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Patient Characteristics and Comorbidities Associated With Cerebrovascular Accident following Acute Myocardial Infarction in the United States

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Abstract

Background—Although cerebrovascular accident (CVA) is a relatively infrequent complication of acute myocardial infarction (AMI), the occurrence of CVA in patients with AMI is associated with increased morbidity and mortality. We wanted to assess post-AMI CVA rate in the United States and identify associated patient characteristics, comorbidities, type of AMI, and utilization of invasive procedures.

Methods—This is an observational study from the Nationwide Inpatient Sample, 2006–2008. Using multivariate regression models, we assessed predictive risk factors for post-AMI CVA among patients admitted for AMI.

Results—Among the 1,924,413 patients admitted for AMI, the overall rate of CVA was 2% (Ischemic stroke: 1.47%, transient ischemic attack [TIA]: 0.35% and hemorrhagic stroke: 0.21%). In this sample of AMI patient, higher incidence of CVA was associated with: CHF (Adjusted odds ratio [AOR] 1.71; 95% confidence interval [CI], 1.58–1.84,), age over 65 AOR, 1.65; 95% CI, 1.60–1.70, alcohol abuse AOR, 1.60; 95% CI, 1.49–1.73, cocaine use AOR, 1.48; 95% CI, 1.29–1.70, atrial fibrillation AOR, 1.43; 95% CI, 1.39–1.46, Black race AOR, 1.35; 95% CI, 1.30–1.40, female gender AOR, 1.32; 95% CI, 1.29–1.35, peripheral vascular disease [PVD] AOR, 1.26; 95%

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Dr. Masoomi: Statistical analysis, acquisition of data
Dr. Mozaffar: critical revision of manuscript for important intellectual content
Dr. Malik: study supervision, critical revision of manuscript

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CI, 1.22–1.30, coronary artery bypass graft (CABG) AOR, 1.22; 95% CI, 1.17–1.27, P <0.0001, STEMI AOR, 1.17; 95% CI, 1.14–1.20 and teaching hospitals AOR, 1.09; 95% CI, 1.06–1.12.

Conclusion—Female gender, older age (age ≥ 65), black ethnicity, comorbidities including CHF, PVD, atrial fibrillation as well as STEMI and undergoing CABG were associated with the highest risk of CVA post- AMI.

Keywords

Cerebrovascular Accident; Transient Ischemic Attack; Stroke; Acute Myocardial Infarction

INTRODUCTION

The development of a stroke in the immediate period after an acute myocardial infarction (AMI) is a devastating complication and is associated with a significant risk of morbidity and mortality[1]. Cerebrovasular accident (CVA) and AMI share a number of predisposing risk factors including hypertension, hypercholesterolemia, smoking, diabetes, and advanced age. [2–4] Additionally, the pathophysiology associated with AMI can itself predispose patients to stroke through different mechanisms such as emboli, either during revascularization[5–6] or from atrial fibrillation or other arrhythmias associated with AMI[7–10] or from blood stasis and thrombi in a poorly functioning left ventricle.[3] While the risk of stroke after myocardial infarction (AMI) is increased compared with the risk among those without AMI, associated risk factors as well as the magnitude of CVA risk post-AMI remain unclear.

Knowledge of risk factors associated with higher incidence of CVA in patients with AMI may aid clinicians in using appropriate methods of prophylaxis to minimize the chance of CVA as well as raise clinical suspicion to improve early diagnosis and treatment of post-AMI CVA. Since the rate of CVA after AMI has been previously shown to be relatively low[11] identification of risk factors that may predict CVA following AMI requires a large series of patients that is not frequently available from single institutional case series. In this study, we use the Nationwide Inpatient Sample (NIS) database; 1) to evaluate the incidence of different type of CVA in patients who were admitted for AMI to a sample of US hospitals from 2006–2008 and 2) to assess the relationship between patient demographics, patient comorbidities, and hospital factors with post-AMI CVA.

