Stroke Care Units Versus General Medical Wards for Acute Management of Stroke in Japan

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**Background and Purpose**—The Japanese stroke guideline recommends the use of stroke care units (SCUs) for acute stroke treatment, but few SCUs have been established and the evidence supporting their use is limited. The aim of this study was to evaluate the efficacy of SCUs compared with general medical wards (GMWs).

**Methods**—A multicenter observational study was conducted using a large administrative database involving 52 hospitals; patients with either intracerebral hemorrhage or cerebral infarction were included. In-hospital mortality was the primary end point, and this parameter as well as the proportion of patients with a modified Rankin Scale score of ≤2 at discharge were compared between patients who were treated at SCUs and GMWs. Propensity score matching was performed to correct for selection bias.

**Results**—A total of 6977 patients were identified, of which 4527 patients were admitted to SCUs and 2450 patients were admitted to GMWs. The in-hospital mortality of patients with intracerebral hemorrhage was 14.8% and 24.1% in SCUs and GMWs, respectively (P=0.0004); the mortality of patients with cerebral infarction was 3.6% and 5.7%, respectively (P=0.003). Multivariate analysis in propensity score–matched pairs indicated significantly lower risk of death in the SCU group among patients with both intracerebral hemorrhage (odds ratio, 0.36; P=0.0007) and cerebral infarction (odds ratio, 0.60; P=0.02). However, the proportions of patients with a modified Rankin Scale score of ≤2 were not significantly different between SCUs and GMWs.

**Conclusions**—SCUs were associated with a reduced risk of in-hospital mortality of stroke patients compared with GMWs alone. *(Stroke. 2013;44:3142-3147.)*

**Key Words:** hospital mortality ■ Japan ■ propensity score ■ wards, general

From 1980 to 2011, stroke was the third most common cause of death, following cancer and heart disease, in Japan.1 It is a significant public health problem as stroke is the leading cause of becoming bedridden and dependent. The incidence of stroke is 3- to 5-fold greater than the incidence of myocardial infarction.2 The prevention and the management of stroke are critically important issues in Japan.

The efficacies of stroke units have been extensively investigated in prospective randomized studies, which have primarily been conducted in European countries.3-8 Many of the findings suggest that stroke units reduce both short-term and long-term mortality, as well as reducing the rate of institutionalization and improving stroke scales, such as the Scandinavian Stroke Scale. One meta-analysis involving these studies reported reductions in mortality, dependency, and the need for institutional care, and these benefits were not limited to any particular model of stroke unit care.9,10 Such evidence led to the development of stroke units for the management of stroke in Europe. In the United States, where tissue-type plasminogen activator (tPA) was introduced earlier than any other country in the world, the Brain Attack Coalition recommended primary stroke centers that are similar to stroke units as being essential elements of stroke care11; as a result, the quality of stroke management has improved.

The 2004 Japanese stroke guidelines evaluated stroke care units (SCUs) as level A evidence for stroke management, except in the case of subarachnoid hemorrhage and lacunar infarction, and stated that care in SCUs staffed by healthcare professionals with stroke expertise could improve outcomes by reducing mortality, shortening the length of hospital stay, increasing the rate of discharge, and improving activities of daily living and long-term quality of life. The 2004 guidelines strongly recommended establishing SCUs for effective stroke management, especially for the care of patients at an early disease phase; however, the 2004 guidelines did not specify detailed information regarding the organizational structure of SCUs. This omission occurred because the guidelines mainly relied on evidence from Western countries, which have different healthcare systems, and no evidence from Japanese patients was available at the time the guidelines were developed.

In 2006, a special medical fee for SCUs was established in the Japanese healthcare payment system, which allows the cost of treatment in SCUs to be reimbursed at more than twice the cost of treatment in general medical wards.
(GMWs). The definition and requirements for SCUs in this new payment system are slightly different from stroke units in Europe, but they have the same concept in terms of focusing on acute care for stroke patients. Because the organizational requirements necessitate an adequate number of experienced medical professionals, SCUs have not been widely established in Japan, and only 1.1% of all acute care hospitals had established an SCU by 2010. Evidence regarding the treatment of stroke patients in SCUs is slightly controversial. Several studies based on a single study center reported reduced mortality and improved prognosis on comparing the periods before and after implementation of this new treatment ward. One multicenter study also reported improvements in the modified Rankin Scale (mRS) 3 months after onset, but this study did not observe decreases in 28-day or 3-month mortality. Thus, further adequately powered investigations of treatment efficacy among patients treated in SCUs for intracranial hemorrhage and cerebral infarction are necessary to promote widespread establishment of SCUs in core hospitals.

