The Effect of Cuts in Reimbursement on Stroke Outcome
A Nationwide Population-Based Study During the Period 1998 to 2007
Yu-Chi Tung, PhD; Guann-Ming Chang, MD, MS

Background and Purpose—As healthcare costs keep rising, cuts in reimbursement such as the Balanced Budget Act in the United States or global budgeting have become the key to healthcare reform efforts. Limited information is available, however, concerning whether reimbursement cuts are associated with changes in stroke outcomes. The objective of this study is to determine whether 30-day mortality rates for patients with ischemic stroke changed under increased financial strain from global budgeting in Taiwan.

Methods—We analyzed all 258,167 patients with ischemic stroke admitted to general acute care hospitals in Taiwan over the period 1998 to 2007 through Taiwan’s National Health Insurance Research Database. Multilevel logistic regression analysis was used to examine whether 30-day stroke mortality rates varied after the implementation of hospital global budgeting since July 2002 adjusted for patient, physician, and hospital characteristics.

Results—The magnitude of payment reduction on overall hospital net revenues was between 4.3% and 10.0%. The 30-day mortality rates for patients with ischemic stroke in Taiwan increased after the implementation of hospital global budgeting after adjustment for patient gender and age, comorbidities, surgery, physician age and volume, specialty, hospital volume, ownership, accreditation level, bed size, geographic location, competition, and trend.

Conclusions—The mortality rate of patients with stroke rose under increased financial strain from cuts in reimbursement. Therefore, stroke outcomes are more likely to be affected by hospital financial pressures. It is imperative to monitor stroke outcomes and develop strategies to maintain levels of stroke care as cuts in reimbursement are adopted. (Stroke. 2010;41:504-509.)

Key Words: health policy ■ outcome ■ stroke
Physician covariates were age, specialty (neurology versus others), and physician volume. In Taiwan, there are 23 official physician specialties, including neurology, neurosurgery, internal medicine, surgery, gynecology, pediatrics, and so on. For physician volume, each patient admission was linked with the number of patients with ischemic stroke treated by that physician in the calendar year before the year of the patient’s admission.

Hospital covariates were ownership (public, not-for-profit, private), accreditation level (academic medical center, regional, district), bed size, hospital volume, geographic location (Taipei, northern, central, southern, Kao-Ping, eastern), and competition. For hospital volume, each patient admission was linked with the number of patients with ischemic stroke admitted to that hospital in the calendar year before the year of the patient’s admission. In Taiwan, every patient is free to go to any hospital because all hospitals have contracts with the Bureau of National Health Insurance. Additionally, because stroke care is not regionalized or centralized, patients with acute stroke are generally sent to the nearest hospital. Thus, Taiwan’s healthcare system provides an excellent opportunity to examine the volume–outcome relationship for stroke. Hospital competition was measured by the Herfindahl–Hirschman Index (HHI). We calculated HHI for the 17 medical area networks (markets) demarcated by Taiwan’s Department of Health. HHI is the sum of squared market shares of each hospital in the market, and the market share is the ratio of bed counts in each hospital divided by the total beds in the market. The trend variable (linear time trend) was included to capture all omitted trending variables such as advances in medical technology and to separate them from the effect of hospital global budgeting.

## Outcome Measures

We used 30-day mortality, which the Centers for Medicare and Medicaid Services and the Agency for Healthcare Research and Quality have suggested.\(^3,19\) The advantage of using 30-day mortality is that variation in lengths of stay does not have an undue influence on mortality rates. Without a standardized period, institutions would have an incentive to adopt strategies that would shift deaths out of the hospital without improving quality of care. Quality of care can affect patient outcomes in this timeframe. The period of 30 days after admission is used commonly in stroke studies to assess short-term mortality.\(^2,6,13,20\) Thirty-day mortality was calculated by linking inpatient admission records with withdrawal certificate records.\(^5,21\) Withdrawal dates are the same as death dates based on death certificate records. Because Taiwan’s National Health Insurance is a compulsory single-payer program and, for Taiwanese residents, the only reason for being withdrawn from the National Health Insurance coverage within 30 days of hospital admission would be that they had died (the other 2 conditions for withdrawal being jailed for >2 months or disappearing for >6 months would not be possible reasons for withdrawal within 30 days of hospital admission).