MATERIALS AND METHODS

Database

The NIS is the largest inpatient care database in the United States in which approximately 1000 hospitals participate and contains information from nearly 8 million hospital stays each year across the country and is administered by Healthcare Cost and Utilization Project (HCUP) and sponsored by Agency for Healthcare Research and Quality (AHRQ). The NIS is comprised of a nationally representative sample of approximately 20% of United States community hospitals, resulting in a sampling frame, which when weighted comprises approximately 90% of all hospital discharges in the United States. Data elements within the NIS are drawn from hospital discharge abstracts that allow determination of all procedures performed during a given hospital admission. It also contains discharge information on inpatient hospital stay, including patient characteristics, patient comorbidities, length of hospital stay, specific morbidity, and observed in-hospital mortality. The NIS database has no information available on complications occurring after discharge. Approval for use of the NIS patient-level data in this study was obtained from the Institutional Review Board of the University of California, Irvine Medical Center and HCUP.

Data Analysis

Using the NIS data from 2006 to 2008, we analyzed discharge data on patients who admitted for AMI using International Classification of Disease ninth revision (ICD-9) principal diagnosis codes (410.0–410.9). Cerebrovascular accident (CVA) was defined as the presence of ischemic stroke, transient ischemic attack (TIA) or hemorrhagic stroke following AMI admissions, which have been diagnosed with ICD-9 diagnosis codes of 430.–435.0. Factors that were analyzed include patient's characteristics (age, gender and race), comorbidities, teaching status of hospital, type of AMI, ST elevation MI (STEMI) or non-ST elevation MI (NSTEMI) and performing procedures (diagnostic cardiac catheterization, percutaneous transluminal coronary angioplasty [PTCA] and coronary artery bypass graft [CABG]). For ease of clinical interpretation of the results, all factors were analyzed as dichotomous variables. These factors were categorized as follows: 1) patient-specific factors; age (≤40, ≥ 65 vs. 40–65 years), gender (male vs. female), race (Caucasian vs. non-Caucasian); 2) presence or absence of comorbidities; 3) teaching status of hospital (teaching vs. non-teaching); 4) AMI-type (STEMI vs NSTEMI) and 5) procedure utilization including diagnostic cardiac catheterization, percutaneous transluminal coronary angioplasty (PTCA) and coronary artery bypass graft (CABG).

Statistical Analysis

Multivariate regression analysis was performed to identify independent predictors of CVA following AMI. As the pathogenesis of ischemic stroke and hemorrhagic stroke are different, the risk factor of different types of CVA after AMI could be different. Therefore, we used multivariate regression analyses in four different patient groups including: 1) All types of CVA; 2) Ischemic stroke; 3) TIA; and 4) Hemorrhagic stroke. The adjusted odds ratio (AOR) with a 95% confidence interval was calculated to determine the combined effect of various factors on CVA. Age 40–65 years, female gender, Caucasian race, non-teaching hospital, NSTEMI and no procedures were used as a reference. All statistical analyses for the NIS database were conducted using SAS version 9.3 (SAS institute, Cary, North Carolina), incorporating recommended discharge and hospital weights. Discharge weight (DISCWT) was used to create national estimates for all analysis. Statistical significance was set at p-values <0.003, we did a Bonferroni adjustment for multiple comparisons and odds ratios and 95% confidence intervals were calculated.

RESULTS

A total 1,924,413 patients admitted for AMI during these 3-year period. The majority of the patients were male (60%) and Caucasian (77.7%). The mean age was 67.6 with 57.5% of patients were older than 65 years Table 1. The most prevalent comorbidities were hypertension (63.2%), hyperlipidemia (50.1%) and diabetes mellitus (32.0%). Sixteen percent of patients had atrial fibrillation. Almost half the patients (48%) were admitted in teaching hospitals. The most common AMI-type was non-ST elevation MI (62.4%). Overall, 61.95% of these patients underwent diagnostic cardiac catheterization as well as 41.47% of patients underwent PTCA and 9.09% underwent CABG.

Overall 38,577 patients (2%) experienced CVA during hospitalization (NSTEMI, 2.12% vs. STEMI, 1.82%). Table 2 shows the rate of ischemic stroke, hemorrhagic and TIA in MI (STEMI and NSTEMI). In general, incidence of CVA during hospitalization was higher in those with NSTEMI (2.12%) when compared to those with STEMI (1.82%). Compared with patients without CVA, patients with CVA had a higher in-hospital mortality (19.6% vs. 5.8%; $p<0.01$), longer mean hospital stay (9.5 days vs. 5.0 days; $p<0.01$), and higher mean hospital charges ($80,107 vs. $55,086; $p<0.01$), Table 3.