The present study assessed the efficacy of treatment provided in SCUs compared with that provided in GMWs in terms of in-hospital mortality based on a large administrative database in Japan.

Materials and Methods

Data Source

We performed a retrospective observational study using Diagnosis Procedure Combination (DPC) data. The DPC data are administrative information obtained during acute phase hospitalization and are used for reimbursement in the Per-Diem Payment System. The data contain patient information on demographics; their most resource-consuming disease; in-hospital death; disease-specific conditions such as the mRS score, comorbidities, complications, and treatment procedures; as well as type of hospital ward to which the patient was admitted during hospitalization. We used data from patients discharged between July and December in 2010. In 2010, the DPC/Per-Diem Payment System was implemented by all 82 university hospitals on a mandatory basis and by community hospitals on a voluntary basis. The number of hospitals implementing the system was 1391, which covered ≈50.4% of all hospitalization to acute care hospitals in Japan. Our data include ≈68% of such hospitals. The study was approved by the Tokyo Medical and Dental University ethics committee.

Study Population

To select the study population, we began by identifying cases where either intracerebral hemorrhage or cerebral infarction was the most resource-consuming disease using International Classification of Diseases, Tenth Revision codes (I61 for intracerebral hemorrhage and I63 for cerebral infarction). We considered that patients treated at GMWs would be different between hospitals with only GMWs and hospitals with both SCUs and GMWs because patients at hospitals with only GMWs could not have been treated at SCUs due to no SCUs functioning within hospitals. Accordingly, in order to create an appropriate GMW group as a comparator, we included hospitals with both an SCU and a GMW and excluded hospitals with only a GMW. Hospitals with only 1 case per month were also excluded. The study inclusion criteria were: (1) ≥15 years of age; (2) hospitalization within 2 days of disease onset; (3) hospitalization for stroke treatment (ie, patients undergoing stroke examination were excluded); and (4) hospitalization for ≥90 days. Furthermore, if patients had been hospitalized more than once, only their first record was included in the analysis.

Variables and Statistical Analysis

The primary study outcome was all-cause in-hospital mortality. The secondary outcome was the proportion of patients who were independent at discharge as defined by a mRS score of ≤2 at discharge. The primary explanatory variable was the ward of stroke management (ie, either an SCU or a GMW). The SCU group consisted of patients who were admitted to an SCU for 1 day during their hospitalization, and the GMW group consisted of patients who were treated only in a GMW. Typical patients in the SCU group were managed in an SCU for the first several days for acute intensive treatment and were then transferred to a GMW for additional treatment until discharge. Other covariates included patient characteristics such as age, sex, urgency of admission, transport by ambulance, comorbidities, mRS score at admission, presence of stroke-related operation, length of stay, and recurrence of stroke during hospitalization. Stroke-related operations included craniotomy or cerebrovascular surgery, which were defined using the DPC/Per-Diem Payment System.

We applied a propensity score approach because nonrandom assignment to either an SCU or a GMW in this observational study likely produced selection bias. Propensity scores to estimate the probability of being treated in an SCU were calculated based on patient characteristics, and these scores were used to match patients who were admitted to an SCU with those who were admitted to a GMW. The method of matching was based on an absolute distance of 0.001 between exact propensity scores with a 1:1 ratio of patients in SCUs and GMWs to maximize the number of matches.

Summary statistics of categorical patient characteristics are presented as percentages, and continuous variables are presented as means and SDs. Patient characteristics between the SCU and GMW groups were compared using either χ² statistics or Mantel–Haenszel statistics for categorical variables and t tests for continuous variables. In-hospital mortality and the proportion of patients who were independent at discharge as defined by an mRS score of 0 to 2 were summarized and compared between the wards of stroke management. Multivariate conditional logistic models were developed to compare the effect of treatment in SCUs and GMWs between matched pairs. P values <0.05 were considered to be statistically significant.

Results

Patient Characteristics

In total, 6977 patients from 52 hospitals in Japan met all inclusion and exclusion criteria. Of these patients, 4527 were hospitalized in an SCU for ≥1 day, and 2450 were hospitalized in the GMW group. As of July 2010, 82 hospitals in Japan had an SCU. Thus, our data cover ≈63% of all hospitals with an SCU. After propensity score matching, 452 pairs of patients with intracerebral hemorrhage and 1805 pairs of patients with cerebral infarction were found.

