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Costs of Hospitalization for Stroke Patients Aged 18-64 Years in the United States

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Abstract

Background—Estimates for the average cost of stroke have varied 20-fold in the United States. To provide a robust cost estimate, we conducted a comprehensive analysis of the hospitalization costs for stroke patients by diagnosis status and event type.

Methods—Using the 2006-2008 MarketScan inpatient database, we identified 97,374 hospitalizations with a primary or secondary diagnosis of stroke. We analyzed the costs after stratifying the hospitalizations by stroke type (hemorrhagic, ischemic, and other strokes) and diagnosis status (primary and secondary). We employed regressions to estimate the impact of event type and diagnosis status on costs while controlling for major potential confounders.

Results—Among the 97,374 hospitalizations (average cost: \$20,396 ± \$23,256), the number with ischemic, hemorrhagic, or other strokes was 62,637, 16,331, and 48,208, respectively, with these types having average costs, in turn, of \$18,963 ± \$21,454, \$32,035 ± \$32,046, and \$19,248 ± \$21,703. A majority (62%) of the hospitalizations had stroke listed as a secondary diagnosis only. Regression analysis found that, overall, hemorrhagic stroke cost \$14,499 more than ischemic stroke (P <.001). For hospitalizations with a primary diagnosis of ischemic stroke, those with a secondary diagnosis of ischemic heart disease (IHD) had costs that were \$9836 higher (P < .001) than those without IHD.

Conclusions—The costs of hospitalizations involving stroke are high and vary greatly by type of stroke, diagnosis status, and comorbidities. These findings should be incorporated into cost-effective strategies to reduce the impact of stroke.

Keywords

Cost; stroke type; diagnosis type; comorbidity

Introduction

In 2008, stroke still accounted for about 1 of every 18 deaths in the United States, and it was the nation's fourth leading causes of death.[1] Not surprisingly, stroke is a leading cause of

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serious long-term disability in the United States and other nations.[2-5] Consistent with the huge health burden, stroke imposes enormous economic costs. For example, in the United States, the direct medical cost of stroke in 2008 was estimated to be $18.8 billion, and for the same year, the estimated per-person expenditure for stroke care was $7657.[6] Going forward, the total cost of stroke for the period of 2005-2050 (in 2005 dollars) has been projected at a staggering $1.52 trillion for non-Hispanic whites, $313 billion for Hispanics, and $379 billion for blacks (the single highest contributor being loss of productivity).[7] Moreover, a forecast from the American Heart Association (AHA) suggests that the direct medical cost of stroke will increase 238% from 2010 to 2030, a higher percentage increase than that predicted for any other cardiovascular disease, including hypertension, coronary heart disease, or heart failure.[8] The AHA study predicted that the indirect costs of stroke will increase 73% during the same time period, a percent increase second only to the 80% projected for heart failure among the cardiovascular diseases.[8] Given these daunting figures, it is rather surprising that a systematic literature review published in 2010 found few recent studies on the costs associated with stroke.[9]

The incidence of stroke increases with age, and we know that many investigators have conducted studies of the health and economic burden of this disease among persons aged 65 years or older.[10-15] However, a significant proportion of all strokes occur in “younger” people, that is, those below 65.[16-18] In fact, by 2050, about half of stroke-related costs in the United States, including treatment, rehabilitation, and lost productivity, may be associated with victims under the age of 65.[7] It follows that having a better understanding of stroke among patients below 65 could help to improve the design of programs to prevent this disease.[19] Furthermore, focusing on prevention within this younger age group can be expected to reduce the health and economic burdens imposed by our aging society, increase quality of life in the later years, lower the indirect costs of stroke from lost productivity in the working-age group, and reduce stress on affected family members.[20-22]

To date, most researchers have focused primarily on the costs of hospitalization as they account for about one-half of the direct costs of stroke.[14,23,24] Unfortunately, information on hospitalization costs categorized by the status of the diagnosis (primary versus secondary) and the stroke type (ischemic, hemorrhagic, ill-defined, late effects) is lacking. Furthermore, a review article found that for over 60% of the stroke-related hospitalizations, stroke was a secondary diagnosis and, further, that treatment approaches differed across types of stroke. From this information, one can conclude that hospitalization costs estimated without considering the diagnosis status and stroke type may be misleading.[25] In the present study, we investigated hospitalization costs by detailed diagnosis status and type of stroke using a large administrative data set while controlling for major demographic variables, including age, sex, and geographic regions.

