Economic Impact of Stroke-related Comorbid Conditions on the Treatment of Stroke: Analysis of Medicare Beneficiaries in the US

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Background and Objectives

- Each year, 700,000 people experience a stroke, of which 500,000 are first attacks.
- Ischemic strokes (IS) are most common, accounting for 88% of all strokes. Although intracerebral hemorrhage (ICH) and subarachnoid hemorrhage (SAH) are much less prevalent forms of stroke (9% and 3%, respectively), they have significantly higher mortality rates.[1]
- In a recent study, average per-patient Medicare expense for 4 years from initial event was $48,327 for SAH, $38,023 for ICH and $39,396 for IS.[2]
- Type 2 diabetes mellitus (type 2 DM) and hypertension are high-risk factors for stroke. Medical conditions associated with risk for stroke include metabolic syndrome[3], kidney disease (risk increases 5-10 fold)[4-6], depression, mood disorders[7], chronic headache, migraine[8,9] and cancer.[10]

Methods—Data source and approaches

- The analysis was based on data from the Centers for Medicare and Medicaid Services Medicare outcomes and care database, which have been used by multiple studies and provide reliable information on the medical needs, associated clinical outcomes, and healthcare costs of the elderly U.S. population (≥ 65 years).
- Medical claims and administrative data for a 5% random sample of Medicare beneficiaries followed longitudinally between 2002 and 2005 across multiple settings of care were identified.
- An analytical file was created from individual data files that contained medical services from settings including hospital inpatient and outpatient, emergency department, physician office, nursing facility, and home health settings. These data were linked longitudinally using encrypted unique patient identification numbers.
- Patients were selected for analysis based on a diagnosis of hemorrhagic stroke (HS) (ICD-9-CM code 430.xx for SAH and 431.xx for ICH) or IS (ICD-9-CM code 434.xx) in 2003. To capture new stroke cases, patients with any of the diagnoses in previous 4 quarters in an inpatient, emergency room, or an outpatient setting were excluded.
- Patients were divided into 2 stroke groups for HS and IS. The 2 stroke groups were stratified into 5 categories according to the presence or absence of coded co-morbidities (hypertension, type 2 DM, and congestive heart failure [CHF]) in the 4 quarters before the index event.
- Direct medical costs, including inpatient hospitalizations, outpatient care, physician visits, skilled care services, home healthcare, and rehabilitation were assessed from the Medicare perspective.
- Cost incurred in the 3 years after the index event was compared with 4 quarters prior to the index event.

Statistical Analysis

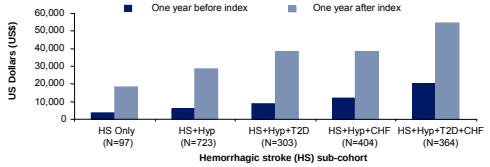
- Descriptive statistics were produced on baseline demographic characteristics and co-morbid conditions for HS and IS.
- The chi-square test of association was conducted for the analyses of categorical variables.
- For continuous variables, non-parametric Wilcoxon tests were performed, as the assumption of normality was untenable. Values of p<0.05 were considered statistically significant.
- Demographic statistics were stratified by the stroke/comorbidity subgroups, and pre-index and post-index event costs were compared.
- The difference between pre- and post-index event costs was calculated.
- The association between comorbid conditions and the incremental cost of stroke was also examined in a multivariate analysis by stroke type.

