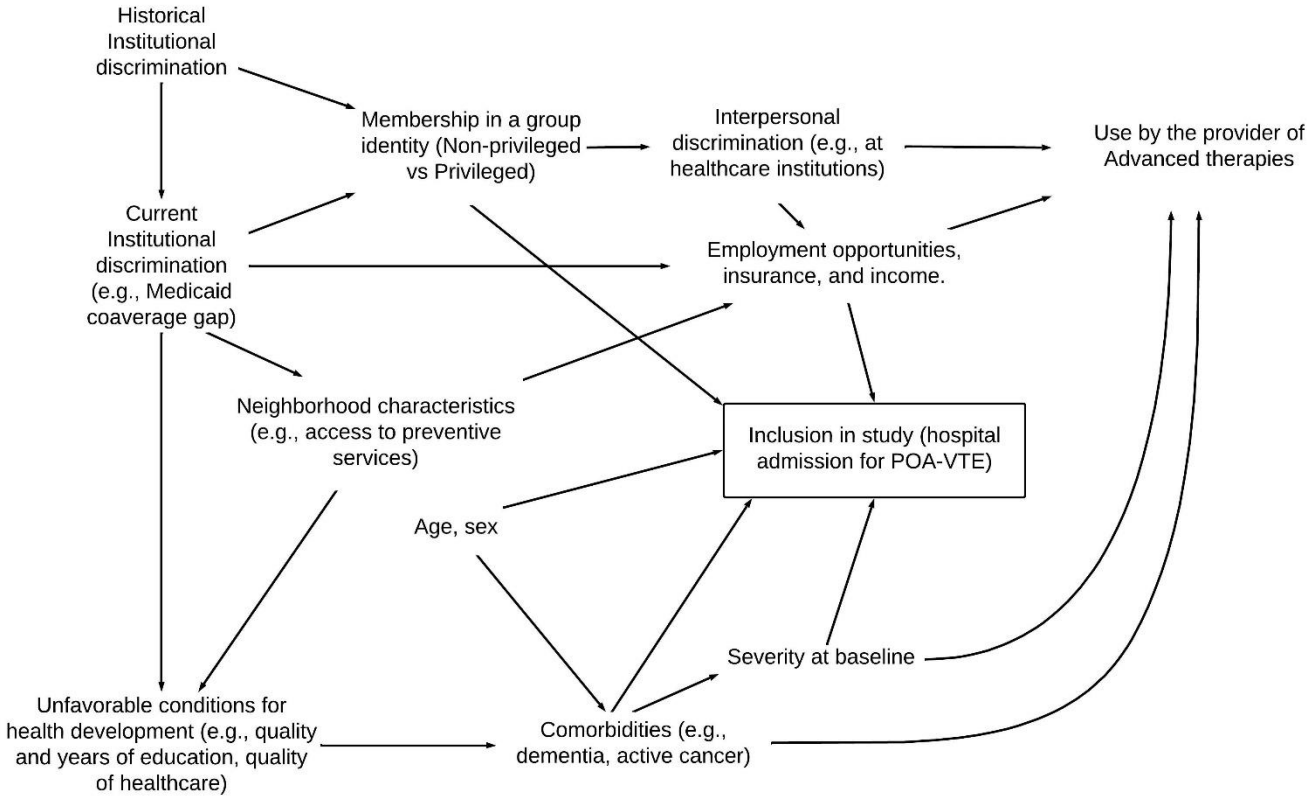
Table S3. Variables included for analysis in the main, secondary, and sensitivity analyses.

Table S4. Baseline characteristics of patients according to the presence of missing data on variables included in the statistical analysis models.

Table S5. Baseline characteristics by medical center of patients with a first hospitalization for present on admission venous thromboembolism.

Table S6. Analyses for the association between group identity and individual advanced therapies.

Figure S1. Directed acyclic graph for the association of group identity and use by the provider of advanced therapies.



POA: present on admission; VTE: venous thromboembolism. Boxes around nodes indicate conditioning for such variable by design (i.e., selection in the study).

The directed acyclic graph depicts[24] the simplified relationships between sociodemographic, clinical, and enviromental factors acting at several levels (i.e., policy, institutional, interpersonal) for the association between group identity (i.e., Membership in a non-privileged identity) and the use by the provider of advanced therapies for venous thromboembolism based on previous research and recommendations.[4-10,12, 24] The present directed acyclic does not account for the bidirectional and time-varying nature of realationships (e.g., employment status and insurance status). While membership in a group identity is a social construct, discrimination based on group identity is pervasive and driven by several factors, including disparities in built environment, employment opportunities which condition access to health insurance, access to healthcare facilities, and treatments. Furthermore, current institutional discrimination (i.e., at the policy and institutional level), which is influenced by past discrimination, creates unfavorable conditions for the development of health of individuals based on group identity. The graph underscores how inclusion in the study (i.e., admission to medical services in 3 medical systems in the United States for venous thrombombolism) can oversample individuals from non-privileged group identites with higher burden of comorbidities and with severe disease at baseline, and we decided to include such variables in the regression models. Finally, the graph identifies actionable upstream social determinants of health to lessen health disparities, such as employment, income, access to insurance, and neighborhood built environment characteristics.

Table S1. Data source and definition of clinical, laboratory, and sociodemographic factors.