Methods

Study Population

For this study, we relied on the 2006-2008 MarketScan Commercial Claims and Encounter (CCAE) database that contains information on inpatients in the United States who were members of any of the more than 100 health insurance plans offered by about 40 large employers in the 50 states or the District of Columbia. In addition to major sociodemographic information, the database contains comprehensive, high-quality coding of medical conditions and of hospitalization costs based on payments to providers for a large sample of patients.[26] The CCAE data have been used by many researchers to estimate the medical costs of cardiovascular diseases.[27-31]

To identify stroke-related hospitalizations with a primary or secondary diagnosis of stroke, we searched the data using the International Classification of Diseases, Ninth Revision (*ICD-9*), codes, which included hemorrhagic, ischemic, and "other" stroke, among patients aged 18-64 years who were enrolled in noncapitated health insurance plans (Table 1). We excluded patients younger than 18 years because of their low prevalence of stroke, and we excluded patients older than 64 years because the CCAE data were for people with employer-sponsored health insurance plans. We excluded patients with capitated plans because their costs of hospitalization would not reflect all the medical services provided to them. To limit the influence of extreme values, we excluded those hospitalizations with costs below the 1st or above the 99th percentile in their year of admission. Hospitalization costs (expressed in 2008 dollars) were defined as the total aggregated payments to providers, including the payments for all diagnostic tests, therapeutics, supplies, and room fees. We adjusted the costs of 2006 and 2007 hospitalizations to 2008 dollars using medical care component of the US Consumer Price Index.[32]

We analyzed the hospitalization costs by diagnosis status (primary versus secondary) and event type: ischemic, hemorrhagic, and other stroke. The last category included ill-defined and late effects of stroke. Ideally, costs would be analyzed separately for ill-defined strokes and late effects, but our data indicated that costs were almost identical for the 2 types. Accordingly, we pooled these 2 categories for simplicity. Among hospitalizations in which stroke was the secondary diagnosis, we examined the 5 most frequent primary diagnoses, which were transient cerebral ischemia (codes 435), ischemic heart disease (IHD, codes 410-414), cases involving the use of rehabilitation procedures (code V57), general symptoms (codes 780), and subarachnoid, subdural, or extradural hemorrhage following injury (code 852). We also used *ICD-9* codes to identify 3 common comorbidities of hypertension (codes 401-405), IHD (codes 410-414), and diabetes (code 250) for stroke as a primary diagnosis.

Statistical Analysis

After we first derived the mean costs of hospitalization by diagnosis status and event type, we specified 6 multivariate regression models for the cost analysis. These models examined costs for (1) stroke as a primary or secondary diagnosis, (2) stroke as a primary diagnosis including those with both a primary and secondary diagnosis of stroke, (3) stroke as a secondary diagnosis only (excluding those with a primary diagnosis), (4) ischemic stroke, (5) hemorrhagic stroke, and (6) other stroke. We also used logistic regression to investigate the factors associated with the diagnosis status. Because our data were for admissions and, thus, were not at the level of individual patients, a patient included in the study might have had more than 1 admission during the 3-year period. To account for this, we estimated the regression models using mixed-effects models with repeated-measure approaches. We noted that data on medical costs are usually skewed and not normally distributed, especially for population-level data covering many persons with either zero or very low costs and a few with very large costs, and thus, many researchers have used log transformation in their regression analyses. We did not log-transform the costs for our analysis, however, because of the difficulties in interpreting the results. In addition, many other studies[33,34] have not used the log-transformation procedure. Beyond possible difficulties in interpretation, our decision to not transform the data is supported by our very large sample and our exclusion of hospitalizations with a cost below the 1st or above 99th percentile to avoid the effects of outliers. All the statistical analyses were performed using the SAS version 9.1.[35]

