National trends in stroke after acute myocardial infarction among Medicare patients in the United States: 1999 to 2010

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Background Stroke is a common and important adverse event after acute myocardial infarction (AMI) in the elderly. It is unclear whether the risk of stroke after AMI has changed with improvements in treatments and outcomes for AMI in the last decade.

Methods To assess trends in risk of stroke after AMI, we used a national sample of Medicare data to identify Fee-for-Service patients (n = 2,305,441) aged ≥65 years who were discharged alive after hospitalization for AMI from 1999 to 2010.

Results We identified 57,848 subsequent hospitalizations for ischemic stroke and 4,412 hospitalizations for hemorrhagic stroke within 1 year after AMI. The 1-year rate of ischemic stroke decreased from 3.4% (95% CI 3.3%-3.4%) to 2.6% (2.5%-2.7%; $P < .001$). The risk-adjusted annual decline was 3% (hazard ratio, 0.97; [0.97-0.98]) and was similar across all age and sex-race groups. The rate of hemorrhagic stroke remained stable at 0.2% and did not differ by subgroups. The 30-day mortality for patients admitted with ischemic stroke after AMI decreased from 19.9% (18.8%-20.9%) to 18.3% (17.1%-19.6%) and from 48.3% (43.0%-53.6%) to 45.7% (40.3%-51.2%) for those admitted with hemorrhagic stroke. We observed a decrease in 1-year mortality from 37.8% (36.5%-39.1%) to 35.3% (33.8%-36.8%) for ischemic stroke and from 66.6% (61.4%-71.5%) to 60.6% (55.1%-65.9%) for hemorrhagic stroke.

Conclusions From 1999 to 2010, the 1-year risk for ischemic stroke after AMI declined, whereas the risk of hemorrhagic stroke remained unchanged. However, 30-day and 1-year mortality continued to be high. (Am Heart J 2015;169:78-85.e4.)

Elderly patients have an elevated risk of acute myocardial infarction (AMI) and stroke. The vast majority of AMI and strokes occur in the Medicare population, and AMI is a key risk factor for subsequent stroke.[1,2] As the population in the United States ages, the risk of stroke after AMI could be expected to increase. However, other factors may counterbalance the effect of this demographic change. Extensive national efforts to improve processes of care and outcomes for AMI, which resulted in reductions in AMI hospitalization and mortality rates,[3,4] might also reduce the risk of stroke after AMI. Improved secondary prevention with statins and antiplatelet therapy to avoid adverse events after AMI could also contribute to risk reduction.[5-12] Moreover, the trends in revascularization treatments, such as the increase in rates of percutaneous coronary intervention (PCI) and the decline in rates of coronary artery bypass graft (CABG) surgery,[13,14] may impact the risk of stroke. Conversely, the greater use of antiplatelet agents recommended by recent guidelines intended to reduce the risk of ischemic stroke, such as clopidogrel and aspirin, could increase the risk of hemorrhagic stroke.[15-18] Surveillance studies using contemporary national data are needed to evaluate whether the risk of stroke after AMI has changed over the last decade.[19]

To better understand changes in the incidence of stroke after AMI, we used 100% Medicare Fee-For-Service inpatient

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Table I. Patient characteristics, 1999 to 2010