Variable	Definition
Discharge date	Mm/dd/yyyy
Age	Truncated age in years at admission.
Female	Recorded sex in administrative database
Median income	Data linked with the American Census Statistics database using 5-digit area Zip codes for 5 year median income for 2020.
Insurance	"Uninsured / Self-Pay", "Medicaid", "Medicare / Medicare Advantage", "Commercial", "Other"
Group identity	"Asian", "Black non-Hispanic", "Hispanic or Latino", "Other identity", "White non-Hispanic"
ICU admission	CPT code 99291
Death	In-hospital death
Venous thromboembolism	ICD-10 codes I26.0*, I26.9*, I80.10, I80.11, I80.12, I80.13, I80.20*, I80.22*, I80.23*, I80.29*, I82.220, I82.40*, I82.41*, I82.42*, I82.43*, I82.44*, I82.49*, I82.4Y*, I82.4Z*, I82.62*, I82.60*, I82.A1*, I82.B1*, I82.C1*, I82.210, I82.290, I82.890
Past Medical History	ICD-10 codes
Active cancer	C00.*, C01*, C02.*, C03.*, C04.*, C05.*, C06.*, C06.80*, C06.80*, C07*, C08.*, C09.*, C10.*, C11.*, C12*, C13.*, C14.*, C30.0*, C30.1*, C31.*, C32.0*, C32.1*, C32.2*, C33*, C69*, C69.0*, C69.1*, C69.2*, C69.3*, C69.4*, C69.5*, C69.6*, C69.8*, C69.9*, C76.0*, C77.0*, C14.8*, C32.3*, C32.8*, C32.9*, C45.*, C77.1*, C34.0*, C34.1*, C34.2*, C34.3*, C34.8*, C34.9*, C37*, C38*, C38.*, C39.*, C95.0*, C95.1*, C95.7*, C95.9*, C90.1*, C90.2*, C90.3*, C91.0*, C91.1*, C91.3*, C91.4*, C91.5*, C91.6*, C91.A*, C91.Z*, C91.9*, C92.0*, C92.1*, C92.2*, C92.3*, C92.4*, C92.5*, C92.6*, C92.A*, C92.Z*, C92.9*, C93.0*, C93.1*, C93.3*, C93.Z*, C93.9*, C94.0*, C94.2*, C94.4*, C94.6*, C94.3*, C90.0*, C44.0*, C44.10*, C44.11*, C44.12*, C44.19*, C44.20*, C44.21*, C44.22*, C44.29*, C44.30*, C44.31*, C44.32*, C44.39*, C44.4*, C44.50*, C44.51*, C44.52*, C44.59*, C44.60*, C44.61*, C44.62*, C44.69*, C44.70*, C44.71*, C44.72*, C44.79*, C44.8*, C44.9*, C86.6*, C43.0*, C43.1*, C43.2*, C43.3*, C43.4*, C43.5*, C43.6*, C43.7*, C43.8*, C43.9*, C88.4*, C81.0*, C81.1*, C81.2*, C81.3*, C81.4*, C81.7*, C81.9*, C82.0*, C82.1*, C82.2*, C82.3*, C82.4*, C82.5*, C82.6*, C82.7*, C82.9*, C83.0*, C83.1*, C83.3*, C83.5*, C83.7*, C83.8*, C83.9*, C84.0*, C84.1*, C84.4*, C84.5*, C84.6*, C84.7*, C84.A*, C84.Z*, C84.9*, C85.1*, C85.2*, C85.8*, C85.9*, C86.*, M31.2*, C15.*, C16.*, C17.*, C18.*, C19*, C20*, C21*, C21.*, C25.*, C26.0*, C26.1*, C26.9*, C22.*, C23*, C24.*, C53.*, C54.*, C55*, C56.*, C57.0*, C57.1*, C57.2*, C57.3*, C57.4*, C57.7*, C57.8*, C57.9*, C61*, C62.0*, C62.1*, C62.9*,