Results

We identified 97,374 hospitalizations with a primary or secondary diagnosis of stroke, with 37,305 (38%) having a primary diagnosis (including those with both a primary and secondary diagnosis of stroke) and the remaining 60,069 (62%) with a secondary diagnosis of this event. The mean per-admission costs were $20,396 for a primary or secondary diagnosis, $19,836 for a primary diagnosis, and $20,744 for a secondary diagnosis (Table 2). By event type, 62,637 hospitalizations (64% of all hospitalizations) included an ischemic stroke, 16,331 (17%) a hemorrhagic stroke, and 48,208 (50%) an other stroke (The percentages sum to over 100% because of overlapping of primary and secondary diagnosis by stroke types). Per-admission costs for these 3 kinds of stroke (primary or secondary diagnosis, Table 2) were $18,963, $32,035, and $19,248, respectively. For both hemorrhagic and other strokes, the costs were higher for those with a primary diagnosis than for those with a secondary diagnosis, whereas the opposite was true for ischemic stroke. Overall (ie, primary or secondary diagnosis), neither age nor sex was significantly associated with per-admission costs, but there were some clear patterns for age and sex by diagnosis status and stroke types. For example, among those with a primary diagnosis of stroke, the costs were higher for younger patients (18-44 years) than for older (45-64). Costs were higher for female than for male patients if the stroke was listed as a primary diagnosis, but the opposite was true if the stroke was a secondary diagnosis. For ischemic stroke, men had higher costs than women, but the reverse was true for hemorrhagic stroke. By region, per-admission costs were highest in the West for all 6 categories (3 for diagnosis status, 3 for types of stroke) but were very similar in the other 3 regions.

In the regression analysis, age was not significantly associated with costs overall, but costs were significantly higher for younger patients than for older patients if the stroke was a primary diagnosis or if it was hemorrhagic or an other stroke (Table 3). Confirmed the findings in Table 2, costs for men were significantly higher than those for women if the stroke was a secondary diagnosis or if it was ischemic, whereas the opposite was true if the stroke was a primary diagnosis after controlling for major confounders.

Overall, having hypertension or diabetes as a comorbidity was negatively associated with costs, whereas having IHD as a comorbidity significantly increased the costs. Compared with the costs of ischemic stroke, the costs of hemorrhagic stroke were significantly higher, especially for hospitalizations with a primary diagnosis of stroke ($20,352 higher, $P < .001$). Primary diagnosis status was negatively associated with costs for ischemic stroke and positively associated with costs for hemorrhagic and for other types of stroke. When stroke was a secondary diagnosis, having IHD as a primary diagnosis increased the costs by $21,196, whereas the primary diagnoses of transient cerebral ischemia, general symptoms, and subarachnoid, subdural, or extradural hemorrhage after injury were associated with lower costs.

For each type of stroke, regression results found that patients aged 45-64 years were more likely than younger patients to have it listed as their primary (versus secondary) diagnosis (Table 4). In addition, men were more likely than women to have ischemic stroke or other stroke listed as a primary diagnosis rather than a secondary diagnosis. Patients in urban areas were in all categories less likely to have their stroke listed as their primary diagnosis than were their rural counterparts. Compared with patients in the West, patients in the Northeast and North Central regions were less likely to have ischemic stroke listed as their primary rather than a secondary diagnosis, whereas patients in the South were more likely to have their hemorrhagic stroke listed as a primary diagnosis. Compared with ischemic stroke, both hemorrhagic and other stroke were more likely to be listed as a primary (rather than a secondary) diagnosis.

