Code stroke: A mismatch between number of activation and number of thrombolysis

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Background/Purpose: Code stroke systems are widely implemented to expedite acute stroke treatment. Although this system requires considerable resources, so far no reimbursement has been provided by the Bureau of National Health Insurance (BNHI) in Taiwan. We investigated how often a code stroke was initiated and the percentage of patients treated with intravenous (IV) tissue plasminogen activator, and draw attention to the resulting mismatch.

Methods: From January 2010 to September 2011, we prospectively registered all consecutive code stroke patients. Patient characteristics, including demographic data, medical history, comorbidity conditions, treatments, and discharge diagnosis were collected, together with the exact time of onset (or last known normal time) and management. The eligibility of thrombolysis for each patient recorded originally on the chart was reviewed retrospectively on the basis of two sets of criteria, namely, the BNHI reimbursement criteria and the Taiwan Stroke Society (TSS) guideline.

Results: During the study period, code strokes were activated for 419 patients at an average of around 20 patients per month. About 57% of code strokes were initiated outside of office hours. Stroke was diagnosed in 377 (90%) patients and 304 (73%) patients had ischemic stroke or transient ischemic attack. A total of 42 (10%) patients according to the BNHI reimbursement criteria and 101 (24%) patients by the TSS guideline were eligible for IV thrombolytic therapy. Of all the code stroke patients, only 49 (12%) were actually treated. Before each additional patient was thrombolysed, about eight patients had been evaluated and excluded from treatment.

Conclusion: The majority of code stroke patients were stroke patients; however, most of them could not be treated with thrombolytic therapy. These findings underscore the need for further support from the BNHI in order for health-care providers to implement the code stroke systems successfully.

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Introduction

Because the effectiveness of intravenous (IV) tissue plasminogen activator (tPA) in acute stroke treatment is time-dependent, it is advised to minimize the symptoms to needle time so as to improve treatment outcomes. Many factors, at both the prehospital and hospital levels, are associated with delays of thrombolytic therapy in stroke patients. Code stroke systems are commonly implemented to shorten the hospital delay in the emergency department (ED). However, lack of in-hospital stroke code protocol might cause up to 18% of eligible stroke patients not receiving tPA because of an avoidable cause. Overall, implementation of code stroke systems requires considerable logistic and human resources.

IV tPA treatment for acute ischemic stroke was approved in Taiwan in November 2002. In July 2003, the Taiwan Stroke Society (TSS) released a guideline regarding the use of IV tPA for acute ischemic stroke in which the exclusion criteria were modified from the National Institute of Neurological Disorders and Stroke (NINDS) tPA trial. Based on the guideline, the Bureau of National Health Insurance (BNHI) started the reimbursement of tPA for acute stroke treatment in 2004. Data from the Taiwan Stroke Registry, a nationwide registry enrolling stroke patients from 2006 to 2008, showed that only 1.5% of patients with ischemic stroke received IV tPA treatment. A less restrictive TSS guideline regarding thrombolytic therapy was released in 2008 to respond to new evidence. This updated TSS guideline expands the patient population suitable for thrombolytic therapy.

A mismatch between the risks and benefits of managing acute IV tPA treatment in an emergency setting may threaten the IV tPA treatment for acute ischemic stroke in Taiwan. The greatest concern is legal liability that can arise from negative patient outcomes, especially when the rate of symptomatic intracerebral hemorrhage after using IV tPA has been found as high as 10.4% among the Chinese-Taiwanese people. Moreover, failures in identifying thrombolyis candidates at an earlier stage or treating eligible patients have also led to medical malpractice lawsuits. Additionally, up to date, the BNHI does not provide financial benefits to physicians performing IV tPA therapy nor offer any financial incentives to hospitals implementing code stroke systems. This may partially explain why IV tPA therapy for acute ischemic stroke remains underused.

The primary objective of this study was to explore the therapeutic yield of an in-hospital code stroke system in a community hospital by examining how often a code stroke was initiated and the percentage of patients treated with IV tPA. Our secondary objective was to underscore the workload of neurologists caused by the code stroke protocol.