Tables 1 and 2 summarize patient characteristics based on the type of stroke and show the difference between the SCU and GMW groups in the original cohorts. Although patients with intracerebral hemorrhage who were admitted to SCUs were significantly younger than patients who were admitted to GMWs, they were also more likely to have been transported by ambulance, to undergo surgery, and to have a severe mRS score compared with patients admitted to GMWs. For patients with cerebral infarction, no significant differences were observed in either age or sex between the SCU and GMW groups; however, a significantly greater proportion of patients in the SCU group compared with the GMW group was found to have characteristics indicating severity of disease, such as transport by ambulance, heart failure, stroke recurrence during hospitalization, operation during hospitalization, and a...
more severe mRS score. There were significantly more prescriptions for tPA in the SCU group compared with the GMW group among patients with cerebral infarctions. These patient characteristics were not significantly different in the propensity score–matched cohorts for either type of stroke.

Mortality
The Figure summarizes the in-hospital mortality rates for the SCU and GMW groups. The mortality for patients with intracerebral hemorrhage was 14.8% among patients admitted to SCUs and 24.1% among patients admitted to GMWs; this difference between treatment wards was statistically significant ($P=0.0004$). Similarly, a significant difference in in-hospital mortality was observed among patients with cerebral infarction; in particular, patients admitted to SCUs experienced 3.6% mortality and patients in GMWs experienced 5.7% mortality ($P=0.003$).

Table 3 shows that the odds ratio (OR) of in-hospital mortality in propensity score–matched pairs of patients with intracerebral hemorrhage was 0.36 ($P=0.0007$; 95% confidence interval, 0.20–0.65) among patients treated in SCUs. As shown in Table 4, for patients with cerebral infarction, the multivariate conditional logistic model with propensity score–matched pairs indicated lower risk of in-hospital mortality among patients treated in SCUs (OR, 0.60; 95% confidence interval, 0.39–0.93; $P=0.0212$).

Other Outcomes
The proportion of patients with intracerebral hemorrhage who were independent at discharge as defined by a mRS score of ≤2 at discharge was 32.2% in the SCU group and 34.0% in the GMW group. The proportions of independent patients were similar for patients with cerebral infarction (57.4% in SCU, 57.8% in GMW). Multivariate analysis using propensity score–matched pairs demonstrated that SCUs did not significantly improve patient independence regardless of stroke type (intracerebral hemorrhage: OR, 0.66; 95% confidence interval, 0.41–1.07; $P=0.09$ and cerebral infarction: OR, 0.90; 95% confidence interval, 0.74–1.09; $P=0.27$).

Discussion
The present study was the largest multicenter observational study using administrative data to assess the efficacy of treatment in SCUs in Japan. The observed results suggest that treatment in SCUs is beneficial for decreasing the risk of in-hospital mortality in patients with intracerebral hemorrhage and those with cerebral infarction.

A number of observational studies have recently been conducted in several countries, and they have reported the efficacy of stroke units and primary stroke centers in a real-world setting. These studies showed the absolute reduction in mortality for patients admitted to a stroke unit or stroke center regardless of the type of stroke. For example, studies in
Italy and Canada reported a reduction in mortality of ≈5%. Matched pair cohorts in our analysis also revealed an absolute reduction in mortality for patients with both intracerebral hemorrhage and cerebral infarction. Our study findings are noteworthy because the mRS score was taken into account for the estimation of the risk of death. The adjustment for stroke severity using the mRS score at admission is likely what caused the large reduction in the OR of death because the mRS score was a significant factor that predicted mortality in the multivariate analysis. Many observational studies adjusted for disease severity using comorbidities, but they did not adjust for stroke severity or patient conditions caused by the primary disease. Patient comorbidities are an important factor in considering long-term mortality, but they may not be as relevant for the evaluation of short-term mortality. Therefore, our study using the mRS score is considered to be a rigorous evaluation to demonstrate the efficacy of treatment in SCUs in terms of reducing in-hospital mortality.

The meta-analyses reported a beneficial effect of care in a stroke unit that was independent of patient characteristics and variation in stroke unit organization. A possible reason for the beneficial effect of SCU treatment observed in our study is the difference in the organizational structures of SCUs and GMWs. In SCUs, a neurologist or neurosurgeon with ≥5 years of experience treating stroke patients is present at all times, and nurses who have received special training for stroke care are allocated to every 3 patients, which is more than twice the number of nurses available in GMWs. Additionally, SCUs are required to have an appropriate allocation of experienced and trained physical and occupational therapy staff at all times.
therefore, SCUs are able to offer intensive treatment from a multidisciplinary care team that begins at the early stage of disease. This organizational structure of SCUs is especially useful for tPA therapy, which requires prompt diagnosis of infarction and needs to be administered within 3 hours (at the time of data collection) of the onset of the disease. Our analysis showed a significantly higher proportion of patients receiving tPA therapy in SCUs than in GMWs. Studies in the United States also demonstrated that patients admitted to a stroke center were likely to receive tPA therapy. In accordance with these findings, SCUs in Japan play a similar role to stroke centers in the United States as well as stroke units in the European Union.