	1999*	2000	2004	2005	2009	2010
Total, no.	190,745	197,916	207,584	200,092	169,716	169,863
Age, mean (SD)	78.6 (7.8)	78.8 (7.8)	78.8 (8.1)	78.9 (8.2)	78.8 (8.6)	78.8 (8.6)
Female, n (%)	97398 (51.1)	102061 (51.6)	105022 (50.6)	100186 (50.1)	83214 (49.0)	82915 (48.8)
White, n (%)	169698 (89.0)	175784 (88.8)	182244 (87.8)	175552 (87.7)	148338 (87.4)	148211 (87.3)
Black, n (%)	13451 (7.1)	14148 (7.1)	15583 (7.5)	15097 (7.5)	13409 (7.9)	13441 (7.9)
Other, n (%)	7596 (4.0)	7984 (4.0)	9757 (4.7)	9443 (4.7)	7969 (4.7)	8211 (4.8)
Atherosclerosis, n (%)	130343 (68.3)	138158 (69.8)	152343 (73.4)	147186 (73.6)	125652 (74.0)	125929 (74.1)
Respiratory failure, n (%)	4798 (2.5)	5333 (2.7)	6029 (2.9)	6049 (3.0)	8126 (4.8)	8466 (5.0)
Hypertension, n (%)	101361 (53.1)	108999 (55.1)	124539 (60.0)	120195 (60.1)	112716 (66.4)	113563 (66.9)
Renal failure, n (%)	8049 (4.2)	9335 (4.7)	13988 (6.7)	14767 (7.4)	21803 (12.8)	22986 (13.5)
Home, n (%)	119406 (62.6)	122708 (62.0)	115209 (55.5)	111251 (55.6)	94702 (55.8)	95123 (56.0)
Homecare, n (%)	25560 (13.4)	25729 (13.0)	33006 (15.9)	31214 (15.6)	26645 (15.7)	27008 (15.9)
ICF/SNF, n (%)	36242 (19.0)	38198 (19.3)	42555 (20.5)	41419 (20.7)	33434 (19.7)	32953 (19.4)
Hospice, n (%)	191 (0.1)	396 (0.2)	4152 (2.0)	4602 (2.3)	5770 (3.4)	5775 (3.4)
Length of stay, mean (SD)	7.2 (6.2)	7.1 (6.2)	6.7 (6.2)	6.5 (6.0)	5.8 (5.4)	5.6 (5.3)
Days to readmission, Mean (SD)	142 (108)	141 (109)	138 (108)	139 (109)	138 (109)	142 (110)

Abbreviation: *ICF/SNF*, intermediate care facility/skilled nursing facility.
*Data and the comorbidities that increased by ≥5 absolute percentage points over the study period are reported for 1999, 2000, 2004, 2005, 2009, and 2010 for display purposes (see online Appendix Supplementary Table I for all comorbidities).

data from the Centers for Medicare & Medicaid Services (CMS) to characterize temporal trends in the risk for ischemic and hemorrhagic stroke within 1 year after hospitalization for AMI from 1999 to 2010. We also evaluated whether these trends varied by patient age, sex, race, and major surgical treatment subgroups (ie, PCI and CABG). Because of the remarkably high incidence of stroke in the southeastern United States, known as the Stroke Belt, we also examined whether patients who resided in that region also had high risk for strokes after AMI.

Methods

Study sample

We used CMS Medicare Provider Analysis and Review files to identify all Medicare Fee-For-Service patients, aged ≥65 years, who were discharged alive from acute care hospitals with a principal discharge diagnosis of AMI (*International Classification of Diseases, Ninth Revision, Clinical Modification* [*ICD-9-CM*] codes 410.xx except 410.x2) between January 1, 1999, and December 31, 2010. If a patient had ≥1 AMI hospitalization within a year, we randomly selected 1 of these hospitalizations. We used the Medicare denominator file to determine patients' eligibility and enrollment status in Medicare and to obtain patients' death information. We included patients who had participated for ≥12 months in Medicare Fee-For-Service after the index AMI discharge.

Outcomes

Our primary outcome was the 1-year rate of hospitalization for stroke among survivors of an AMI. The 1-year follow-up started from the date of discharge from the hospitalization for AMI. Consistent with prior studies, we classified strokes as ischemic (*ICD-9-CM* code 433.xx, 434.xx, or 436.xx) or hemorrhagic (*ICD-9-CM* codes 430.xx or 431.xx).[20,21] Secondary outcomes were 30-day and 1-year all-cause mortality for patients hospitalized for stroke within a year of a hospitalization for AMI. We calculated rates of mortality for ischemic and hemorrhagic stroke separately, using the date of admission for stroke as "time zero."

Patient characteristics

We used Medicare Provider Analysis and Review data to identify covariates that reflect patient demographic characteristics (age, sex, and race [white, black, and other races]), comorbidities, revascularization, and region of residence. Comorbidities were based on the principal and secondary diagnoses during the 12 months before the index hospitalization using the CMS Hierarchical Condition Categories (online Appendix Supplementary).[7,22-27] We also identified whether patients received revascularization during the index AMI hospitalization with PCI only, CABG only, or both PCI and CABG. We defined residence in the Stroke Belt region as primary residence in Alabama, Arkansas, Georgia, Indiana, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, or Virginia, applying the definition used by the Stroke Belt initiative of the National Heart, Lung, and Blood Institute.[28]

Statistical analysis

We described the baseline characteristics of patients hospitalized for AMI for each year from 1999 through 2010 using the Cochran-Armitage trend test to examine the significance of trends. We then fit a Cox proportional hazards model to assess the annual trends in the 1-year rate of stroke after AMI, adjusting for age, sex, race, and comorbidities. We fit separate Cox models for age and