	C63.0*, C63.1*, C63.2*, C63.3*, C63.7*, C63.8*, C63.9*, C67.*, C68.*,C50.*, C70.0*, C75.1*, C75.2*, C75.3*, C75.4*, C75.5*, C75.8*, C70.1*, C72.9*, C70.9*, C71.0*, C71.1*, C71.2*, C71.3*, C71.4*, C71.5*, C71.6*, C71.7*, C71.8*, C71.9*, C72.0*, C72.1*, C72.2*, C72.3*, C72.4*, C72.5*, C72.8*, C47.0*, C47.1*, C47.2*, C47.3*, C47.4*, C47.5*, C47.6*, C47.8*, C47.9*, C48.0*, C48.1*, C48.2*, C48.8*, C40.0*, C40.1*, C40.2*, C40.3*, C40.8*, C40.9*, C41.*, C7A.00*, C7A.010*, C7A.011*, C7A.012*, C7A.019*, C7A.020*, C7A.021*, C7A.022*, C7A.023*, C7A.024*, C7A.025*, C7A.026*, C7A.029*, C7A.090*, C7A.091*, C7A.092*, C7A.093*, C7A.094*, C7A.095*, C7A.096*, C7A.098*, C64.*, C65.*, C74.0*, C74.1*, C74.9*, C75.*, C66.*, C41.9*, C46.0*, C46.1*, C46.2*, C46.3*, C46.7*, C46.9*, C73*, C75.*
Atrial fibrillation	I48*, I48.1*, I48.2*, I48.3*, I48.4*, I48.9*, I48.91*, I48.92*
Diabetes Mellitus	E11.00*, E11.01*, E11.10*, E11.11*, E11.21*, E11.22*, E11.29*, E11.311*, E11.319*, E11.321*, E11.329*, E11.331*, E11.339*, E11.341*, E11.349*, E11.351*, E11.352*, E11.353*, E11.354*, E11.355*, E11.359*, E11.36*, E11.37*, E11.39*, E11.40*, E11.41*, E11.42*, E11.43*, E11.44*, E11.49*, E11.51*, E11.52*, E11.59*, E11.610*, E11.618*, E11.620*, E11.621*, E11.622*, E11.628*, E11.630*, E11.638*, E11.641*, E11.649*, E11.65*, E11.69*, E11.8*, E11.9*
Chronic obstructive pulmonary disease	J47*, J40*, J41*, J41.1*, J41.8*, J42*, J43*, J43.1*, J43.2*, J43.8*, J43.9*, J44*, J44.1*, J44.1*, J44.9*
Prior Myocardial infarction	I25.2, I21.01, I21.02, I21.09, I21.11, I21.19, I21.21, I21.29, I21.3, I21.4, I21.9, I21.A1, I21.A9, I22.0, I22.1, I22.2, I22.8, I22.9
Prior Congestive heart failure	I09.81, I11.0, I13.0, I13.2, I50.1, I50.20, I50.21, I50.22, I50.23, I50.30, I50.31, I50.32, I50.33, I50.40, I50.41, I50.42, I50.43, I50. 810, I50.811, I50.812, I50.813, I50.814, I50.82, I50.83, I50.84, I50.89, I50.9, R57.0, R57.9
Stroke	ICD 10 Codes: I63.39, I63.40, I63.411, I63.412, I63.413, I63.419, I63.421, I63.422, I63.423, I63.429, I63.431, I63.432, I63.433, I63.439, I63.441, I63.442, I63.443, I63.449, I63.49, I63.50, I63.511, I63.512, I63.513, I635.19, I635.21, I635.22, I635.23, I635.29, I635.31, I635.32, I635.33, I635.39, I635.41, I635.42, I635.43, I635.49, I635.9, I63.6, I63.8, I63.9, I63.39, I63.40, I63.411, I63.412, I63.413, I63.419, I63.421, I63.422, I63.423, I63.429, I63.431, I63.432, I63.433, I63.439, I63.441, I63.442, I63.443, I63.449, I63.49, I63.50, I63.511, I63.512, I63.513, I635.19, I635.21, I635.22, I635.23, I635.29, I635.31, I635.32, I635.33, I635.39, I635.41, I635.42, I635.43, I635.49, I635.9, I63.6, I63.8, I63.9
Hypertension	I10*, I11*, I12*, I13*, I15*, I16*
Gastrointestinal Ulcers	K25.*, K26.*, K27.*, K28.*
Hemodialysis	Z49*, Z99.2
Dementia, any type	F03.90, F01.50, F01.51, F04, F02.80, F02.81, F03.90, F03.91, F06.1, F06.8, G30.0, G30.1, G30.8, G30.9, G31.01, G31.09, G31.0, G31.1, G94, G31.83, R41.81
Intracranial Hemorrhage or Gastrointestinal Bleeding	D78.0*, D78.01*, D78.02*, D78.2*, D78.21*, D78.22*, E36.0*, E36.01*, E36.02*, E89.81*, E89.810*, E89.811*, G97.3*, G97.31*, G97.32*, G97.5*, G97.51*, G97.52*, H05.23*, H05.231*, H05.232*, H05.233*, H05.239*, H11.3*, H11.30*, H11.31*, H11.32*, H11.33*, H31.3*, H31.30*, H31.301*, H31.302*, H31.303*, H31.309*, H31.31*, H31.311*, H31.312*, H31.313*, H31.319*, H35.6*, H35.60*, H35.61*, H35.62*, H35.63*, H43.1*, H43.10*, H43.11*, H43.12*, H43.13*, H47.02*, H47.021*, H47.022*, H47.023*, H47.029*, H59.1*, H59.11*, H59.111*, H59.112*, H59.113*, H59.119*, H59.12*, H59.121*, H59.122*, H59.123*, H59.129*, H59.3*, H59.31*, H59.311*, H59.312*, H59.313*, H59.319*, H59.32*, H59.321*, H59.322*, H59.323*, H59.329*, H95.2*, H95.21*, H95.22*, H95.4*, H95.41*, H95.42*, I60*, I60.0*, I60.00*, I60.01*, I60.02*, I60.1*,