Table 4 lists the multivariate logistic regression analysis for overall CVA and 3 subtypes of CVA. For patient's characteristics, factors associated with higher CVA rate were age ≥ 65 years (AOR, 1.65; 95% CI, 1.60–1.70, P <0.0001), female gender (AOR, 1.41; 95% CI, 1.37–1.44, P <0.0001) and Black race (AOR, 1.40; 95% CI, 1.34–1.45, P <0.0001). Comorbidities, such as congestive heart failure (AOR, 2.50; 95% CI, 2.31–2.71, P <0.0001), atrial fibrillation (AOR, 1.51; 95% CI, 1.47–1.55, P <0.0001), and peripheral vascular disease (AOR, 1.23; 95% CI, 1.18–1.27, P <0.0001) were independent factors associated with increased risk of CVA. Also, substance abuse including alcohol abuse (AOR, 1.67; 95% CI, 1.55–1.79, P <0.0001) and history of cocaine use (AOR, 1.34; 95% CI, 1.17–1.54, P <0.0001) were associated with higher incidence of post-AMI CVA. Among those that underwent procedures, patients with CABG were at higher risk of CVA (AOR, 1.22; 95% CI, 1.17–1.27, P <0.0001) compared to those without CABG. STEMI was associated with a higher risk of CVA (AOR, 1.17; 95% CI, 1.14–1.20, P <0.0001) compared to NSTEMI and teaching hospitals was slightly had higher risk of CVA (AOR, 1.09; 95% CI, 1.06–1.12, P <0.0001) compared with non-teaching hospitals. There was no effect of diabetes mellitus, liver disease, chronic pulmonary disease, chronic renal failure, obesity, hyperlipidemia, hypertension, smoking, anemia, diagnostic cardiac catheterization and PTCA on CVA.

Although risk factors of post-AMI ischemic stroke were similar to the overall CVA, most of these relationships persisted when looking at other subtypes of CVA. The differences in risk factors between ischemic and hemorrhagic stroke included older age (≥65), female gender, Black race and cocaine use for ischemic but not hemorrhagic stroke, female gender for ischemic but not hemorrhagic stroke following AMI. Also, in patients who experienced TIA, age over 65, female gender, Black race, atrial fibrillation, hypertension, PVD, NSTEMI and non-teaching hospitals were significant risk factors (Table 4).

DISCUSSION

This report with data from a large number of patients who admitted for AMI between 2006 and 2008 in the United States showed a relatively low in-hospital CVA rate of 2%. Despite this lower rate, we found that having a CVA during the hospitalization was related to a 3.4 times higher in-hospital mortality rate compared with patients without CVA which is similar

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to 3-fold increased in mortality according to other studies. [11–13] There are several studies that have been reported the incidence of in-hospital stroke following MI, from 0.9% to 5%.[11,14] Our study is the first to show the rate of different type of in-hospital CVA following AMI in the United States.

We also identified several risk factors for the incidence of in-hospital CVA in patients with AMI. Knowledge of these factors could result in greater surveillance and early diagnosis and treatment of CVA in this high risk patient population. Patients characteristics that were found to be predictive of higher risk for in-hospital CVA were female gender, age over 65 and Black race. Our study showed female patients had higher chance of CVA following AMI. While male sex is a traditional risk factors of AMI and stroke[3,15]; our study found the risk of CVA following AMI is significantly higher in women. This finding is similar to the recent observational study that has shown that women experience worse outcomes following AMI. Canto et al.[16] examined the relationship between sex, symptoms when presenting to the hospital, and the risk of death while in the hospital, before and after accounting for age in patients hospitalized with MI. The study consisted of an analysis of data from the National Registry of Myocardial Infarction, 1994–2006, of 1,143,513 registry patients. They found in-hospital mortality rate was 14.6% for women compare to 10.3% for men.

Our study showed age over 65 is a predictive risk of CVA following MI. Given the positive association between advanced age and risk of stroke[3] as well as risk of AMI[2], the finding of increased risk of CVA after AMI among older patients is not surprising. Similarly, Witt et al.[17] in a meta-analysis in evaluation of risk factors of post-MI stroke found that among patient characteristics, advanced age and non-white race were independent risk factors of stroke following MI. Also, Uchechukwu et al.[18] in evaluation of risk factors of stroke in AMI patients showed that patients under 70 years of age, there was a 39% increase in the risk of stroke with each decade increase in age; the same trend was seen in patients older than 70 years, but it was not statistically significant.