Patients and methods

The study hospital is a community hospital with an ED volume of 100,000 patient visits per year. In October 2009, the ED started a thrombolysis protocol (code stroke) to guide the evaluation and management of patients suspected of having a stroke. The protocol is activated by triage nurses or ED physicians when a patient with suspected stroke was identified within 3 hours of onset. The code stroke activities include establishment of an IV line, immediate blood testing (complete blood counts, biochemistries, prothrombin, and activated partial thromboplastin times), 12-lead electrocardiography, noncontrast head computed tomography (CT), determination of blood pressure in both arms, measurement of body weight, and notification of the on-call neurologist. A nurse practitioner on the acute stroke team is responsible for the evaluation of the National Institutes of Health Stroke Scale (NIHSS) and assessment of the eligibility for IV tPA treatment. An on-call neurologist has to examine each patient in person before the decision to administer thrombolytic therapy.

From January 2010 to September 2011, we prospectively registered all consecutive patients for whom a code stroke was activated. Patient characteristics, including demographic data, medical history, comorbidity conditions, treatments, discharge diagnosis, and outcomes were collected following the identical registry protocol as the nationwide Taiwan Stroke Registry. The diagnosis was made by the treating physicians, based on a clinical assessment, radiologic findings, and other laboratory tests as considered relevant by the clinician in charge of the treatment. Acute stroke was defined as rapid onset of focal neurological deficits, lasting longer than 24 hours, with no apparent cause other than vascular origin. Transient ischemic attack (TIA) required full resolution of symptoms within 24 hours and no evidence of acute infarct on neuroimaging studies. A stroke mimic was diagnosed when the clinical details did not indicate a vascular etiology, and an alternate convincing explanation for the symptoms was established. The exact time of onset (or last known normal time), arrival at ED, ordering of CT and laboratory tests, evaluation by neurologists, start of CT scanning, availability of coagulation results, thrombolysis, and admission to the intensive care unit (if applicable) were recorded. Eligibility of thrombolysis for each patient recorded originally on the chart was reviewed retrospectively according to the BNHI reimbursement criteria and the 2008 TSS guideline. The data collection had been approved by the hospital’s Institutional Review Board.

Median values and interquartile ranges (IQRs) of the time intervals were used for descriptive statistics because of their non-normal distributions. While making comparisons, we used $\chi^2$ or Fisher exact test for categorical variables and t-test or the Wilcoxon rank-sum test for continuous or ordinal measures. A value of $p < 0.05$ (two-sided) was considered statistically significant.

Results

From January 2010 to September 2011, 419 patients were prospectively accrued to this study through the code stroke protocol, with an average of around 20 patients per month. More than half of code stroke patients (239 or 57%) were initiated outside the office hours. Stroke was diagnosed in 377 (90%) patients and 304 (73%) patients had ischemic stroke or TIA. Demographic and clinical characteristics for
the 419 patients, stratified by diagnosis, are summarized in Table 1. The most frequent stroke mimics included seizure, toxic-metabolic encephalopathy, and peripheral nerve disorders (Fig. 1).

Of all the code stroke patients studied (n = 419), 42 (10%) patients were eligible for IV thrombolytic therapy based on the current BNHI reimbursement criteria, whereas 101 (42 plus additional 59 patients or 24%) patients were eligible according to the 2008 TSS guideline (Fig. 2). Most of those eligible patients according to the BNHI reimbursement criteria received IV tPA except three patients (two refused thrombolysis and one was not treated because of an inaccurate medical history provided by a family member which resulted in delayed CT examination). Of the remaining 262 patients who were not eligible for IV tPA based on the BNHI reimbursement criteria, 59 patients were otherwise thrombolysis candidates using the 2008 TSS guideline, and 10 of them did receive IV tPA. Overall, 49 (12%) out of 419 code stroke patients received IV tPA. Notably, before a patient was thrombolysed, about eight patients had been evaluated and excluded from treatment.

For patients treated with IV tPA, 29% achieved a modified Rankin scale score of 0 or 1 at 3 months and 8% suffered a symptomatic intracerebral hemorrhage. Table 2 shows the characteristics of these patients and outcomes of thrombolysis. The outcomes were comparable with the results of other Taiwan studies.10,11 Patients who were not eligible for IV tPA according to the BNHI reimbursement criteria but actually received the treatment tended to be older and have a higher NIHSS score. Nevertheless, the efficacy and safety outcomes were not significantly different between the two groups.