	I60.10*, I60.11*, I60.12*, I60.2*, I60.20*, I60.21*, I60.22*, I60.3*, I60.30*, I60.31*, I60.32*, I60.4*, I60.5*, I60.50*, I60.51*, I60.52*, I60.6*, I60.7*, I60.8*, I60.9*, I61*, I61.0*, I61.1*, I61.2*, I61.3*, I61.4*, I61.5*, I61.6*, I61.8*, I61.9*, I62*, I62.0*, I62.00*, I62.01*, I62.02*, I62.03*, I62.1*, I62.9*, I69.0*, I69.00*, I69.01*, I69.02*, I69.020*, I69.021*, I69.022*, I69.023*, I69.028*, I69.03*, I69.031*, I69.032*, I69.033*, I69.034*, I69.039*, I69.04*, I69.041*, I69.042*, I69.043*, I69.044*, I69.049*, I69.05*, I69.051*, I69.052*, I69.053*, I69.054*, I69.059*, I69.06*, I69.061*, I69.062*, I69.063*, I69.064*, I69.065*, I69.069*, I69.09*, I69.090*, I69.091*, I69.092*, I69.093*, I69.098*, I69.1*, I69.10*, I69.11*, I69.12*, I69.120*, I69.121*, I69.122*, I69.123*, I69.128*, I69.13*, I69.131*, I69.132*, I69.133*, I69.134*, I69.139*, I69.14*, I69.141*, I69.142*, I69.143*, I69.144*, I69.149*, I69.15*, I69.151*, I69.152*, I69.153*, I69.154*, I69.159*, I69.16*, I69.161*, I69.162*, I69.163*, I69.164*, I69.165*, I69.169*, I69.19*, I69.190*, I69.191*, I69.192*, I69.193*, I69.198*, I69.2*, I69.20*, I69.21*, I69.22*, I69.220*, I69.221*, I69.222*, I69.223*, I69.228*, I69.23*, I69.231*, I69.232*, I69.233*, I69.234*, I69.239*, I69.24*, I69.241*, I69.242*, I69.243*, I69.244*, I69.249*, I69.25*, I69.251*, I69.252*, I69.253*, I69.254*, I69.259*, I69.26*, I69.261*, I69.262*, I69.263*, I69.264*, I69.265*, I69.269*, I69.29*, I69.290*, I69.291*, I69.292*, I69.293*, I69.298*, I97.4*, I97.41*, I97.410*, I97.411*, I97.418*, I97.42*, I97.6*, I97.61*, I97.610*, I97.611*, I97.618*, I97.62*, J95.01*, J95.6*, J95.61*, J95.62*, J95.83*, J95.830*, J95.831*, K22.6*, K25.0*, K25.2*, K25.3*, K25.4*, K25.6*, K25.7*, K25.9*, K26.0*, K26.2*, K26.3*, K26.4*, K26.6*, K26.7*, K26.9*, K27.0*, K27.2*, K27.3*, K27.4*, K27.6*, K27.7*, K27.9*, K28.0*, K28.2*, K28.3*, K28.4*, K28.6*, K28.7*, K28.9*, K55.20*, K55.21*, K62.5*, K91.6*, K91.61*, K91.62*, K91.84*, K91.840*, K91.841*, K92.2*, K94.01*, K94.11*, K94.21*, K94.31*, L76.0*, L76.01*, L76.02*, L76.2*, L76.21*, L76.22*, M96.81*, M96.810*, M96.811*, M96.83*, M96.830*, M96.831*, N42.1*, N99.510*, N99.520*, N99.530*, N99.6*, N99.61*, N99.62*, N99.82*, N99.820*, N99.821*, O03.1*, O03.6*, O04.6*, O07.1*, O08.1*, O20*, O20.8*, O20.9*, O44.0*, O44.00*, O44.01*, O44.02*, O44.03*, O44.1*, O44.10*, O44.11*, O44.12*, O44.13*, O46*, O46.0*, O46.00*, O46.001*, O46.002*, O46.003*, O46.009*, O46.01*, O46.011*, O46.012*, O46.013*, O46.019*, O46.02*, O46.021*, O46.022*, O46.023*, O46.029*, O46.09*, O46.091*, O46.092*, O46.093*, O46.099*, O46.8*, O46.8X*, O46.8X1*, O46.8X2*, O46.8X3*, O46.8X9*, O46.9*, O46.90*, O46.91*, O46.92*, O46.93*, O67*, O67.0*, O67.8*, O67.9*, O72*, O72.0*, O72.1*, O72.2*, O73*, O73.0*, O73.1*, P02.1*, P10*, P10.0*, P10.1*, P10.2*, P10.3*, P10.8*, P10.9*, P12.2*, P26*, P26.0*, P26.1*, P26.8*, P26.9*, P38.1*, P38.9*, P50.3*, P50.4*, P51*, P51.0*, P51.8*, P51.9*, P52*, P52.0*, P52.1*, P52.2*, P52.21*, P52.22*, P52.3*, P52.4*, P52.5*, P52.6*, P52.8*, P52.9*, P54*, P54.2*, P54.3*, P54.4*, P54.5*, P54.6*, P54.8*, P54.9*, R04*, R04.1*, R04.8*, R04.81*, R04.89*, R04.9*, R58*, S06.34*, S06.340*, S06.340A*, S06.340D*, S06.340S*, S06.341*, S06.341A*, S06.341D*, S06.341S*, S06.342*, S06.342A*, S06.342D*, S06.342S*, S06.343*, S06.343A*, S06.343D*, S06.343S*, S06.344*, S06.344A*, S06.344D*, S06.344S*, S06.345*, S06.345A*, S06.345D*, S06.345S*, S06.346*, S06.346A*, S06.346D*, S06.346S*, S06.347*, S06.347A*, S06.347D*, S06.347S*, S06.348*, S06.348A*, S06.348D*, S06.348S*, S06.349*, S06.349A*, S06.349D*, S06.349S*, S06.35*, S06.350*, S06.350A*, S06.350D*, S06.350S*, S06.351*, S06.351A*, S06.351D*, S06.351S*, S06.352*, S06.352A*, S06.352D*, S06.352S*, S06.353*, S06.353A*, S06.353D*, S06.353S*, S06.354*, S06.354A*, S06.354D*, S06.354S*, S06.355*, S06.355A*, S06.355D*, S06.355S*, S06.356*, S06.356A*, S06.356D*, S06.356S*, S06.357*, S06.357A*, S06.357D*, S06.357S*, S06.358*, S06.358A*, S06.358D*, S06.358S*, S06.359*, S06.359A*, S06.359D*, S06.359S*, S06.36*, S06.360*, S06.360A*, S06.360D*, S06.360S*, S06.361*, S06.361A*, S06.361D*, S06.361S*, S06.362*, S06.362A*, S06.362D*, S06.362S*, S06.363*, S06.363A*, S06.363D*, S06.363S*, S06.364*, S06.364A*, S06.364D*, S06.364S*, S06.365*, S06.365A*, S06.365D*, S06.365S*, S06.366*, S06.366A*, S06.366D*, S06.366S*, S06.367*, S06.367A*, S06.367D*, S06.367S*, S06.368*, S06.368A*, S06.368D*, S06.368S*, S06.369*, S06.369A*, S06.369D*, S06.369S*, S06.37*, S06.370*, S06.370A*, S06.370D*, S06.370S*, S06.371*,