## Statistical Analysis

We applied multilevel logistic regression (also known as the hierarchical generalized linear model) to inpatient admissions data over a period of 10 years (1998 to 2007 inclusive) to analyze trends in 30-day ischemic stroke mortality.\(^17\) The patient was the unit of analysis. When data comprising patients treated by physicians who practice in hospitals are structured hierarchically, multilevel modeling is appropriate because it provides more accurate results in terms of precise estimates than conventional regression modeling, which ignores the possible correlation of outcomes within a given physician or hospital.\(^2,22\) Multilevel modeling also avoids the problem of atomistic fallacy, in which inferences about the groups are incorrectly drawn from individual-level information.\(^24,25\) Patients (Level 1) were considered to be nested within physicians at Level 2 and then nested within hospitals at Level 3.

Multilevel logistic regression was used to examine the effects of cuts in reimbursement and other health system factors on 30-day mortality adjusted for patient demographics and complexity, physician age, geographic location, and trend. A cross-level interaction term of physician volume and hospital volume was also included to control medical expenditures, which increased rapidly after the implementation of National Health Insurance for the entire population in March 1995. Reimbursement to providers is based on an existing fee-for-service schedule, which lists a relative value or number of points for each item of service. The monetary value of each point was fixed (NT $1 [US $0.03]) until the adoption of global budgeting. Since then, the monetary value of each point has been equal to the fixed budget divided by the number of points, so it fluctuates. The value of NT $0.9460 per point for the fourth quarter of 2007\(^11\) meant that hospitals had an average decrease in National Health Insurance reimbursement of NT $0.0540 per point, which corresponded to a 5.4% reduction in net revenues (Table 1). Thus, the monetary value per 100 points represents the percentage of reimbursement (with 100% indicating the preglobal budget period). Patient covariates were gender, age, comorbid conditions, administration of surgical operation (yes/no), and weekend admission (yes/no). The Charlson–Deyo index was used to quantify patients’ comorbidity burden.\(^12\) The index is a widely used comorbidity index in stroke outcome studies\(^4,6,13,16\) and provides as good a prediction of stroke outcome as stroke-specific comorbidities or other indices developed specifically for stroke.\(^15,16\) Thus, the Charlson–Deyo index was selected to facilitate comparisons across studies. This index is the sum of weighted scores based on the presence or absence of 17 different medical conditions. Cerebrovascular disease and hemiplegia were excluded, however, because they are reflected in the condition being evaluated.\(^14\) The higher the scores, the greater the comorbidity burden.

### Table 1. The Monetary Value of Each Point Under Hospital Global Budgeting in Taiwan

<table>
<thead>
<tr>
<th>Year</th>
<th>Quarter 1</th>
<th>Quarter 2</th>
<th>Quarter 3</th>
<th>Total</th>
<th>Impact_total</th>
<th>Net Impact_total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>...</td>
<td>0.9614</td>
<td>0.9522</td>
<td>0.9568</td>
<td>-4.32%</td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>0.9559</td>
<td>0.9559</td>
<td>0.9559</td>
<td>0.9559</td>
<td>-4.41%</td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>0.8936</td>
<td>0.8994</td>
<td>0.9099</td>
<td>0.9061</td>
<td>-10.03%</td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>0.8920</td>
<td>0.9080</td>
<td>0.9008</td>
<td>0.9001</td>
<td>-9.98%</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>0.9286</td>
<td>0.9367</td>
<td>0.9281</td>
<td>0.9414</td>
<td>-6.63%</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>0.9424</td>
<td>0.9564</td>
<td>0.9468</td>
<td>0.9460</td>
<td>-5.21%</td>
<td></td>
</tr>
</tbody>
</table>

*Net Impact_total = (1 - monetary value_total) × 100."
examine whether the relationship between physician volume and 30-day mortality differed by hospital volume.\textsuperscript{24,25} The SAS statistical software (Version 9.1) and HLM (Version 6.02) were used for analysis. A 2-sided \textit{P} value of less than 0.05 was considered statistically significant.

\section*{Results}

\subsection*{Descriptive Trends}

A total of 289,972 patients hospitalized for first-ever ischemic stroke in Taiwan between 1998 and 2007 was used for analysis. After removal of patients with missing data, 258,167 patients were available for analysis. The number of patients with first-ever ischemic stroke was 22,744 from 1299 physicians in 1998, gradually increasing to 27,376 from 1739 physicians in 2007. The percentage of male patients increased slightly from 57.4\% to 58.6\%. The mean age of patients increased steadily from 67.8 to 68.7 years. The mean Charlson-Deyo index increased from 0.53 to 0.65. The percentage of patients receiving surgery decreased slightly from 1.6\% to 1.5\%. The proportion of weekend admissions was almost constant (approximately 23.0\%). The mean age of physicians increased from 39.9 to 41.8 years. The percentage of neurologists grew from 65.8\% to 77.7\%. Mean physician volume increased from 81 cases in 1997 to 94 cases in 2002, but then decreased to 82 cases in 2006. The proportion of not-for-profit hospitals increased from 49.3\% to 54.9\%. The proportion of academic medical centers increased from 29.2\% to 36.7\%. The mean number of hospital beds rose from 852 to 1120. Mean hospital volume increased from 420 to 569 cases. The mean HHI declined from 0.055 to 0.042. The 30-day mortality rate decreased from 5.8\% to 3.7\% (Table 2).