To facilitate comparison with other studies that included patients with ischemic stroke and TIA as candidates for IV tPA therapy, we conducted further analysis. Among the 304 patients with ischemic stroke or TIA, 42 (14%) were eligible for IV tPA according to the BNHI reimbursement criteria. However, if the 2008 TSS guideline was applied, 101 (33%) were potentially eligible for tPA. There was a considerable mismatch between the numbers of thrombolysis candidates eligible for IV tPA according to the BNHI reimbursement criteria.

| Table 1 Characteristics of the study patients by diagnosis (N = 419). |
|---------------------------------|-----------------|-----------------|------|
|                                | Stroke (n = 377) | Stroke mimics (n = 42) | p    |
| Mean age (y) (SD)              | 68 (13)          | 61 (18)          | 0.009|
| Men                             | 226 (60)         | 23 (55)          | 0.516|
| Visit outside office hours      | 214 (57)         | 25 (60)          | 0.732|
| Transported by EMS              | 151 (40)         | 19 (45)          | 0.516|
| Stroke type                     |                 |                 |      |
| Ischemic stroke                 | 241 (64)         | —                | —    |
| Transient ischemic attack       | 63 (17)          | —                | —    |
| Intracerebral hemorrhage        | 69 (18)          | —                | —    |
| Subarachnoid hemorrhage         | 4 (1)            | —                | —    |
| Hospitalization                 | 346 (92)         | 29 (69)          | <0.001|
| Length of stay (d), median (IQR)| 7 (4–12)         | 4 (2–7)          | 0.001|

Data are number (percentage) unless specified otherwise. EMS = emergency medical service; IQR = interquartile range; SD = standard deviation.

Figure 1 Discharge diagnosis of stroke mimics (N = 42).

Figure 2 Clinical results of activation of the code stroke protocol. BNHI = Bureau of National Health Insurance; IV tPA = intravenous tissue plasminogen activator; TIA = transient ischemic attack; TSS = Taiwan Stroke Society.
using different eligibility criteria. Nevertheless, only 49 (16%) patients were actually treated with IV tPA. Of these treated patients, 74% were thrombolysed within 60 minutes of ED arrival. The median time from door to CT was 14 minutes (IQR: 10.5–21). The median time from door to drug administration was 53 minutes (IQR: 43–61.5), and the median time from door to monitored bed was 103 minutes (IQR: 85–127.5). All the time intervals were within the recommended goal (25 minutes for door to CT, 60 minutes for door to drug administration, and 180 minutes for door to monitored bed) established by the NINDS.15

In the study hospital, attending neurologists provided inpatient and outpatient services, performed routine and emergency consultations for adult patients, and carried out electrodiagnostic studies. Before the era of thrombolytic therapy, neurologists usually responded to consultation requests for stroke patients in a less hurry. With the advent of tPA treatment for acute ischemic stroke, quick access to neurologic expertise within 15 minutes was recommended when a potential thrombolytic candidate presented to the ED.15 After the implementation of the code stroke protocol, when a code stroke occurred during office hours, neurologists must interrupt their routine work in order to assist colleagues in the ED to provide IV tPA. During off-hours, on-call neurologists need to rush to the hospital within a very tight time frame. On average, 9 code stroke alerts arose during office hours and 11 outside office hours each month.

Table 2  Baseline characteristics of patients and outcomes of thrombolysis stratified according to eligibility criteria.

<table>
<thead>
<tr>
<th>Patients eligible according to BNHI reimbursement criteria (n = 39)</th>
<th>Patients eligible according to 2008 TSS guideline but not fulfilling the BNHI reimbursement criteria (n = 10)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (y) (SD)</td>
<td>65 (12)</td>
<td>75 (17)</td>
</tr>
<tr>
<td>Men</td>
<td>22 (56)</td>
<td>5 (50)</td>
</tr>
<tr>
<td>Baseline NIHSS, median (IQR)</td>
<td>15 (9–20)</td>
<td>22 (10–34)</td>
</tr>
<tr>
<td>mRS 0 or 1 at 3 mo</td>
<td>11 (28)</td>
<td>3 (30)</td>
</tr>
<tr>
<td>SICH</td>
<td>3 (8)</td>
<td>1 (10)</td>
</tr>
</tbody>
</table>

Data are n (%) unless otherwise specified. BNHI = Bureau of National Health Insurance; IQR = interquartile range; mRS = modified Rankin scale; NIHSS = National Institutes of Health Stroke Scale; SD = standard deviation; SICH = symptomatic intracerebral hemorrhage; TSS = Taiwan Stroke Society.

Discussion

Our main finding is that the in-hospital code stroke system has proved itself as an effective way to minimize hospital delay as shown by the achievement of the time targets set forth by the NINDS.15 However, the effectiveness was achieved probably at the expense of adding a considerable amount of workload to the already very busy neurologists. The urgent need to arrive to an ED within a very brief period from notification apparently may have infringed toward the more restrictive BNHI reimbursement criteria to avoid protocol violations with resulting unfavorable patient outcomes or even lawsuits.