	S06.371A*, S06.371D*, S06.371S*, S06.372*, S06.372A*, S06.372D*, S06.372S*, S06.373*, S06.373A*, S06.373D*, S06.373S*, S06.374*, S06.374A*, S06.374D*, S06.374S*, S06.375*, S06.375A*, S06.375D*, S06.375S*, S06.376*, S06.376A*, S06.376D*, S06.376S*, S06.377*, S06.377A*, S06.377D*, S06.377S*, S06.378*, S06.378A*, S06.378D*, S06.378S*, S06.379*, S06.379A*, S06.379D*, S06.379S*, S06.38*, S06.380*, S06.380A*, S06.380D*, S06.380S*, S06.381*, S06.381A*, S06.381D*, S06.381S*, S06.382*, S06.382A*, S06.382D*, S06.382S*, S06.383*, S06.383A*, S06.383D*, S06.383S*, S06.384*, S06.384A*, S06.384D*, S06.384S*, S06.385*, S06.385A*, S06.385D*, S06.385S*, S06.386*, S06.386A*, S06.386D*, S06.386S*, S06.387*, S06.387A*, S06.387D*, S06.387S*, S06.388*, S06.388A*, S06.388D*, S06.388S*, S06.389*, S06.389A*, S06.389D*, S06.389S*, S06.4*, S06.4X*, S06.4X0*, S06.4X0A*, S06.4X0D*, S06.4X0S*, S06.4X1*, S06.4X1A*, S06.4X1D*, S06.4X1S*, S06.4X2*, S06.4X2A*, S06.4X2D*, S06.4X2S*, S06.4X3*, S06.4X3A*, S06.4X3D*, S06.4X3S*, S06.4X4*, S06.4X4A*, S06.4X4D*, S06.4X4S*, S06.4X5*, S06.4X5A*, S06.4X5D*, S06.4X5S*, S06.4X6*, S06.4X6A*, S06.4X6D*, S06.4X6S*, S06.4X7*, S06.4X7A*, S06.4X7D*, S06.4X7S*, S06.4X8*, S06.4X8A*, S06.4X8D*, S06.4X8S*, S06.4X9*, S06.4X9A*, S06.4X9D*, S06.4X9S*, S06.5*, S06.5X*, S06.5X0*, S06.5X0A*, S06.5X0D*, S06.5X0S*, S06.5X1*, S06.5X1A*, S06.5X1D*, S06.5X1S*, S06.5X2*, S06.5X2A*, S06.5X2D*, S06.5X2S*, S06.5X3*, S06.5X3A*, S06.5X3D*, S06.5X3S*, S06.5X4*, S06.5X4A*, S06.5X4D*, S06.5X4S*, S06.5X5*, S06.5X5A*, S06.5X5D*, S06.5X5S*, S06.5X6*, S06.5X6A*, S06.5X6D*, S06.5X6S*, S06.5X7*, S06.5X7A*, S06.5X7D*, S06.5X7S*, S06.5X8*, S06.5X8A*, S06.5X8D*, S06.5X8S*, S06.5X9*, S06.5X9A*, S06.5X9D*, S06.5X9S*, S06.6*, S06.6X*, S06.6X0*, S06.6X0A*, S06.6X0D*, S06.6X0S*, S06.6X1*, S06.6X1A*, S06.6X1D*, S06.6X1S*, S06.6X2*, S06.6X2A*, S06.6X2D*, S06.6X2S*, S06.6X3*, S06.6X3A*, S06.6X3D*, S06.6X3S*, S06.6X4*, S06.6X4A*, S06.6X4D*, S06.6X4S*, S06.6X5*, S06.6X5A*, S06.6X5D*, S06.6X5S*, S06.6X6*, S06.6X6A*, S06.6X6D*, S06.6X6S*, S06.6X7*, S06.6X7A*, S06.6X7D*, S06.6X7S*, S06.6X8*, S06.6X8A*, S06.6X8D*, S06.6X8S*, S06.6X9*, S06.6X9A*, S06.6X9D*, S06.6X9S*, T79.2*, T79.2XXA*, T79.2XXD*, T79.2XXS*, T82.83*, T82.837*, T82.837A*, T82.837D*, T82.837S*, T82.838*, T82.838A*, T82.838D*, T82.838S*, T83.83*, T83.83XA*, T83.83XD*, T83.83XS*, T84.83*, T84.83XA*, T84.83XD*, T84.83XS*, T85.83*, T85.83XA*, T85.83XD*, T85.83XS*, D78.0*, D78.01*, D78.02*, D78.2*, D78.21*, D78.22*, E36.0*, E36.01*, E36.02*, E89.81*, E89.810*, E89.811*, G97.3*, G97.31*, G97.32*, G97.5*, G97.51*, G97.52*, H05.23*, H05.231*, H05.232*, H05.233*, H05.239*, H11.3*, H11.30*, H11.31*, H11.32*, H11.33*, H31.3*, H31.30*, H31.301*, H31.302*, H31.303*, H31.309*, H31.31*, H31.311*, H31.312*, H31.313*, H31.319*, H35.6*, H35.60*, H35.61*, H35.62*, H35.63*, H43.1*, H43.10*, H43.11*, H43.12*, H43.13*, H47.02*, H47.021*, H47.022*, H47.023*, H47.029*, H59.1*, H59.11*, H59.111*, H59.112*, H59.113*, H59.119*, H59.12*, H59.121*, H59.122*, H59.123*, H59.129*, H59.3*, H59.31*, H59.311*, H59.312*, H59.313*, H59.319*, H59.32*, H59.321*, H59.322*, H59.323*, H59.329*, H95.2*, H95.21*, H95.22*, H95.4*, H95.41*, H95.42*, I60*, I60.0*, I60.00*, I60.01*, I60.02*, I60.1*, I60.10*, I60.11*, I60.12*, I60.2*, I60.3*, I60.30*, I60.31*, I60.32*, I60.4*, I60.5*, I60.50*, I60.51*, I60.52*, I60.6*, I60.7*, I60.8*, I60.9*, I61*, I61.0*, I61.1*, I61.2*, I61.3*, I61.4*, I61.5*, I61.6*, I61.8*, I61.9*, I62*, I62.0*, I62.00*, I62.01*, I62.02*, I62.03*, I62.1*, I62.9*, I69.0*, I69.00*, I69.01*, I69.010*, I69.011*, I69.012*, I69.013*, I69.014*, I69.015*, I69.018*, I69.019*, I69.02*, I69.020*, I69.021*, I69.022*, I69.023*, I69.028*, I69.03*, I69.031*, I69.032*, I69.033*, I69.034*, I69.039*, I69.04*, I69.041*, I69.042*, I69.043*, I69.044*, I69.049*, I69.05*, I69.051*, I69.052*, I69.053*, I69.054*, I69.059*, I69.06*, I69.061*, I69.062*, I69.063*, I69.064*, I69.065*, I69.069*, I69.09*, I69.090*, I69.091*, I69.092*, I69.093*, I69.098*, I69.1*, I69.10*, I69.11*, I69.110*, I69.111*, I69.112*, I69.113*, I69.114*, I69.115*, I69.118*, I69.119*, I69.12*, I69.120*, I69.121*, I69.122*, I69.123*, I69.128*, I69.13*, I69.131*, I69.132*, I69.133*, I69.134*, I69.139*, I69.14*, I69.141*, I69.142*, I69.143*, I69.144*, I69.149*, I69.15*, I69.151*, I69.152*, I69.153*, I69.154*, I69.159*, I69.16*, I69.161*, I69.162*, I69.163*, I69.164*, I69.165*, I69.169*,