Although the efficacy of treatment in stroke units and stroke centers has been repeatedly demonstrated, SCUs have not become widely used in Japan despite the SCU having been established as the organizational structure for stroke management in terms of reimbursement for healthcare expenses. One reason for this discrepancy is that meeting the criteria for establishing an SCU, including having the required number of medical and nursing staff, is difficult for many hospitals to invest in because stroke patients are geographically dispersed and the number of stroke patients treated in each hospital is relatively small. According to the reimbursement rule, >80% of patients in an SCU should have some type of stroke. The use of an intensive care unit instead of an SCU may be another reason, as the features of an intensive care unit overlap with those of an SCU. However, the majority of stroke patients do not require the services provided in a typical intensive care unit, and the cost of treatment in an intensive care unit is higher than that in an SCU; monitoring patients in an SCU may be more reasonable in some cases. Considering these conditions as well as our study results, the establishment of SCUs should be promoted and coordinated nationally for more effective stroke management.

There are several limitations of the present study. One limitation is that the study did not include detailed clinical information such as the location of the hemorrhage and infarction because the study used administrative DPC data. However, this limitation may have been partially overcome by the use of the mRS score, which is a good representation of several clinical factors. Another limitation is that data regarding treatment details, such as the amount of tPA administered, were not available; therefore, the previously observed efficacy of tPA was not reconfirmed in our analysis. A third important limitation is outcome measurement, specifically the analysis

Table 3. Independent Predictors of In-hospital Mortality for Patients With Intracerebral Hemorrhage After Propensity Score Matching

<table>
<thead>
<tr>
<th></th>
<th>OR</th>
<th>Lower 95% CI</th>
<th>Upper 95% CI</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke care unit</td>
<td>0.36</td>
<td>0.20</td>
<td>0.65</td>
<td>0.0007</td>
</tr>
<tr>
<td>Age</td>
<td>1.06</td>
<td>1.02</td>
<td>1.10</td>
<td>0.0012</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>0.35</td>
<td>0.14</td>
<td>0.87</td>
<td>0.0236</td>
</tr>
<tr>
<td>mRS score at admission</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mRS score of 5</td>
<td>11.72</td>
<td>3.93</td>
<td>34.97</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>mRS score of 0–4</td>
<td></td>
<td>Reference</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CI indicates confidence interval; mRS, modified Rankin Scale; and OR, odds ratio.

Table 4. Independent Predictors of In-hospital Mortality for Patients With Cerebral Infarction After Propensity Score Matching

<table>
<thead>
<tr>
<th></th>
<th>OR</th>
<th>Lower 95% CI</th>
<th>Upper 95% CI</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke care unit</td>
<td>0.60</td>
<td>0.39</td>
<td>0.93</td>
<td>0.0212</td>
</tr>
<tr>
<td>Age</td>
<td>1.04</td>
<td>1.01</td>
<td>1.07</td>
<td>0.0030</td>
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<tr>
<td>Sex</td>
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</tr>
<tr>
<td>Men</td>
<td></td>
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</tr>
<tr>
<td>Women</td>
<td>1.70</td>
<td>0.92</td>
<td>3.12</td>
<td>0.0885</td>
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<tr>
<td>mRS score at admission</td>
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<td></td>
</tr>
<tr>
<td>mRS score of 5</td>
<td>4.25</td>
<td>2.14</td>
<td>8.44</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>mRS score of 0–4</td>
<td></td>
<td>Reference</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CI indicates confidence interval; mRS, modified Rankin Scale; and OR, odds ratio.
of only short-term outcomes because long-term follow-up was not available. This would be the reason why we could not see significant improvements of patient independence at discharge, which was ≥24 to 30 days. Previous studies that reported improvements of patient functional status in Japan evaluated a long-term outcome, such as 1 to 5 years. To the best of our knowledge, this study was the first to investigate the effects of SCUs in Japan, but given the several limitations, further research is necessary. For future study, statistical methods to further reduce selection bias, which is always an issue for observational studies, may be considered. A recent study used an instrumental variable to adjust for unmeasured confounders. For our study, no appropriate instrumental variables were found. It is often difficult to identify a good instrument, although the instrumental variable method is a strong statistical tool for analyzing observational studies.

In conclusion, the major and significant findings of this study were that treatment in SCUs reduced the risk of in-hospital mortality among patients with intracerebral hemorrhage and cerebral infarction compared with treatment in GMWs alone.

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Disclosures
None.

References
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