We found that stroke mimics accounted for 10% of all code stroke activations. A previous study retrospectively examining database for discharge diagnosis reported that up to 25% of patients who activated a code stroke were discharged with a diagnosis other than ischemic stroke or TIA.16 If we likewise consider all nonischemic stroke as stroke mimics, we had a comparable 27% (115 of 419) stroke mimics in our study patients.

In this study, more than 70% of code stroke patients were diagnosed as having an ischemic stroke or TIA. Of these 304 patients, 49 (16%) were actually treated with IV tPA. A study conducted in a university hospital in Taiwan reported that despite the implementation of an in-hospital stroke code, only 6% of patients activating the protocol were treated with IV tPA. The majority of patients were not treated in their study because of fulfillment of one or more exclusion criteria on the basis of the BNHI reimbursement criteria. The therapeutic yield of a code stroke protocol in Taiwan hospitals was relatively low as compared with studies conducted in the US (24–27%).18,19 A systematic review found an average thrombolysis rate of 38% in hospitals with an in-hospital code stroke protocol.4

By applying the less-restrictive 2008 TSS guideline, eligibility for tPA in patients with ischemic stroke/TIA increased from 14% to 33% in our study, but only 16% were treated. A recent study conducted in a university hospital in Taiwan showed a similar increase of eligible patients for tPA from 12% to 27% and a low treatment rate of 6%.20 The major discrepancy between the BNHI reimbursement criteria and the 2008 TSS guideline was that the TSS guideline includes patients older than 80 years, patients with history of previous stroke and diabetes mellitus, and patients with minor (NIHSS = 4 or 5) or severe (NIHSS > 25) stroke as eligible for thrombolysis treatment, though they may not be covered by the National Health Insurance. These patients had to pay the cost of IV tPA treatment out of pocket. The discrepancy between the eligibility criteria could contribute to the low treatment rate. Patients with minor stroke tended to opt out rather than taking the risk of bleeding, which is inherent in thrombolytic therapies. Another potential explanation for the low treatment rate is the neurologist’s preference toward the more restrictive BNHI reimbursement criteria to avoid protocol violations with resulting unfavorable patient outcomes or even lawsuits.

Our data also showed that the on-call neurologists had to travel to and from the hospital during off-hours around 11–12 times per month. Moreover, the low therapeutic yield (one IV tPA-treated patient for every nine patients evaluated) would have diluted the financial benefits associated with thrombolysing a patient, not to mention that there are no financial benefits to the treatment according...
to the current BNHI reimbursement policy. Although practicing medicine is much more about appropriate medical care and altruism than financial gain, the current system in Taiwan would have driven neurologists into other specialties and away from acute stroke care.

Physician reimbursement for the evaluation and treatment of acute stroke has been relatively low in both the US and Canada.\(^{21}\) In 2005, the US Centers for Medicare & Medicaid Services created diagnosis-related group code 559 to increase reimbursement for stroke patients treated with IV tPA. With the increased payment to hospitals that provided acute stroke care, a new economically favorable cost-reimbursement ratio has been established.\(^{22}\) From 2005 to 2009, the treatment rates of IV tPA for acute ischemic stroke have been doubled.\(^{13}\)

Our findings are limited, however, by the observational and descriptive nature of hospital-based evidence. We did not have statistical power to detect a difference in the outcomes of thrombolysis between patients who were eligible according to the BHNI reimbursement criteria and those who were eligible solely by the 2008 TSS guideline owing to the small patient numbers. This study was also limited by the correctness of discharge diagnosis, particularly for patients without hospitalization. Furthermore, we did not investigate the real time spent on evaluating patients and on traveling to and from the hospital by on-call neurologists.

In sum, although Taiwan’s National Health Insurance system has been well acknowledged for its many merits, two “mismatches” regarding the administration of thrombolytic therapy are still pending to be resolved. The first is the discrepancy in exclusion criteria between the 2008 TSS guideline and the reimbursement criteria adopted by the BHNI. Expanding the BHNI reimbursement coverage of IV tPA treatment should increase the number of stroke patients who may benefit from IV tPA therapy. The second mismatch is caused by the substantial workload required for administration of IV tPA in general, or implementation of the code stroke system in particular. If the delivery of thrombolytic therapy and corresponding reimbursement are not balanced or properly aligned, neurologists may be frustrated (if not burned out) by treating acute stroke patients.

Acknowledgments

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References