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 $39,386 for IS.²

Type 2 Diabetes mellitus (type 2 DM) and hypertension are high-risk factors for stroke. Clinical conditions associated with risk for stroke include metabolic syndrome, kidney disease, risk increases 5-10 fold,¹ depression, mood disorders, chronic headache, migraines, and cancer.¹²

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 (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 as 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 of 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, visit, skilled care services, home healthcare, and rehabilitation were assessed from the Medicare prospective payment system.
- 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 patient identification numbers.

For continuous variables, non-parametric Wilcoxon tests were performed, as the normality of normality was questionable. Values of p<0.05 were considered statistically significant.

Demographic statistics were stratified by the stroke/comorbidity subgroups, and pre- and post-index event costs were compared.

The difference between pre- and post-index event costs was calculated. The association between co-morbid conditions and the incremental cost of stroke was also examined in a multivariate analysis by stroke type.

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 (26.3%).
- 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 and hypertension (93.2% vs. 87.9%), and migraine (2.5% vs. 1.7%).

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

<table>
<thead>
<tr>
<th>Comorbidity</th>
<th>HS</th>
<th>IS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>1,764 (90.2)</td>
<td>7,137 (86.7)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>607 (32.1)</td>
<td>2,487 (29.2)</td>
</tr>
<tr>
<td>CHF</td>
<td>0 (0.0)</td>
<td>4 (0.0)</td>
</tr>
<tr>
<td>Migraine</td>
<td>342 (18.1)</td>
<td>1,612 (19.1)</td>
</tr>
<tr>
<td>Lung Cancer</td>
<td>45 (2.4)</td>
<td>164 (2.0)</td>
</tr>
<tr>
<td>Brain Cancer</td>
<td>56 (3.0)</td>
<td>225 (2.7)</td>
</tr>
<tr>
<td>Prostate Cancer</td>
<td>95 (5.0)</td>
<td>423 (5.0)</td>
</tr>
<tr>
<td>Mood Disorders</td>
<td>121 (6.4)</td>
<td>579 (6.9)</td>
</tr>
<tr>
<td>Full model</td>
<td>2,184 (26.0)</td>
<td>7,137 (86.7)</td>
</tr>
</tbody>
</table>

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 and IS, the incremental cost more than doubled compared to the HS only group ($34,000 vs. $15,000) (Figure 1).

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

<table>
<thead>
<tr>
<th>Comorbidity</th>
<th>HS</th>
<th>IS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>0.07</td>
<td>0.15</td>
</tr>
<tr>
<td>Diabetes</td>
<td>-0.10</td>
<td>-0.17</td>
</tr>
<tr>
<td>CHF</td>
<td>0.09</td>
<td>0.17</td>
</tr>
<tr>
<td>Migraine</td>
<td>1.01</td>
<td>-0.21</td>
</tr>
<tr>
<td>Lung Cancer</td>
<td>-0.39</td>
<td>0.21</td>
</tr>
<tr>
<td>Brain Cancer</td>
<td>0.04</td>
<td>-0.09</td>
</tr>
<tr>
<td>Full model</td>
<td>0.03</td>
<td>0.20</td>
</tr>
</tbody>
</table>

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 event costs, the added costs associated with having 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.

References
- Tuomilehto J, Reunanen A, Sailasluoto J. Migraine - - 0.05 -0.01 0.02 -0.04