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	S06.386D*, S06.386S*, S06.387*, S06.387A*, S06.387D*, S06.387S*, S06.388*, S06.388A*, S06.388D*, S06.388S*, S06.389*, S06.389A*, S06.389D*, S06.389S*, S06.4*, S06.4X*, S06.4X0*, S06.4X0A*, S06.4X0D*, S06.4X0S*, S06.4X1*, S06.4X1A*, S06.4X1D*, S06.4X1S*, S06.4X2*, S06.4X2A*, S06.4X2D*, S06.4X2S*, S06.4X3*, S06.4X3A*, S06.4X3D*, S06.4X3S*, S06.4X4*, S06.4X4A*, S06.4X4D*, S06.4X4S*, S06.4X5*, S06.4X5A*, S06.4X5D*, S06.4X5S*, S06.4X6*, S06.4X6A*, S06.4X6D*, S06.4X6S*, S06.4X7*, S06.4X7A*, S06.4X7D*, S06.4X7S*, S06.4X8*, S06.4X8A*, S06.4X8D*, S06.4X8S*, S06.4X9*, S06.4X9A*, S06.4X9D*, S06.4X9S*, S06.5*, S06.5X*, S06.5X0*, S06.5X0A*, S06.5X0D*, S06.5X0S*, S06.5X1*, S06.5X1A*, S06.5X1D*, S06.5X1S*, S06.5X2*, S06.5X2A*, S06.5X2D*, S06.5X2S*, S06.5X3*, S06.5X3A*, S06.5X3D*, S06.5X3S*, S06.5X4*, S06.5X4A*, S06.5X4D*, S06.5X4S*, S06.5X5*, S06.5X5A*, S06.5X5D*, S06.5X5S*, S06.5X6*, S06.5X6A*, S06.5X6D*, S06.5X6S*, S06.5X7*, S06.5X7A*, S06.5X7D*, S06.5X7S*, S06.5X8*, S06.5X8A*, S06.5X8D*, S06.5X8S*, S06.5X9*, S06.5X9A*, S06.5X9D*, S06.5X9S*, S06.6*, S06.6X*, S06.6X0*, S06.6X0A*, S06.6X0D*, S06.6X0S*, S06.6X1*, S06.6X1A*, S06.6X1D*, S06.6X1S*, S06.6X2*, S06.6X2A*, S06.6X2D*, S06.6X2S*, S06.6X3*, S06.6X3A*, S06.6X3D*, S06.6X3S*, S06.6X4*, S06.6X4A*, S06.6X4D*, S06.6X4S*, S06.6X5*, S06.6X5A*, S06.6X5D*, S06.6X5S*, S06.6X6*, S06.6X6A*, S06.6X6D*, S06.6X6S*, S06.6X7*, S06.6X7A*, S06.6X7D*, S06.6X7S*, S06.6X8*, S06.6X8A*, S06.6X8D*, S06.6X8S*, S06.6X9*, S06.6X9A*, S06.6X9D*, S06.6X9S*, T79.2*, T79.2XXA*, T79.2XXD*, T79.2XXS*, T82.83*, T82.837*, T82.837A*, T82.837D*, T82.837S*, T82.838*, T82.838A*, T82.838D*, T82.838S*, T83.83*, T83.83XA*, T83.83XD*, T83.83XS*, T84.83*, T84.83XA*, T84.83XD*, T84.83XS*, T85.83*, T85.830*, T85.830A*, T85.830D*, T85.830S*, T85.838*, T85.838A*, T85.838D*, T85.838S*, I85.00*, I85.11*, K22.11*, K29.01*, K29.21*, K29.31*, K29.41*, K29.51*, K29.61*, K29.71*, K29.81*, K29.91*, K31.811*, K50.011*, K50.111*, K50.811*, K50.911*, K51.011*, K51.211*, K51.311*, K51.411*, K51.511*, K51.811*, K51.911*, K57.00*, K57.01*, K57.11*, K57.13*, K57.21*, K57.31*, K57.33*, K57.51*, K57.53*, K57.81*, K57.91*, K57.93*, H95.2*, H95.21*, H95.22*, H95.4*, H95.41*, H95.42*, J95.01*, J95.6*, J95.61*, J95.62*, J95.83*, J95.830*, J95.831*, K22.6*, K25.0*, K25.2*, K25.3*, K25.4*, K25.6*, K25.7*, K25.9*, K27.0*, K27.2*, K27.3*, K27.4*, K27.6*, K27.7*, K27.9*, K28.0*, K28.2*, K28.3*, K28.4*, K28.6*
Malnutrition	E40*, E41*, E42*, E43*, E44*, E45*, E46*
Clinical variables	
Heart Rate (beats / minute)	Beats per minute, first record during admission
Systolic Blood Pressure	In mmHg, first record during admission
Respiratory Dysfunction	Requiring assisted ventilation at admission or oxygenation saturation <90%
Laboratory at admission	
Hemoglobin	Continuous variable in g/dL
Platelet Count	Continuous variable in cells/uL
Troponin	Standardized using threshold for abnormal values (upper limit of normal values range)
D-dimer	Standardized using threshold for abnormal values (upper limit of normal values range)
B-type natriuretic peptide	Standardized using threshold for abnormal values (upper limit of normal values range)
Creatinine	Continuous variable in g/l

Table S2. List of CPT codes and medication terminology used to identify the use of advanced therapies, inferior vena cava filter placement, and extracorporeal membrane oxygenation.

