The Impact Factors on the Cost and Length of Stay among Acute Ischemic Stroke

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Background: Understanding hospital costs and length of stay (LOS) can optimize the in-hospital management of acute stroke. We investigated cost and LOS in first-ever and recurrent stroke patients in Taiwan. *Methods:* Data were examined in patients at Chang Gung Memorial Hospital in Chiayi County of Taiwan from April 1, 2005, to March 31, 2007. Predictors of hospital cost and LOS in these patients were studied. *Results:* The study included 1021 patients with 1084 stroke episodes. Mean age was 68.1 ± 10.8 years (range: 32-93). The average cost was NTD$45,709.30 ± NTD$66,697.40 (US$1408.70 ± US$2084.30; US$1 = NTD$32) and average LOS was 13.9 ± 14.1 days (range: 1-129). After multivariate regression analysis, the significant predictive factors for cost were LOS, smoking, and medication for secondary prevention. The significant predictive factors for LOS were diabetes mellitus, atrial fibrillation, recurrence, and stroke subtype. *Conclusions:* Age 65 and over, atrial fibrillation, stroke treatment, and subtypes were the significant predictive factors affecting hospital costs and LOS. Compared to other countries, Taiwan spent the least while Canada had the highest expense. The United States had the shortest LOS (6 days) in contrast to Canada with the longest LOS (34-47 days). Regarding mean daily cost of stroke, the United States had the highest cost per day while China spent the least. **Key words:** Cost—length of stay—acute—ischemic stroke—risk factor—subtypes.

Public health policy has addressed economic issues such as control of health care expenditures for stroke, with characteristics of high prevalence and high cost in recent years.[1] The rising cost of health services increased the importance of identifying factors influencing admission so that the most appropriate management for acute stroke was accepted.[1-3] In Taiwan, the annual incidence of first-ever stroke in subjects aged 36 years or older is 330 per 100,000; 71% are cerebral infarction cases. Hospital cost and length of stay (LOS) are reportedly associated with age.[4,5] Previous studies mostly addressed the relationship between cost and LOS with stroke severity, subtype and risk factors.[1,6-13] The oxfordshire community stroke project (OCSP) classifies stroke subtype according to

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Received September 16, 2012; revision received October 22, 2012; accepted October 24, 2012.

Supported by the Chang Gung Memorial Hospital with grants CMRPG640191, CMRPG660221, CMRPG660313, CMRPG660321, and CMRPG660322.

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1052-3057/$ - see front matter

http://dx.doi.org/10.1016/j.jstrokecerebrovasdis.2012.10.014

vascular territory, which are strongly related to stroke risk factors, outcome, and recurrence.[14,15] Reducing stroke risk factors such as atrial fibrillation, hypertension, and smoking can help reduce medical cost. Since the relationships among cost, LOS, stroke subtypes, and risk factors have not been elucidated, our study aims to identify the possible determinants on the cost and LOS of acute ischemic stroke. The trial of org 10172 in acute stroke treatment (TOAST) classification was not used since more intensive investigations such as duplex survey may not be available outside medical centers and nondeveloped countries.[16,17]