With respect to patient comorbidities; congestive heart failure, atrial fibrillation, and peripheral vascular disease were independent risk factors of CVA. However, our study showed that hypertension, diabetes mellitus, liver disease, chronic pulmonary disease, chronic renal failure, obesity, hyperlipidemia, smoking and anemia were not associated with higher risk of CVA following AMI. Although, diabetes mellitus and smoking are both known risk factors of CVA and have been considered in stroke scoring system in ABCD2[19] and ESSEN[20]; however, current study showed that these factors are not independent risk factor of CVA in patients who was admitted for AMI. Similar to our findings, Witt et al.[17] found that heart failure is a significant risk factor of stroke after AMI; however, contrary to our finding they found hypertension and diabetes as an independent risk factor of stroke. Interestingly, our study showed that hypertension is only a risk factor of TIA. Jakobsson et al.[21] in a recent large study from Sweden in evaluation of stroke risk during first year of follow up in AMI patients showed that diabetes mellitus is a risk factor of ischemic stroke in these patients and also they showed risk-reduction strategies (reperfusion therapy, acetylsalicylic acid, P2Y12 inhibitors and statins) reduced stroke risk in post-AMI patients especially in patients with diabetes.

Our study shows that congestive heart failure is the strongest predictor of CVA after AMI. Heart failure and reduced left ventricular ejection fraction have been associated with increased risk of stroke [22], likely through the increased risk of intra-cardiac thrombus formation[23] and embolic potential of these thrombi[24]. Similar to heart failure, atrial fibrillation is a known risk of development of intracardiac thrombi.[25,26] Not surprisingly our study showed that patient who had atrial fibrillation were at increased risk of CVA; therefore, pre-existing heart failure, reduction in left ventricular ejection fraction post AMI and atrial fibrillation would be expected to be associated with an increased risk of CVA. We showed a 16% of atrial fibrillation occurrence in patients who admitted for AMI. Although our rate of atrial fibrillation is lower than 22% in Rathore et al.[8] study; these differences maybe due to age differences in our respective study populations. Rathore et al included patients with age over 65 and additionally found even higher incidence of atrial fibrillation with increasing age in patients who admitted for AMI. We also found that substance abuse; including alcohol abuse and cocaine abuse/ dependence were associated with post-MI CVA. As expected, the rate of cocaine use was low (0.86%) considering the majority of these patients are elderly. In more detail we found that of these patients; 16% were continues user, 3% were episodic user and 9% were in remission and 72% unspecified. To our knowledge there is no study that evaluated effect of alcohol abuse and cocaine use in post-MI CVA.

Considering MI-type, our study showed that STEMI was associated with higher risk overall CVA, ischemic and hemorrhagic stroke compared with NSTEMI. Interestingly, NSTEMI was a significant risk factor of TIA. Other studies have shown ischemic strokes are the predominant type of stroke seen in patients with NSTEMI, whereas ICH constituted a significant proportion of strokes after thrombolysis for STEMI[27]. Witt et al.[17] showed that anterior MI is a predictor risk factor of post-MI stroke. In our sensitivity analysis, we similarly found a relationship between anterior wall MI and higher risk for stroke (AOR, 1.16; 95% CI, 1.10–1.22; p=0.001). Anterior-wall location of MI has historically been considered a surrogate marker for potential focal dyskinesia leading to left ventricle aneurysm or thrombus complication, which some estimate occurs in approximately one-third of individuals within the first 2 weeks following an anterior MI.[28] Echocardiographic studies have shown that majority of patients with visible mural thrombi have had an anterior infarction, whereas patients with good left ventricular function and inferior infarction rarely had detectable thrombi. The presence of mural thrombi was associated with an increased risk of peripheral embolization and stroke.[29]

Considering CVA risk following procedures, our study showed that CABG was significantly associated with higher risk of overall and ischemic stroke (Table 4). Also, we found cardiac catheterization (diagnostic or interventional) was associated with a reduced risk of all typed of CVA in AMI patients. Similarly, Kajermo et al.[30] in evaluation of risk factors of ischemic stroke in AMI patients found CABG (AOR, 1.64; 95% CI: 1.32–2.03; P<0.001) as a risk factor of stroke and percutaneous coronary intervention (AOR, 0.69; 95% CI: 0.62–0.76; P<0.001) as a predictor of reduced risk of stroke in these patients. In addition, Uchechukwu et al.[18] in a study evaluating risk factors of stroke in AMI patients found the use of percutaneous coronary intervention was a negative risk of stroke (AOR, 0.64; 95%CI: 0.48–0.85; P=0.002).