Discussion

Our study of hospitalizations involving stroke may be the very first large-scale, comprehensive cost analysis of such admissions by the type of stroke and diagnosis status (primary, secondary, or both). Our results should provide much-needed economic information for evaluating the cost effectiveness of programs for managing or preventing stroke. In this study, because stroke was a secondary diagnosis for 62% of the hospitalizations of interest and because costs varied greatly by the type of stroke, a presentation of cost estimates that did not consider diagnosis status and stroke type would have been misleading.[25] We found, for example, that hemorrhagic stroke, overall, cost far more (+$14,499) than ischemic stroke, and this difference was $20,352 when we looked at a primary stroke diagnosis only. When we examined stroke as a secondary diagnosis, we found, overall, that having a primary diagnosis of IHD drove up costs significantly (by $21,196). Even looking at IHD as a secondary diagnosis produced an overall estimate of $8984 in additional costs.

Our results suggest, first of all, that comprehensive stroke prevention programs might consider incorporating a component to improve the prevention or management of IHD. In addition, they might benefit by looking specifically at patients with a secondary stroke diagnosis to see what could have been done to reduce the costs of IHD in those cases where that was the primary diagnosis.

In terms of overall costs, our estimate for all patients was $20,396, and this did not differ a great deal when we looked at primary diagnosis ($19,836) or secondary diagnosis ($20,744). However, the costs were much higher for hospitalizations with a secondary stroke diagnosis than those with a primary stroke diagnosis if the stroke was ischemic ($21,713 versus $15,180, $P < .001$). On the other hand, the costs were much higher for hospitalizations with a primary stroke diagnosis than those with a secondary stroke diagnosis if the stroke was hemorrhagic ($36,176 versus $29,304, $P < .001$). These numbers send a strong message about the importance of better understanding on the costs of treating hospitalized patients with different types and diagnosis status of stroke.

In regression analysis, we found notable cost differences by age, sex, and geographic region. For example, younger people (aged 18-44 years) had significantly higher costs than our older group (aged 45-64 years) in 3 of 6 comparisons, whereas the older group never had significantly higher costs than the younger group. In 2 other US-based studies, Brinjiki et al[36,37] found that costs were higher in their younger group, but they grouped together all patients aged 64 years or younger. Still, the idea of analyzing costs by age seems valuable, especially if the analysis is extended to patients aged 50 or less or even, as in our study, using an upper boundary of 44 years. If consistent findings of greater costs for younger adults are found, they might well be used in the development of prevention programs that are buttressed by an economic rational.

Men in our study had significantly greater costs than women overall, for ischemic stroke, and for a secondary diagnosis, but perhaps surprisingly, they had significantly lower costs when primary diagnosis alone was considered. Matching this information with clinical and epidemiological data might eventually lead to sex-specific interventions that could be argued on economic grounds and pure outcomes. That the West had significantly higher costs than the other 3 regions on every comparison is remarkable, indeed, and deserves further examination.

The findings in this study relative to diagnosis status are intriguing. For example, for primary diagnosis, hemorrhagic and other types of stroke had significantly higher costs than ischemic stroke, but for secondary diagnosis, other stroke had significantly lower costs than ischemic, whereas hemorrhagic continued to have higher costs. Overall, having a primary (versus secondary) diagnosis of stroke was associated with lower costs, and this was true for ischemic stroke considered by itself. And yet, for hemorrhagic and for other stroke, the opposite was true, with the differential a substantial $8002 for hemorrhagic. These results, combined with those presented earlier, suggest that evaluations of the cost effectiveness of stroke programs should consider diagnosis status and event type.