\subsection*{Multilevel Analysis}

Table 3 presents the results of the multilevel logistic regression analysis examining the influences of reimbursement cuts and other health system factors on 30-day ischemic stroke mortality. After adjusting for patient, physician, and hospital characteristics, there were significant relationships of cuts in reimbursement, weekend admissions, physician volume, competition, and trend with 30-day mortality. There was also a significant interaction between physician and hospital volume on adjusted 30-day mortality.

\begin{table}[h]
\centering
\caption{Characteristics of Patients, Physicians, and Hospitals}
\begin{tabular}{lcccccccc}
\hline
\hline
\textbf{No. of patients} & 22,744 & 23,450 & 23,959 & 26,357 & 26,696 & 25,971 & 26,646 & 26,298 & 28,670 & 27,376 \\
\textbf{Patient characteristics} & & & & & & & & & & \\
Gender, male, \% & 57.4 & 57.5 & 57.5 & 57.0 & 57.7 & 58.1 & 57.7 & 59.1 & 59.3 & 58.6 \\
Mean patient age, years & 67.8 & 68.1 & 68.2 & 68.3 & 68.1 & 68.4 & 68.5 & 68.4 & 68.5 & 68.7 \\
Mean Charlson score & 0.53 & 0.56 & 0.57 & 0.58 & 0.59 & 0.65 & 0.66 & 0.64 & 0.66 & 0.65 \\
Surgery, \% & 1.6 & 1.8 & 1.6 & 2.0 & 1.7 & 1.7 & 1.6 & 1.5 & 1.5 & 1.5 \\
Weekend admissions, \% & 22.8 & 22.8 & 22.8 & 22.7 & 22.5 & 22.7 & 22.8 & 22.4 & 22.8 & 23.0 \\
\textbf{Physician characteristics} & & & & & & & & & & \\
Mean physician age, years & 39.9 & 39.9 & 40.3 & 40.7 & 41.1 & 41.6 & 41.9 & 41.9 & 41.7 & 41.8 \\
Neurologists, \% & 65.8 & 66.0 & 67.5 & 72.1 & 72.4 & 72.4 & 77.3 & 74.0 & 74.2 & 77.7 \\
Mean physician volume$\_\_\_1$ & 80.5 & 86.0 & 81.9 & 85.7 & 93.8 & 93.9 & 86.1 & 86.4 & 81.6 & 81.9 \\
\textbf{Hospital characteristics} & & & & & & & & & & \\
Ownership, \% & & & & & & & & & & \\
Public & 20.0 & 24.3 & 24.1 & 24.4 & 25.0 & 25.1 & 26.1 & 25.3 & 26.2 & 27.7 \\
Not-for-profit & 49.3 & 47.4 & 48.8 & 49.0 & 49.4 & 48.9 & 48.9 & 53.6 & 53.4 & 54.9 \\
Accreditation level, \% & & & & & & & & & & \\
Academic medical center & 29.2 & 29.3 & 33.7 & 35.8 & 36.5 & 35.2 & 34.5 & 35.5 & 36.5 & 36.7 \\
Regional & 37.5 & 39.9 & 42.9 & 41.4 & 43.3 & 43.9 & 46.1 & 47.1 & 40.3 & 33.0 \\
Location, \% & & & & & & & & & & \\
Taipei & 27.6 & 27.7 & 26.4 & 24.7 & 25.4 & 24.2 & 25.2 & 22.7 & 26.7 & 26.9 \\
Northern & 15.6 & 16.4 & 14.6 & 16.9 & 16.6 & 18.1 & 16.5 & 16.3 & 15.2 & 16.2 \\
Central & 20.0 & 18.4 & 18.8 & 19.4 & 19.8 & 19.6 & 20.3 & 19.9 & 19.1 & 18.5 \\
Southern & 16.4 & 17.0 & 18.3 & 17.7 & 17.1 & 18.3 & 18.0 & 19.2 & 18.8 & 18.8 \\
Kao-Ping & 18.1 & 17.8 & 19.3 & 18.3 & 17.9 & 16.5 & 16.6 & 18.6 & 17.4 & 16.3 \\
Mean no. of beds & 851.9 & 895.7 & 900.3 & 942.1 & 989.1 & 990.4 & 1010.2 & 1034.0 & 1078.2 & 1119.7 \\
Mean hospital volume$\_\_\_1$ & 420.3 & 444.4 & 472.1 & 498.7 & 552.4 & 541.9 & 506.6 & 524.2 & 528.7 & 568.7 \\
Mean HHI & 0.055 & 0.051 & 0.050 & 0.053 & 0.052 & 0.043 & 0.047 & 0.054 & 0.043 & 0.042 \\
\textbf{Patient outcome} & & & & & & & & & & \\
30-day mortality, \% & 5.8 & 5.3 & 4.9 & 4.8 & 4.3 & 4.5 & 4.2 & 4.1 & 3.9 & 3.7 \\
\hline
\end{tabular}
\footnotesize{$\_\_\_1$ indicates previous year’s volume.}
\end{table}
Table 3. Multilevel Regression Analysis of 30-Day Ischemic Stroke Mortality