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Limitations

There are limitations to this study are related to the use of an administrative database. The NIS database is compiled from discharge abstract data and is limited to in-hospital data without many clinical variables including outpatient follow-up data. For example, any CVA occurring after discharge would not be captured in this database. Therefore, the rate of CVA post-AMI likely underestimates the true CVA rate. In addition, we were unable to capture patients with AMI who may suffered pre-hospital death or did not have access to health care (e.g. not having medical insurance or living in rural countryside). Considering an improvement in the diagnosis technologies during past few years, CVA has been diagnosed much better by sensitive MRI. Therefore current incidence of CVA after AMI might be higher than the reported rate in this study. Additionally, knowledge of medications in this patient population would be helpful in identifying the effect of various medication classes in outcomes. However, there is very limited data on medications of this patient population in this database, especially treatments with anti-thrombotic agents and anti-platelet agents; therefore, we are unable to evaluate the effect of medications in the outcomes. Although 1.53% of patients in this study received thrombolytic agent, we were unable to clarify the indications for using these agents (myocardial infarction vs. ischemic stroke). Therefore, we did not evaluate the effect of thrombolytics in stroke in this patient population. Also, we were unable to identify, the mean time of stroke onset after admission which could help clinician in predicting and being more suspicious for this complication in this patient population. In addition, we couldn’t determine the severity of stroke or post-discharge dependence status in patients who experienced CVA. Lastly, we were unable to determine history of previous CVA or AMI which has been shown as a risk factor of stroke following AMI.[17] Despite these limitations, this study is the largest to date to evaluate factors predictive of CVA in AMI.

In conclusion, our study showed that CVA following AMI occurs in a small number of patients; however, it is associated with much higher morbidity and mortality. Also, we identified multiple risk factors of CVA after AMI. Our better understanding of high risk group can help in improving patients safety with risk factor modification and employing a high clinical suspicion in early diagnosis and early treatment of this high risk patient population.

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Table 1

Characteristics of patients admitted with acute myocardial infarction (AMI) (2006–2008) and those with CVA following AMI

	AMI			Post AMI CVA			
	All	**NSTEMI**	**STEMI**	**ALL**	**Ischemic**	**Hemorrhagic**	**TIA**
Number of Patients (frequency)	1,924,413 (100%)	1,200,833 (62.4%)	733,580 (37.6%)	38,577 (2.0%)	28,379 (1.47%)	4,107 (0.35%)	6,676 (0.21%)
Age group							
≤40	2.8	2.36	3.77	0.99	1.13	0.39	0.73
41–64	39.7	33.41	46.47	21.10	21.17	28.13	16.12
≥ 65	57.5	64.24	49.76	77.92	77.70	71.48	83.15
Mean age (year)	67.6	69.25	64.85	72.38	74.27	72.47	76.10
Median (year)	68	70	64	77	77	82	82
Sex (%)							
Male	60	56.83	64.73	46.14	45.75	45.38	56.93
Female	40	43.17	35.27	53.86	54.25	54.62	43.07
Race (%)							
White	77.7	76.55	79.57	75.73	75.19	74.54	78.80
Black	9.1	10.09	7.49	11.64	12.34	9.64	9.68
Hispanic	7.1	7.25	6.80	7.01	6.72	9.19	6.79
Asian	2.2	2.22	2.09	2.13	2.25	2.98	1.31
Native American	0.7	0.73	0.68	0.65	0.64	0.56	0.71
Other	3.2	3.16	3.36	2.84	2.86	3.09	2.72
Comorbidity (%)							
Diabetes mellitus	32.1	35.44	26.48	32.82	32.35	29.24	35.02
Hypertension	63.2	66.81	57.22	37.82	60.98	58.84	69.27
Atrial fibrillation	16	18.62	13.18	28.27	29.84	24.02	24.66
Congestive heart failure	0.8	0.87	0.82	2.14	2.54	2.59	0.37
Chronic pulmonary disease	20.5	22.87	16.62	20.08	20.37	18.27	19.53
Liver disease	1.0	1.03	0.81	1.06	1.04	1.41	0.86
Chronic kidney disease	15.7	19.26	9.81	20.39	21.14	19.20	17.84
Alcohol abuse	2.6	2.46	2.83	2.81	3.13	3.57	0.99
Peripheral vascular disease	10.1	11.71	7.49	12.86	12.61	9.81	16.01