That younger patients (aged 18-44 years) were less likely to be hospitalized with a primary diagnosis (versus a secondary diagnosis) of stroke than their older counterparts seems unsurprising, but the finding that urbanites were less likely than nonurban patients to have their stroke diagnosis be primary is somewhat puzzling and may deserve further investigation. Our other findings that are new to the field are as follows: male patients were more likely than female patients to be hospitalized with a primary (versus secondary) diagnosis of stroke, except for hemorrhagic stroke; compared with ischemic stroke, hemorrhagic stroke was more likely to be listed as a primary diagnosis; and compared with patients in West region, patients in the South were more likely to have their hemorrhagic stroke listed as a primary diagnosis. These findings may be helpful in identifying targets for stroke prevention and developing cost-effective interventions.

Our study had several limitations that may have affected the estimates or that should be considered in interpreting and applying our results. First, the study population was restricted to persons aged 18-64 years with employer-sponsored noncapitated health insurance. Because it left out the elderly population, which by age has the highest prevalence of stroke, and did not include people with other types of insurance, those who were in government programs, or the uninsured, the study does not apply to the broad US population. Second, we estimated hospitalization costs only. Because stroke is a leading cause of serious long-term disability, the costs of outpatient care and rehabilitation and the indirect costs associated with loss of productivity and informal care provided by the family should also be estimated to obtain a better understanding of the full economic burden of stroke, especially for the working-age population.[5,14,16,21,22] Clearly, our estimates of the hospitalization costs greatly understate the true economic burden of stroke. Third, as with all studies that rely on medical records, the issue of coding error must be considered. Other researchers have discussed the issue of misclassification or misdiagnosis of stroke. This issue may be more important for patients with a secondary diagnosis of stroke and for younger patients.[38,39] In other stroke, we included "ill-defined stroke" and "late effects of stroke," and more than 12% of primary stroke and 73% of secondary stroke were other. This high percentage of "other" stroke warrants further investigation and it also suggests a continued need for improvement in early response and prompt evaluation of stroke.[40,41] In addition, because stroke is less common in young adults than in the elderly population, misdiagnosis might have been a greater problem in our study group than it would have been in an older population, perhaps skewing the results to some degree. Therefore, the misdiagnosis issue can potentially lead to a lost opportunity for proper treatment.[38-41]

Finally, the data did not allow us to identify the hospitalizations as an initial admission or a readmission. Because recurrent strokes tend to leave patients with greater disability than they suffered from their first stroke, patients with recurrent strokes may have poorer outcomes than those with a first stroke. Correspondingly, recurrent stroke may be more costly than initial stroke.[42] Unfortunately, our results do not reflect the presumed cost differences in our study population between those with a first stroke and those with a second or later stroke. Still, regardless of the importance of these factors, the fact that we used a large sample, worked with high-quality coding data, and analyzed these data from several different angles suggests that our findings should have great utility and wide applicability.

Conclusions

This study indicates that the high costs of hospitalizations for patients with a stroke can be expected to vary by diagnosis status, event type, comorbidities, and demographic variables. Thus, reporting the average costs of stroke without account for these factors may be meaningless when assessing the cost effectiveness of stroke interventions.[25] A finding of particular interest from this study is that a primary diagnosis of IHD in patients with a secondary diagnosis of stroke was tied to enormous economic costs. More broadly, we hope that our detailed cost information on patients with stroke could be used to develop cost-effective programs for preventing this epidemic while simultaneously reducing selection bias in the economic analysis of secondary health data on stroke. In addition, because stroke is the leading cause of serious long-term disability in the United States,[2] more studies on the long-term medical expenses for both nursing home and ambulatory care and on indirect costs from lost productivity and the provision of informal care are needed.[9,43] Such information should further underscore the need for effective preventive therapies, timely critical care, and well-designed rehabilitation programs to contain stroke-related health care costs and to enhance the quality of life of our aging society.

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Table 1

Diagnosis codes for stroke and its comorbidities for patients aged 18-64 years

Diagnosis groups	***ICD-9* code**
Stroke	430.xx-434.xx, 436.xx-438.xx
Hemorrhagic	430.xx-432.xx
Ischemic	433.xx-434.xx
Other	436.xx-438.xx
Comorbidity	
Hypertension	401.xx-405.xx
Ischemic heart disease	410.xx-414.xx
Diabetes	250.xx

Abbreviation: *ICD-9, International Classification of Diseases, Ninth Revision*.