<table>
<thead>
<tr>
<th>Patient level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cuts in reimbursement</td>
</tr>
<tr>
<td>100 points</td>
</tr>
<tr>
<td>Male (reference: female)</td>
</tr>
<tr>
<td>Patient age, years</td>
</tr>
<tr>
<td>Charlson score</td>
</tr>
<tr>
<td>Surgery (reference: no)</td>
</tr>
<tr>
<td>Weekend admissions (reference: no)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physician level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physician age, years</td>
</tr>
<tr>
<td>Neurologist (reference: no)</td>
</tr>
<tr>
<td>Physician volumeey/100</td>
</tr>
<tr>
<td>In-hospital volumey/100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hospital level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ownership (reference: for-profit)</td>
</tr>
<tr>
<td>Public</td>
</tr>
<tr>
<td>Not-for-profit</td>
</tr>
<tr>
<td>Accreditation level (reference: district)</td>
</tr>
<tr>
<td>Academic medical center</td>
</tr>
<tr>
<td>Regional</td>
</tr>
<tr>
<td>Location (reference: eastern)</td>
</tr>
<tr>
<td>Taipei</td>
</tr>
<tr>
<td>Northern</td>
</tr>
<tr>
<td>Central</td>
</tr>
<tr>
<td>Southern</td>
</tr>
<tr>
<td>Kaohsiung</td>
</tr>
<tr>
<td>Bed/100</td>
</tr>
<tr>
<td>Hospital volumeyey/100</td>
</tr>
<tr>
<td>HHI</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.941</td>
</tr>
</tbody>
</table>

Owing to cuts in reimbursement, there was deterioration in 30-day ischemic stroke mortality subsequent to the introduction of hospital global budgeting. The analysis found that an increase in reimbursement of NT $1 per 100 points would reduce the odds of 30-day ischemic stroke mortality by 1.2% (OR=0.988; 95% CI=0.979 to 0.997). In other words, for every NT $1 decrease per 100 points, which corresponded to every 1% reduction in average hospital net revenues, the odds of 30-day ischemic stroke mortality rose by 1.2%.

Regarding other health system determinants, patients admitted on weekends had 12.8% higher odds of 30-day death compared with those admitted during weekdays (OR=1.128; 95% CI=1.087 to 1.172). Patients had 24.0% lower odds of 30-day mortality per additional 100 patients treated by a physician (OR=0.760; 95% CI=0.700 to 0.827). Physician volume had a stronger relationship with 30-day mortality in higher-volume hospitals (OR=0.977 with each additional 100 patients in hospital volume; 95% CI=0.963 to 0.990). Lower competition (higher HHI) led to higher mortality (OR=2.104; 95% CI=1.570 to 2.820). The trend was monotonic (P<0.05). There was a trend toward decreased ischemic stroke mortality per year (OR=0.941; 95% CI=0.928 to 0.955).

Discussion
Our results using nationwide longitudinal population-based data show that larger cuts in reimbursement from hospital global budgeting of July 2002 led to higher 30-day ischemic stroke mortality. In terms of other health system determinants, weekend admissions, lower physician volume, simultaneous contribution of lower physician volume and lower hospital volume, and lower competition also increased 30-day ischemic stroke mortality.