Advanced therapy of interest	CPT codes / medication terminology used
Deep vein thrombosis	
CDT, thrombectomy	
Percutaneous transluminal thrombectomy, vein(s)	CPT 37187, 37188
CDT, thrombolysis	
Venous infusion of thrombolysis other than coronary	CPT 37212, 37213, 37214
Surgical embolectomy	
Thrombectomy vena cava/iliac vein, abdominal	CPT 34401
Thrombectomy vena cava, iliac, femoropopliteal - ex	CPT 34421
Thrombectomy vena cava, inguinal and abdominal.	CPT 34451
Thrombectomy subclavian vein, by neck incision	CPT 34471
Thrombectomy; axillary and subclavian vein, by arm incision	CPT 34490
Pulmonary embolism	
Percutaneous arterial mechanical thrombectomy – CDT, thrombectomy	CPT Code 37184, 37185
Transcatheter arterial infusion for thrombolysis – CDT, thrombolytics	CPT code 37211, 37201
Surgical thrombectomy	
Pulmonary artery thrombectomy	CPT 33915
Inferior vena cava filter	
Placement of Inferior vena cava filter	CPT code 37191
Extracorporeal membrane oxygenation	
Extracorporeal membrane oxygenation (ECMO)/extracorporeal life support (ECLS) provided by physician; initiation, veno-venous, veno-arterial,	CPT code 33946, 33947
Extracorporeal membrane oxygenation (ECMO)/extracorporeal life support (ECLS) provided by physician; daily management, each day, veno-venous, veno-arterial	CPT code 33948, 33949
Systemic thrombolysis	Prescription of alteplase, anistreplase, reteplase, saruplase, or tenectoplase at any time point in the hospitalization.

CPT: Current procedural terminology codes.

Table S3. Variables included for analysis in the main, secondary, and sensitivity analyses.

Model	Sociodemographic variables	Comorbidities	Laboratory and vital sign measurements
Main model for the association between group identity and use of advanced therapies	Age (continuous as a linear term), sex (male or female), and treating site (nominal, indicator variable coding).	Prior venous thromboembolism, active cancer, atrial fibrillation, diabetes mellitus, chronic obstructive pulmonary disease, prior myocardial infarction, prior cardiac failure, stroke, hypertension, gastrointestinal ulcers, hemodialysis, dementia, intracranial hemorrhage, gastrointestinal bleeding, and malnutrition; as binary variables.	Hemoglobin (continuous, using a linear term), platelet count (continuous, using a linear term), creatinine levels (continuous, using a linear term), ICU admission (binary), respiratory failure (binary), heart rate (continuous, using a linear term), and systolic blood pressure (continuous, using a linear term)
Secondary analysis: association between group identity and in-hospital mortality.			
Secondary analysis: association between group identity and length of hospital stays.			
Sensitivity analysis: association between group identity and use of advanced therapies excluding hospitalizations after December 31st, 2019			
Sensitivity analysis: association between group identity and length of hospital stay excluding hospitalizations <48 hours			
Secondary analysis: association between group identity and inferior vena cava filter placement.	Same variables as listed above.	Same variables as listed above, excluding gastroduodenal ulcers, intracranial hemorrhage, and gastrointestinal bleeding.	Same variables as listed above.

Table S4. Baseline characteristics of patients according to the presence of missing data on variables included in the statistical analysis models.

Baseline characteristics	No missing data (N = 7319)	Missing data (N = 490)
Sociodemographic		
Age group, in years		
≥18 and <30	287 (4)	26 (5)
≥30 and <45	925 (13)	82 (15)
≥45 and <60	1874 (26)	161 (30)
≥60 and <70	1722 (24)	131 (24)
≥70 and <80	1455 (20)	98 (18)
≥80	1008 (14)	40 (7)
Female	3614 (50)	266 (49)
Group identity		
Asian	73 (1)	5 (1)
Black	2198 (30)	144 (27)
Hispanic or Latino	598 (8)	35 (7)
Other	314 (4)	36 (7)
White	4088 (56)	288 (54)
Missing	-	30 (6)
Site		
Harris Health	1497 (211)	180 (34)
University of Michigan	1082 (15)	209 (39)
University of North Carolina	4692 (65)	149 (28)
Comorbidities		
Malnutrition	890 (12)	74 (14)
Prior VTE	247 (3)	27 (5)
Atrial fibrillation	451 (6)	27 (5)
Stroke	231 (3)	23 (4)
Hypertension	2465 (34)	188 (35)
Congestive heart failure	1826 (25)	101 (19)
Coronary disease	485 (7)	25 (5)
Diabetes mellitus	1237 (17)	93 (17)
Hemodialysis	126 (2)	7 (1)
GI ulcers	109 (2)	10 (2)
Intracranial or GI hemorrhage	331 (5)	20 (4)
Active cancer	2164 (30)	226 (42)
COPD	665 (9)	43 (8)
Dementia	426 (6)	19 (4)
Severity		
ICU admission	1121 (15)	71 (13)
Respiratory dysfunction	1123 (15)	55 (10)
Missing	-	42 (8)
Heart rate, median (IQR)	97 (82, 113)	96 (82, 113)
Missing	-	72 (15)
Systolic blood pressure, median (IQR)	132 (116, 149)	128 (114, 148)
Missing	-	44 (9)
Hemoglobin, g/dl	12 (10, 14)	12 (11, 14)
Missing	-	262 (54)
Platelet count, 10^3 cells/ml, median (IQR)	236 (176, 315)	234 (165, 321)
Missing	-	276 (56)
Creatinine, g/dl, median (IQR)	1.0 (0.7, 1.3)	0.9 (0.7, 1.3)
Missing	-	275 (56)

Numbers reflect absolute counts (%) unless otherwise specified.
Sum of percentages may not equal 100 due to rounding.

Table S5. Baseline characteristics by medical center of patients with a first hospitalization for present on admission venous thromboembolism.