Table 2

Mean hospitalization costs ($) by diagnosis status and stroke type for patients aged 18-64 years in 2008 dollars, MarketScan CCAE inpatient data 2006-2008

	Mean costs ± SD (N)					
	Primary or secondary diagnosis	**Primary diagnosis**	**Secondary diagnosis**	**Ischemic**	**Hemorrhagic**	**Other strokes**
Overall	20,396 ± 23,256 (97,374)	19,836 ± 21,931 (37,305)	20,744 ± 24,036 (60,069)	—	—	—
Ischemic	18,963 ± 21,454 (62,637)	15,180 ± 14,160 (26,370)	21,713 ± 25,124 (36,267)	—	—	—
Hemorrhagic	32,035 ± 32,046 (16,333)	36,176 ± 35,182 (6490)	29,304 ± 29,483 (9841)	—	—	—
Other	19,248 ± 21,703 (48,208)	24,319 ± 27,103 (4532)	18,806 ± 21,569 (43,763)	—	—	—
Age (y)						
18-44	21,562 ± 25,291 (13,645)	24,589 ± 26,978 (4229)	20,202 ± 24,376 (9416)	18,663 ± 21,996 (6904)	32,309 ± 33,136 (3870)	20,573 ± 23,766 (6713)
45-64	20,206 ± 22,902 (83,729)	19,228 ± 21,123 (33,076)	20,845 ± 23,972 (50,653)	19,000 ± 21,386 (55,733)	31,949 ± 31,701 (12,461)	19,034 ± 21,343 (41,495)
Sex						
Male	21,210 ± 23,885 (50,519)	18,639 ± 20,442 (20,065)	22,904 ± 25,764 (30,454)	20,178 ± 22,546 (33,869)	31,153 ± 31,347 (8573)	19,224 ± 21,651 (23,644)
Female	19,518 ± 22,527 (46,855)	21,229 ± 23,469 (17,240)	18,522 ± 21,898 (29,615)	17,532 ± 19,998 (28,768)	33,009 ± 32,776 (7758)	19,271 ± 21,754 (24,564)
Region						
Northeast	20,659 ± 23,077 (7517)	20,279 ± 22,179 (2801)	20,885 ± 23,594 (4716)	18,860 ± 20,537 (4795)	32,401 ± 31,921 (1255)	19,349 ± 21,255 (3783)
North Central	20,012 ± 22,862 (30,581)	19,818 ± 21,880 (11,496)	20,128 ± 23,434 (19,085)	18,561 ± 20,918 (19,898)	31,658 ± 32,186 (5156)	18,809 ± 21,171 (14,694)
South	19,792 ± 22,591 (50,038)	19,124 ± 21,112 (19,467)	20,217 ± 23,475 (30,571)	18,584 ± 21,129 (32,364)	31,148 ± 31,341 (7963)	18,607 ± 20,935 (25,121)
West	24,728 ± 27,420 (9238)	23,456 ± 25,647 (3541)	25,519 ± 28,440 (5697)	22,685 ± 25,289 (5580)	36,399 ± 34,191 (1957)	24,058 ± 26,691 (4610)

Abbreviation: CCAE, MarketScan Commercial Claims and Encounter.

Table 3

Coefficient estimates of costs of stroke hospitalization for patients aged 18-64 years by diagnosis status and stroke type, MarketScan CCAE inpatient data 2006-2008