	AMI			Post AMI CVA			
	All	**NSTEMI**	**STEMI**	**ALL**	**Ischemic**	**Hemorrhagic**	**TIA**
Hyperlipidemia	50.1	50.39	49.44	32.15	29.96	29.78	43.11
Obesity	9.4	9.76	8.71	5.55	5.49	4.83	6.03
Smoker	30.5	27.25	35.58	14.27	13.56	14.03	17.23
Cocaine abuse	0.9	0.82	0.93	0.67	0.73	0.77	0.29
Anemia	13.5	15.52	10.12	16.29	16.38	13.84	17.27
Length of hospital stay (day)							
Mean	5.0	5.24	4.73	9.60	10.55	9.23	6.06
Median	3.0	4	3	7.0	8.0	6.0	4.0
Hospitals (%)							
Teaching	48	48.66	53.61	46.30	46.73	54.01	39.92
Non-teaching	52	51.34	46.39	53.70	53.27	45.99	60.08

*STEMI: ST elevation myocardial infarction; NSTEMI: non-ST elevation myocardial infarction; TIA: transient ischemic attack

Table 2

Frequency of overall and types of cerebrovascular accident (CVA) in acute myocardial infarction and sub-types types (Non-ST elevation [STEMI] and ST elevation [STEM])

Types	CVA	Ischemic	TIA	Hemorrhagic
Overall (%)	2.0	1.47	0.35	0.21
NSTEMI (%)	2.12	1.55	0.42	0.18
STEMI (%)	1.82	1.36	0.23	0.26

Table 3

Characteristics and outcomes of patients with or without cerebrovascular (CVA) following acute myocardial infarction (AMI)

Characteristics and outcomes	With CVA	Without CVA	P-value
Mean age (years)	74.4	67.4	<0.01
Female (%)	39.9	54.1	<0.01
Congestive heart failure (%)	2.14	0.57	<0.01
Atrial fibrillation/ flutter (%)	28.3	16.3	<0.01
In-hospital mortality (%)	19.6	5.8	<0.01
Mean length of hospital Stay (days)	9.5	5.0	<0.01
Mean total hospital charges ($)	80,107	55,088	<0.01