The finding of the impact of cuts in reimbursement on ischemic stroke mortality is similar to Seshamani et al’s research, using 30-day mortality rather than in-hospital acute myocardial infarction mortality may be that in-hospital mortality is a worse outcome measure than 30-day mortality. The disadvantages of using in-hospital mortality are that variation in length of stay has an undue influence on mortality rates and that institutions would have an incentive to adopt strategies that would shift deaths out of the hospital. As for Seshamani et al’s research, using 30-day mortality rather than in-hospital mortality as the outcome measure, they did not find the effect of cuts in Medicare reimbursement on 30-day stroke mortality in Pennsylvania. One likely explanation is that in the United States, clinical practice guidelines for stroke are well defined and implemented so quality of stroke care may be more likely to be maintained and monitored despite increased financial strain from the Balanced Budget Act. Conversely, in Taiwan, guidelines are still being developed.

Another possible explanation for the adverse impact of cuts in reimbursement on ischemic stroke mortality in Taiwan is that hospital operating expenses declined at rates similar to the degree of reduction in hospital net revenues, suggesting that hospitals might cut their operating expenses to maintain profit margins. Decreasing operating expenses may lead to deficiencies in quality of care, which patients with more severe diseases such as stroke may be less able to resist so they have higher mortality. The methods of reducing operating expenses include decreasing service provision, providing lower quality of care, reducing nurse staffing, recruiting nurses with low education levels, or others. Previous studies showed that decreased nurse staffing or lower educational level of nurses was associated with higher mortality. Therefore, there is every likelihood that financial stress affects quality of stroke care without implementation of clinical practice guidelines.

Regarding other health system determinants, we found using a 10-year longitudinal study that patients with stroke admitted on weekends had a higher mortality rate than those admitted on weekdays. The result is consistent with previous cross-sectional studies. The weekend–outcome relation-
ship for stroke may have lasted for many years because hospitals may have faced shortages of medical staff and specialized services on weekends. Thus, disparities in medical resources, expertise, or staffing during weekends may explain the differences in weekend mortality.4

Our study also confirms the volume–outcome relationship and the synergistic contribution of physician and hospital volume for ischemic stroke. The findings that patients treated by physicians with higher volume in the previous year had lower stroke mortality and higher-volume physicians in higher-volume hospitals showed much better outcomes in the next year are similar to another cross-sectional study.5 The explanation for the volume–outcome relationship is that experience in managing a clinical condition may directly affect patient outcomes and that the skill and experience of individual physicians is a critical determinant for patient outcomes. Meanwhile, higher-volume physicians in higher-volume hospitals can receive more assistance from more skillful and interdisciplinary care teams to treat and care for patients, so they are much more likely to improve patient outcomes.6 Moreover, the findings that higher physician volume led to higher stroke mortality but physician specialty (neurologist versus nonneurologist) did not are consistent with another study using data from the Registry of the Canadian Stroke Network.7 Therefore, physician experience rather than physician specialty may play an important role in improving stroke outcomes.

We found that higher hospital competition led to lower stroke mortality. The finding is similar to previous studies.5,29 Hospitals in more competitive market areas are more likely to compete on quality of care rather than just on price or amenities after the implementation of managed care or National Health Insurance.29,30 Therefore, it is possible that hospitals that face a higher degree of competition are compelled to improve overall quality of care, which results in enhanced stroke outcomes. Lastly, the finding that a long-term trend improved stroke mortality is consistent with the advances in medical technology, indicating a steady improvement in stroke mortality for the period from 1998 to 2007. For example, antithrombotic drugs have been gradually applied to patients with stroke.

There are 2 limitations of our study that deserve comment. First, in common with prior studies using administrative databases, we do not have information on stroke severity for stroke risk adjustment. Nevertheless, we controlled for patient age, comorbid conditions, and surgical operations, which are also important for adjustment of stroke complexity.4–6 Second, owing to lack of information on processes of care and staff level, we could not identify the mechanisms through which cuts in reimbursement influence stroke outcomes. It is also possible that other unobservable variables such as number of concomitant medications taken by the patient may explain the differences in stroke mortality.

Our national longitudinal population-based study showed a robust positive relationship between cuts in reimbursement and stroke mortality. As healthcare payers in many countries have gradually implemented reimbursement cuts to control healthcare expenditures, information on whether reductions in reimbursement influence stroke outcomes becomes very important. Our analysis provides a first look into the long-term impact of reimbursement cuts and finds that larger reimbursement reductions led to higher 30-day ischemic stroke mortality. Therefore, it is imperative to monitor processes and outcomes of care for stroke and develop strategies to maintain levels of stroke care as cuts in reimbursement are adopted. For instance, national protocols and guidelines should be implemented not only to assist all physicians to achieve better outcomes for stroke care, but also to aid continuous monitoring of whether stroke care is deficient.

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Disclosures
None.

References


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