Baseline characteristics	Harris Health (N = 1677)	UM (N = 1291)	UNC (N = 4841)	Overall (N = 7809)
Sociodemographic				
Age group, in years				
≥18 and <30	99 (6)	72 (6)	142 (3)	313 (4)
≥30 and <45	335 (20)	179 (14)	493 (10)	1007 (13)
≥45 and <60	625 (37)	344 (27)	1066 (22)	2035 (26)
≥60 and <70	389 (23)	321 (25)	1143 (24)	1853 (24)
≥70 and <80	148 (9)	242 (19)	1163 (24)	1553 (20)
≥80	81 (5)	133 (10)	834 (17)	1048 (13)
Female	768 (46)	612 (47)	2500 (52)	3880 (50)
Neighborhood-level median income (US dollars)				
<35,000	240 (14)	53 (4)	193 (4)	483 (6)
>= 35,000 to <50,000	649 (39)	201 (16)	1472 (30)	2322 (30)
>=50,000 to <100,000	679 (41)	846 (66)	2849 (59)	4374 (56)
>=100,000	76 (5)	187 (15)	257 (5)	520 (7)
Missing	33 (2)	4 (<1)	70 (1)	107 (1)
Group identity				
Asian	27 (2)	25 (2)	26 (1)	78 (1)
Black	691 (41)	198 (15)	1453 (30)	2342 (30)
Hispanic or Latino	421 (25)	38 (3)	174 (4)	633 (8)
Other	251 (15)	20 (2)	79 (2)	350 (5)
White	276 (17)	1002 (78)	3098 (64)	4376 (56)
Missing	11 (1)	8 (1)	11 (<1)	30 (<1)
Insurance payer type				
Medicare / Advantage	295 (18)	422 (33)	2881 (60)	3598 (46)
Medicaid	517 (31)	42 (3)	420 (9)	979 (13)
Commercial	206 (12)	812 (63)	1090 (23)	2108 (27)
Uninsured / self-pay	186 (11)	0 (0)	380 (8)	566 (7)
Other	473 (28)	15 (1)	70 (1)	558 (7)
Comorbidities				
Malnutrition	178 (11)	252 (20)	534 (11)	964 (12)
Prior VTE	157 (9)	68 (5)	49 (1)	274 (4)
Atrial fibrillation	50 (3)	77 (6)	351 (7)	478 (6)
Stroke	77 (5)	71 (6)	106 (2)	254 (3)
Hypertension	686 (41)	545 (42)	1422 (29)	2653 (34)
Congestive heart failure	353 (21)	262 (20)	1312 (27)	1927 (25)
Coronary disease	86 (5)	81 (6)	343 (7)	510 (7)
Diabetes mellitus	353 (21)	234 (18)	743 (15)	1330 (17)
Hemodialysis	46 (3)	25 (2)	62 (1)	133 (2)
GI ulcers	21 (1)	28 (2)	70 (1)	119 (2)
Intracranial or GI hemorrhage	70 (4)	45 (4)	236 (5)	351 (5)
Active cancer	605 (36)	586 (45)	1199 (25)	2390 (31)
COPD	80 (5)	160 (12)	468 (10)	708 (9)
Dementia	51 (3)	46 (4)	348 (7)	445 (6)
Severity				
ICU admission	283 (17)	308 (24)	601 (12)	1192 (15)
Respiratory dysfunction	226 (14)	114 (9)	838 (17)	1178 (15)
Missing	0 (0)	10 (1)	32 (1)	42 (1)
Heart rate, median (IQR)	130 (114, 148)	130 (113, 147)	133 (117, 150)	132 (115, 149)
Missing	12 (1)	13 (1)	47 (1)	72 (1)
Systolic blood pressure, median (IQR)	102 (86, 116)	94 (80, 110)	97 (82, 112)	97 (82, 113)
Missing	1 (<1)	13 (1)	30 (1)	44 (1)
Hemoglobin, g/dl	12 (10, 14)	12 (10, 14)	12 (11, 14)	12 (10, 14)
Missing	118 (7)	138 (11)	6 (<1)	262 (3)

Platelet count, 10^3 cells/ml, median (IQR)	260 (190, 343)	221 (165, 297)	232 (174, 310)	236 (175, 315)
Missing	119 (7)	150 (12)	7 (<1)	276 (4)
Creatinine, g/dl, median (IQR)	0.9 (0.7, 1.3)	0.9 (0.7, 1.2)	1.0 (0.8, 1.3)	1.0 (0.7, 1.3)
Missing	119 (7)	150 (12)	6 (<1)	275 (4)
Elevated troponin	286 (17)	360 (28)	1350 (28)	1996 (26)
Missing	507 (30)	447 (35)	2397 (50)	3351 (43)
Elevated D-dimer	417 (25)	147 (11)	1466 (30)	2030 (26)
Missing	1240 (74)	1129 (88)	3349 (69)	5718 (73)
B-type natriuretic peptide	375 (22)	286 (22)	1934 (40)	2595 (33)
Missing	961 (57)	584 (45)	2003 (41)	3548 (45)

dl: deciliter; g: grams; IQR: interquartile range; UM: University of Michigan; UNC: University of North Carolina.
Numbers reflect absolute counts (%) unless otherwise specified. Sum of percentages may not equal 100 due to rounding. Median neighborhood income data reflects 2022 inflation-adjusted income in US dollars.

Table S6. Analyses for the association between group identity and individual advanced therapies.

Model	Number of events (%)	Adjusted Odds Ratio (95% CI)	p-value
Use of extracorporeal membrane oxygenation[1]			
Asian	-	-	-
Black	1 (<1)	-	-
Hispanic or Latino	-	-	-
Other group identity	1 (<1)	-	-
White	1 (<1)	-	-
Use of systemic thrombolytics or catheter-directed thrombolytics[1]			
Asian	4 (5.1)	0.76 (0.27, 2.19)	0.61
Black	190 (8.1)	1.01 (0.81, 1.26)	0.92
Hispanic or Latino	55 (8.7)	0.76 (0.54, 1.08)	0.13
Other group identity	32 (9.1)	0.79 (0.51, 1.22)	0.28
White	278 (6.4)	Ref.	-
Use of surgical embolectomy or catheter-directed thrombectomy[1]			
Asian	1 (1.3)	-	-
Black	38 (1.6)	-	-
Hispanic or Latino	11 (1.7)	-	-
Other group identity	8 (2.3)	-	-
White	69 (1.6)	-	-

CI: confidence interval.

3. Multivariable model adjusted for age (linear term), sex, treating site (indicator variable coding), prior thromboembolism, active cancer, atrial fibrillation, diabetes, chronic obstructive pulmonary disease, prior myocardial infarction, prior cardiac failure, stroke, hypertension, gastrointestinal ulcers, hemodialysis, dementia, intracranial hemorrhage, gastrointestinal bleeding, malnutrition, hemoglobin (linear term), platelet count (linear term), creatinine (linear term), intensive care unit admission, respiratory failure, heart rate (linear term), and systolic blood pressure (linear term). Variables were included as binary unless otherwise specified.