Table 1. Demographic characteristics in 1 year before index event

		Stroke study population (n, %)			p-value*
		HS	IS	Overall	
Sample size (n)		**1,891**	**8,444**	**10,335**	
Age	65-69	270 (14.3)	1,121 (13.3)	1,391 (13.5)	0.19
	70-74	317 (16.8)	1,389 (16.5)	1,706 (16.5)	
	75-79	434 (23.0)	1,796 (21.3)	2,230 (21.6)	
	80-84	397 (21.0)	1,900 (22.5)	2,297 (22.2)	
	≥ 85	473 (25.0)	2,238 (26.5)	2,711 (26.2)	
Race	Asian	28 (1.5)	76 (0.9)	104 (1.0)	<0.01
	Hispanic	74 (3.9)	281 (3.3)	355 (3.4)	
	Black	171 (9.0)	1,090 (12.9)	1,261 (12.2)	
	White	1,611 (85.2)	6,983 (82.7)	8,594 (83.2)	
	Other	7 (0.4)	14 (0.2)	21 (0.2)	
Sex	Male	791 (41.8)	3,335 (39.5)	4,126 (39.9)	0.06
	Female	1,100 (58.2)	5,109 (60.5)	6,209 (60.1)	
Geographic Location	Northeast	434 (23.0)	1,617 (19.2)	2,051 (19.9)	<0.01
	South	723 (38.2)	3,512 (41.6)	4,235 (41.0)	
	Midwest	448 (23.7)	2,184 (26.0)	2,632 (25.5)	
	West	286 (15.1)	1,131 (13.4)	1,417 (13.7)	

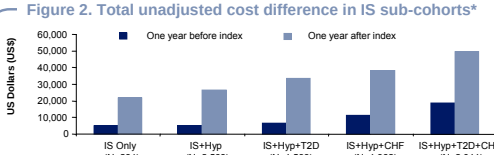
* Based on Chi-square tests. HS:hemorrhagic stroke; IS:ischemic stroke

Figure 1. Total unadjusted cost difference in HS sub-cohorts*



*1 year before and 1 year after index event.

Figure 2. Total unadjusted cost difference in IS sub-cohorts*



*1 year before and 1 year after index event.

Results—Demographics and comorbidity

- 1,891 (18.3%) of patients experienced HS, the remaining 8,444 (81.7%) experienced IS. The population contained more women (60.1%)(**Table 1**).
- Percentage of patients experiencing HS or IS increased with age (5 year intervals), with the highest prevalence in those 85 years or older (26.2%).
- Most patients were white (83.2%). The largest percentage was from the South (41.0%), followed by the Midwest (25.5%).
- The most prevalent comorbid conditions in this population were: hypertension (86.1%), CHF (31.3%) and type 2 DM (30.6%) (**Table 2**).
- HS patients had a significantly higher rate of CHF (35.2% vs 30.5%), hypertension (93.2% vs. 86.7%), and migraine (2.5% vs. 1.7%).
- CHADS(2) scores of 2-3 or greater were recorded in 70.1% of the total population, 68.1% of IS population and 79.2% of HS population.

Table 2. Comorbidities (n, %) in 1 year before index event

	HS N = 1,891	IS N = 8,444	Overall N = 10,335	p-value*
CHF	666 (35.2)	2,573 (30.5)	3,239 (31.3)	<0.01**
Hypertension	1,764 (93.2)	7,137 (86.7)	8,901(86.1)	<0.01**
Type 2 Diabetes	607 (32.1)	2,487 (30.2)	3,094 (30.6)	0.11
Metabolic Syndrome	0 (0.0)	4 (0.05)	4 (0.04)	0.34
Depression	342 (18.1)	1,612 (19.1)	1,954 (18.9)	0.31
Migraine	47 (2.5)	147 (1.7)	195 (1.9)	0.02**
Lung Cancer	45 (2.4)	164 (2.0)	209 (2.0)	0.22
Brain Cancer	56 (3.0)	225 (2.7)	281 (2.7)	0.47
Prostate Cancer	95 (5.0)	423 (5.0)	518 (5.0)	0.98
Mood Disorders	121 (6.4)	579 (6.9)	700 (6.8)	0.47
Smoking	144 (7.6)	679 (8.0)	823 (8.0)	0.54
CHADS(2) Score 0-1	394 (20.8)	2,697 (31.9)	3,091 (29.9)	<0.01**
CHADS(2) Score 2-3	1,288 (68.1)	5,169 (61.2)	6,457 (62.5)	
CHADS(2) Score ≥ 4	209 (11.1)	578 (6.9)	787 (7.6)	

*Based on Chi-square tests. **Significant at 95% confidence. HS:hemorrhagic stroke; IS:ischemic stroke; CHF:congestive heart failure