	Primary or secondary diagnosis	Primary diagnosis	Secondary diagnosis	Ischemic	Hemorrhagic	Other
Age (y)						
18-44	567.8	**2177.4**	−193.7	700.8	**2248.4**	**1825.9**
45-64	Ref	Ref	Ref	Ref	Ref	Ref
Male	**865.8**	**−1697.0**	**2369.8**	**1844.2**	−1369.3	−377.2
Urban	−161.6	623.0	−133.7	−193.3	−381.8	114.8
Region						
Northeast	−3899.8	**−2580.0**	**−4669.0**	−4348.9	−4538.0	−5071.1
North Central	−4486.7	−2861.5	−5597.2	−4605.5	−5933.7	−5260.8
South	−4475.8	−3449.1	−5085.2	−4444.5	−5882.2	−5252.2
West	Ref	Ref	Ref	Ref	Ref	Ref
CCI*	1548.1	**962.2**	1370.3	1862.7	1809.9	1457.6
Primary diagnosis						
Transient cerebral ischemia	—	—	**−10,357.0**	—	—	—
Ischemic heart disease	—	—	**21,196.0**	—	—	—
Care involving use of rehabilitation procedures	—	—	1003.4	—	—	—
General symptoms	—	—	**−9237.3**	—	—	—
Subarachnoid, subdural, or extradural hemorrhage following injury	—	—	**−3270.3**	—	—	—
Secondary diagnosis						
Hypertension	**−2129.8**	**702.4**	—	**−2503.7**	**−2042.0**	**−1681.2**
Ischemic heart disease	**8983.6**	**2010.5**	—	**9835.5**	1467.4	**3286.7**
Diabetes	**−3807.7**	**−3189.2**	—	**−4263.8**	**−5816.0**	**−4799.4**
Stroke type						
Hemorrhagic	**14,499.0**	**20,352.0**	**9135.5**	—	—	—
Other	193.5	**4259.8**	**−1794.0**	—	—	—
Ischemic	Ref	Ref	Ref	—	—	—
Primary vs. secondary diagnosis of stroke	−648.2	—	—	**−3195.5**	**8001.7**	**3476.2**

Abbreviation: CCI, Charlson Comorbidity Index; Ref, reference.

Values in bold indicate statistical significance ($P < .001$).

* CCI measures the likelihood of death or serious disability in the subsequent year by diagnosis codes for up to 18 different diseases.

Table 4

Odds ratios (95% confidence interval) of the predictors of stroke hospitalization as a first vs. second diagnosis

	Not including ischemic and hemorrhagic	Including ischemic and hemorrhagic	Ischemic	Hemorrhagic	Other
Age (y)					
18-44	.678 (.652, .705)	.623 (.598, .648)	.724 (.687, .762)	.540 (.500, .582)	.853 (.808, .899)
45-64	Ref	Ref	Ref	Ref	Ref
Male	1.120 (1.091, 1.149)	1.141 (1.112, 1.172)	1.214 (1.176, 1.253)	.835 (.784, .888)	1.156 (1.115, 1.199)
Urban	.852 (.824, .880)	.833 (.806, .861)	.856 (.823, .891)	.898 (.827, .975)	.906 (.864, .950)
Region					
Northeast	.963 (.904, 1.026)	.988 (.927, 1.053)	.902 (.834, .975)	1.042 (.902, 1.204)	1.029 (.943, 1.123)
North Central	.961 (.916, 1.009)	.991 (.944, 1.040)	.902 (.850, .958)	1.060 (.954, 1.179)	.982 (.918, 1.051)
South	1.024 (.978, 1.072)	1.055 (1.007, 1.105)	.999 (.943, 1.058)	1.252 (1.132, 1.385)	.956 (.897, 1.019)
West	Ref	Ref	Ref	Ref	Ref
CCI*	.950 (.944, .957)	.940 (.933, .946)	.948 (.940, .957)	1.005 (.991, 1.020)	1.021 (1.011, 1.031)
Stroke type					
Hemorrhagic	—	1.758 (1.696, 1.821)	—	—	—
Other	—	1.465 (1.426, 1.505)	—	—	—
Ischemic	—	Ref	—	—	—

Abbreviation: CCI, Charlson Comorbidity Index; Ref, reference.

* CCI measures the likelihood of death or serious disability in the subsequent year by diagnosis codes for up to 18 different diseases.