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Table 4

Predictive risk factors of CVA following myocardial infarction

Characteristics	All CVA N=38,577 (2%) Odds (95%CI)	Ischemic N=28,379 (1.47%) Odds (95%CI)	TIA N=6,676 (0.35%) Odds (95%CI)	Hemorrhagic N=4,107 (0.21%) Odds (95%CI)
Age Group				
≤40	0.65 (0.58–0.74)*	0.74 (0.65–0.85)*	0.73 (0.53–1.1)	0.23 (0.14–0.37)*
41–64	Reference	Reference	Reference	Reference
≥65	1.65 (1.60–1.70)*	1.62 (1.56–1.88)*	2.50 (2.30–2.72)*	1.05 (0.96–1.15)
Gender				
Male	Reference	Reference	Reference	Reference
Female	1.32 (1.29–1.35)*	1.34 (1.30–1.38)*	1.48 (1.34–1.50)*	1.01 (0.93–1.08)
Race				
White	Reference	Reference	Reference	Reference
Black	1.35 (1.30–1.40)*	1.44 (1.38–1.51)*	1.12 (1.02–1.23)*	1.0 (0.88–1.13)
Hispanic	1.08 (1.03–1.13)*	1.04 (0.98–1.10)	1.02 (0.92–1.14)	1.37 (1.21–1.57)*
Asian\Pacific Islander	0.99 (0.92–1.08)	1.08 (0.98–1.18)	0.62 (0.49–0.79)*	1.25 (1.01–1.57)*
Native American	1.04 (0.90–1.20)	1.01 (0.85–1.20)	1.14 (0.83–1.58)	0.89 (0.56–1.43)
Comorbities				
No comorbidity	Reference	Reference	Reference	Reference
Atrial fibrillation	1.43 (1.39–1.46)*	1.52 (1.48–1.58)*	1.18 (1.11–1.26)*	1.13 (1.04–1.13)*
Diabetes mellitus	0.98 (0.96–1.01)	1.01 (0.97–1.03)	1.02 (0.96–1.08)	0.80 (0.74–0.87)*
Hypertension	1.02 (0.99–1.05)	1.01 (0.98–1.03)	1.20 (1.12–1.27)*	1.05 (0.97–1.13)
Congestive heart failure	1.71 (1.58–1.84)*	1.89 (1.74–2.06)*	0.64 (0.48–0.86)	2.04 (1.65–2.52)*
Chronic pulmonary disease	0.83 (0.80–0.85)*	0.84 (0.81–0.90)*	0.78 (0.73–0.84)*	0.82 (0.74–0.90)*
Liver disease	1.12 (1.01–1.26)	1.12 (0.98–1.27)	0.83 (0.60–1.42)	1.23 (0.92–1.65)
Chronic kidney disease	0.95 (0.92–0.98)	0.97 (0.94–1.01)	0.83 (0.77–0.89)*	0.99 (0.90–1.09)
Alcohol abuse	1.60 (1.49–1.73)*	1.78 (1.64–1.93)*	0.68 (0.52–0.89)*	1.67 (1.36–2.03)*
Peripheral vascular disease	1.26 (1.22–1.30)*	1.25 (1.21–1.31)*	1.44 (1.33–1.55)*	0.93 (0.82–1.05)
Hyperlipidemia	0.64 (0.63–0.66)*	0.60 (0.58–0.62)*	0.91 (0.86–0.96)*	0.58 (0.53–0.62)*
Obesity	0.79 (0.75–0.83)*	0.79 (0.74–0.84)*	0.79 (0.70–0.89)*	0.79 (0.67–0.93)*
Smoker	0.66 (0.64–0.69)*	0.63 (0.61–0.66)*	0.86 (0.80–0.93)*	0.59 (0.53–0.66)*
Cocaine abuse	1.48 (1.29–1.70)*	1.56 (1.34–1.82)*	1.08 (0.69–1.71)	1.13 (0.76–1.66)
Anemia	0.95 (0.92–0.98)	0.98 (0.95–1.02)	0.91 (0.84–0.98)*	0.82 (0.74–0.91)*
MI –type				
NSTEMI	Reference	Reference	Reference	Reference
STEMI	1.17 (1.14–1.20)*	1.18 (1.14–1.22)*	0.81 (0.76–0.86)*	1.89 (1.75–2.04)*
Teaching status of hospital				
Non-teaching	Reference	Reference	Reference	Reference

Characteristics	All CVA N=38,577 (2%) Odds (95%CI)	Ischemic N=28,379 (1.47%) Odds (95%CI)	TIA N=6,676 (0.35%) Odds (95%CI)	Hemorrhagic N=4,107 (0.21%) Odds (95%CI)
Teaching	1.09 (1.06–1.12)*	1.08 (1.05–1.11)*	0.87 (0.83–0.92)*	1.72 (1.61–1.86)*
Diagnostic cardiac cath				
No	Reference	Reference	Reference	Reference
Yes	0.70 (0.68–0.72)*	0.78 (0.69–0.74)*	0.82 (0.77–0.88)*	0.48 (0.44–0.53)*
PTCA[1]				
No	Reference	Reference	Reference	Reference
Yes	0.54 (0.52–0.56)*	0.55 (0.53–0.58)*	0.48 (0.44–0.53)*	0.57 (0.51–0.64)*
CABG[2]				
No	Reference	Reference	Reference	Reference
Yes	1.22 (1.17–1.27)*	1.40 (1.34–1.47)*	0.81 (0.73–0.91)*	0.49 (0.41–0.59)*

*P<0.003 and considered significant; PTCA: percutaneous transluminal coronary angioplasty; CABG: coronary artery bypass graft