Methods

The study enrolled 1021 patients with 1084 stroke episodes admitted to Chang Gung Memorial Hospital in Chiayi County of Taiwan between April 1, 2005, and March 31, 2007. Demographic data including age, gender, and stroke risk factors were obtained. Ischemic stroke was diagnosed by a senior neurologist using brain imaging evidence. By OCSP criteria, ischemic stroke was classified as total anterior circulation infarct (TACI), partial anterior circulation infarct, posterior circulation infarct (POCI), and lacunar infarct (LACI).[16] More than OCSP criteria, we added transient ischemic stroke (TIA), comprising carotid artery territory TIA and vertebrobasilar insufficiency (VBI), as one of our subgroups. Carotid artery territory TIA was characterized by neurological deficit remitted within 24 hours and vertebral–basilar insufficiency was characterized by neurological deficit remitted within 72 hours. Patients with any medical history of stroke were classified as recurrent stroke. Stroke risk factors were retrieved from the patient's medical records included history of heart disease, hyperlipidemia, atrial fibrillation, hypertension, and diabetes mellitus; advanced age (≥65 years); and smoking. Heart disease was defined as history of angina or myocardial infarction, valvular heart disease, or heart failure. Atrial fibrillation was defined by continuous or paroxysmal arrhythmia characterized by rapid, chaotic atrial electrical activity and an irregularly irregular ventricular response in electrocardiagram.[17] Hypertension was diagnosed by any medical record of blood pressure 140/80 mm Hg or higher[18] or regular use of antihypertensive drugs. Diabetes mellitus was defined by either medical records or history of diet control and hypoglycemic treatment.[19] Patients having smoked over or equal to 10 cigarettes per day during the previous 6 months were considered as smokers. Hyperlipidemia was diagnosed as fasting cholesterol level higher than 200 mg/dL or fasting triglyceride level higher than 150 mg/dL. Stroke sites were categorized as left hemisphere, right hemisphere, bilateral hemisphere, and vertebral-basilar area (cerebellum or brain stem). Treatments included: no medicine, aspirin, clopidogrel, warfarin, Aggrenox (Boehringer Ingelheim, Ingelheim am Rhein, Germany), others such as neuroprotective agents, and combined use of any of the above-mentioned medications. Intravenous recombinant tissue plasminogen activator was excluded since it changed the direct and indirect cost and was not commonly used in Taiwan until 2008.

Resource Use and Costs

The costs of diagnostic tests were based on the guidelines from public health insurance in Taiwan. They included nonenhanced computed tomography (US$118.80), nonenhanced magnetic resonance imaging (US$203.10), electrocardiogram (US$4.70), chest x-ray (US$6.25), carotid Doppler (US$53.10), and transcranial Doppler (US$62.50). Routine laboratory tests, including complete blood cell count with differential count, serum urea nitrogen and creatinine, aspartate aminotransferase and alanine transaminase, cholesterol/triglyceride, and urine/stool had a cost of US$153.40 in all. These patients were hospitalized after the diagnosis was defined in the emergency unit (US$14.30) or by an outpatient clinic (US$6.40). Estimated hospitalization cost was based on instances of the following: treatment in general ward (US$14.30), nursing fee (US$16.90), and visiting physician fee (US$8.40). The LOS was estimated as the date of discharge or date of death. The decision to discharge was based on patient condition, family preferences, and physician opinions.

Statistical Methods

Analysis were performed using SPSS version 16.0 (IBM Corp, Armonk,NY) with $\chi 2$ test for categorical variables, t test for continuous normally distributed variables, and Mann-Whitney U test for continuous skewed variables. One-way analysis of variance and multivariate regression test were applied as appropriate. Effects of linear factors were analyzed by multivariate linear regression using hospital cost or LOS as the dependent variable. Significance for p-values was set at $p<.05$ (two tailed).

Results

A total of 1021 patients with 1084 episodes were recruited: 587 male patients (57%) had 630 episodes (58%) and 434 female patients (43%) had 454 episodes (42%). Among the 1084 episodes, 429 were first-ever strokes (39.5%) and 655 were recurrent strokes (60.5%). Mean age was 68.1 ± 10.8 years (range: 32-93) and 66.5% of patients were older than 65 years. The associated diseases were hypertension (71.7%), hyperlipidemia (39.0%), diabetes mellitus (37.0%), heart disease (13.6%), and atrial fibrillation (12.8%). The stroke subtypes were 37.8% lacunar stroke, 23.5% in partial anterior circulation infarct, 21.3% in POCI, 9.4% transient ischemic attack, and 2.9% TACI. The differences of clinical profiles and stroke subtypes in first-ever and recurrent stroke are shown in Table 1. The average cost per patient was US$35.50 ± US$65.13 and the average LOS was 13.9 ± 14.1 days