Results—Cost

- For HS patients, the incremental treatment cost was approximately $15,000 without comorbid conditions, and over $22,000 with at least one comorbid condition. For patients who had hypertension, type 2 DM, CHF and HS, the incremental cost more than doubled compared to the HS only group ($34,000 vs. $15,000) (**Figure 1**).
- Incremental treatment cost for IS ranged from $21,000 to $31,000 with other comorbidities vs. $17,000 in IS only patients. Hospitalizations accounted for 60-70% of overall differences in treatment cost (**Figure 2**).
- Results from the multivariate analysis supported the validity of the descriptive statistics; hypertension and type 2 DM; CHF and hypertension; and CHF, hypertension, and type 2 DM were significantly associated with higher incremental cost of stroke (p<0.01 for all) (**Table 3**).

Table 3. Comorbid conditions associated with 1-Year treatment costs of HS and IS: multivariate analysis[1]

		Without pre-index cost and comorbid conditions		Without pre-index cost		Full model	
		PE (HS)	PE (IS)	PE (HS)	PE (IS)	PE (HS)	PE (IS)
Age (ref: 65-69 yrs)	70-74	-0.01	0.11*	0.01	0.11*	-0.01	0.07
	75-79	0.07	0.16*	0.08	0.16*	0.03	0.11*
	80-84	-0.09	0.15*	-0.07	0.15*	-0.12	0.09*
	≥85	-0.27*	0.07*	-0.26*	0.08*	-0.30*	0.02
Sex (ref: male)	Male	0.03	0.07*	0.04	0.07*	0.03*	0.05*
Pre-index cost[2]		-	-	-	-	0.03*	0.05*
Race (ref: white)	Asian	0.01	0.17	0.03	0.20	0.03	0.19
	Hispanic	-0.10	0.19*	-0.07	0.20*	-0.04	0.21*
	Black	0.09	0.17*	0.11	0.19*	0.13	0.20*
	Other	1.01*	-0.21	1.01	-0.18	1.02*	-0.18
Comorbidity	HYP	0.56*	0.24*	0.55*	0.24*	0.53*	0.20*
	HYP+T2D	0.81*	0.44*	0.78*	0.44*	0.73*	0.37*
	CHF+HYP	0.92*	0.64*	0.90*	0.63*	0.85*	0.53*
	CHF+HYP+T2D	1.24*	0.87*	1.21*	0.85*	1.13*	0.71*
	Brain Cancer	-	-	0.39*	0.21*	0.37*	0.17*
	Depression	-	-	0.35*	0.20*	0.33*	0.16*
	Lung Cancer	-	-	0.21	0.29*	0.15	0.22*
	Migraine	-	-	0.05	-0.01	0.02	-0.04
	Mood Disorders	-	-	-0.07	0.24*	-0.09	0.21*
	Prostate Cancer	-	-	0.31	0.12*	0.27*	0.06
	Smoking	-	-	0.03	-0.01*	0.03	-0.00

[1]Dependent variable, post-index costs log-transformed. [2]Pre-index costs log-transformed. *Significant at 95% confidence. PE:parameter estimate; HS:hemorrhagic stroke; IS:ischemic stroke; HYP:hypertension; T2D:type 2 diabetes mellitus; CHF:congestive heart failure

Discussion

- This study is the first to provide a real-world longitudinal forecast of the economic impact of comorbidities on stroke management using medical claims.
- This study suggests that the presence of comorbidities is an important factor in treatment cost. Even after controlling for demographic characteristics, other co-morbidities, and pre-index costs, the added costs associated with hypertension, type 2 DM, and CHF and their combination significantly contributed to costs in the years following stroke.
- These results indicate that a stroke patient with multiple chronic conditions will be more costly to the health care system, and institutions such as hospitals and long-term care facilities may need to be prepared for the higher costs associated with having hypertension, CHF, and/or type 2 DM in addition to stroke.

Conclusions

- **This study is the first to estimate the economic impact of comorbidities on stroke management.**
- **It suggests that in patients with either HS or IS, comorbidities contribute substantial additional costs to the costly nature of stroke.**

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