Factors Associated with Prolonged Hospital Stay for Acute Stroke in Taiwan

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Abstract-

Background and Purpose: Stroke is one of the causes of prolonged hospital stay (PHS) in Taiwan. This study aimed to examine the magnitude and associated factors for such prolonged stays.

Methods: Patients admitted between 1997 and 2002 with the principal diagnosis of acute cerebrovascular diseases were identified from the claims data of a nationally representative cohort of 200,000 National Health Insurance enrollees. There were 2,358 subjects eligible for analysis. PHS was defined as length of stay ≥ 23 days. Patient and hospital factors related to PHS were explored.

Results: A total of 245 subjects (10.4%) had PHS, but they accounted for 38.9% of the total person-hospital days and 47.8% of the total in-hospital medical expenses. PHS was statistically associated to surgical operation, physical/ADL dependency, infections or aspiration pneumonia, speech/swallowing disorders, female, stroke types, increased number of comorbidities, and increased age. PHS was inversely related to in-hospital mortality.

Conclusions: An organized, multidisciplinary team approach should be initiated early after the onset of acute stroke to minimize functional disability, prevent complications and hence decrease the likelihood of PHS. Establishment of an integrated and affordable post-acute system should be a policy priority to effectively reduce unnecessary acute hospital use and to ensure a seamless stroke care.

Key Words: Stroke, Prolonged hospital stay, Associated factors, Taiwan

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INTRODUCTION

As a major cause of mortality, hospitalization, and chronic disability, stroke imposed considerable physical and socioeconomic burden. Economic burden of stroke has direct, indirect and intangible components. The direct cost of stroke is largely determined by the length of initial hospital stay[1-3]. Several factors have been demonstrated to be significantly predictive of the length of acute hospital stay, including initial stroke severity, functional dependence at admission, small-vessel occlusion or lacunar stroke, prestroke dementia, sex, and smoking[4,5]. Moreover, comorbidities or complications have been demonstrated to carry important prognostic meanings on stroke outcome or resources utilization[6,7].

A substantial number of stroke survivors experience physical disability at hospital discharge and might require varying levels of post-acute rehabilitation or long-term care after discharge[8]. However, Taiwan's National Health Insurance (NHI) program reimburse mainly acute care services, and the coverage on skilled home nursing care and chronic units in hospital setting is limited[9,10]. The post-acute and long-term care system[11] is also inadequate and fragmented; some patients may stay hospital longer than necessary to acquire post-acute or chronic care[9,12,13]. Prolonged hospital stay (PHS) is associated with increased cost and is related to complications such as nosocomial infections, immobility, pressure sores, deep vein thrombosis and deconditioning[14].

Although stroke has been identified to be one of the most common causes of PHS, no previous study has specifically focused on PHS for acute stroke in Taiwan. Using Taiwan's NHI medical claims data, this study examined the magnitude and associated factors for PHS.

METHODS

Study subjects

A longitudinal NHI claims data, "Cohort Dataset", was utilized to identify our study samples. It contained all the inpatient, outpatient medical claims and the registration files of 200,000 NHI enrollees from 1996 to 2005 (as the status in September 2007), who were randomly sampled from 23,753,407 persons insured by NHI from March 1, 1995 to December 31, 2000. The dataset serves as a representative cohort of the population in terms of age, sex and health services utilization. Claims data of the cohort were updated by the National Health Research Institute (NHRI) every year.

In the current study, we extracted all admissions between 1 January 1997 and 31 December 2002 with a principal diagnosis of acute cerebrovascular disease 〔International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes 430 to 437〕 from the dataset. The admission records for the patients hospitalizaed for acute stroke were assembled. The first ever admission was chosen as the index stroke event if a patient had more than one such hospital admission during the study period.

A total of 2,641 stroke subject were identified. To limit our observation on acute stay for a stroke, 283 subjects were excluded (2 with extremely long stay of >200 days at a Veterans' chronic hospital, 173 subjects transferred to another ward or hospital, 108 subjects directly admitted to the rehabilitation ward during acute onset). This left a final study sample of 2,358 eligible stroke subjects.

Key variables of interest

The dependent variable was whether the stroke patient has PHS during the index stroke admission. For statistical reason, we defined PHS as length of stay (LOS) at 90th percentile of the 2,358 eligible subjects, ie, 23 days, which was approximately twice the mean LOS (10.7 days) and triple the median (7 days). To estimate the magnitude of PHS, the total person-hospital bed days (number of patients times by LOS) and total inpatient medical expenses (number of patients times by medical cost per discharge) was calculated. Those for PHS group and non-PHS group were analyzed separately. To examine the extent of acute wards occupied by the patients with PHS, the durations of acute and chronic bed-days were differentiated.

The independent variables were categorized into patient and hospital characteristics (Table 1). The former referred to stroke type, stroke severity and comorbidi-

ties. Stroke types were classified using the ICD-9-CM codes, including subarachnoid hemorrhage (SAH, code 430), intracerebral hemorrhage (ICH, codes 431, 432), cerebral infarction (CI, codes 433, 434, 436), and unspecified cerebrovascular diseases (codes 435, 437) [15,16].

We constructed several proxy indicators to represent stroke severity[17] since it was not available in this claims dataset. Firstly, administration of surgical operation was identified. Use of mechanical ventilation (CPT codes 94656, 94657; ICD-9-CM codes 96.7x) was used as a reasonable proxy indicator for altered consciousness or acute respiratory failure. The presence of hemiplegia or hemiparesis (ICD-9-CM codes 342.xx) or residual neurological deficits (ICD-9-CM codes 345.40-345.51, 345.80-345.91 for epilepsy; 348.1 for anoxic brain damage; 348.3x for encephalopathy; 780.3x for convulsions; and 784.3 for aphasia) were also used to represent neurological severity. Furthermore, receiving physical therapy (PT) or occupational therapy (OT) was used to indicate the presence of physical impairment or functional disability, while receiving speech therapy (ST) was used to indicate the presence of speech or swallowing disorder.

Patient's death status at hospital discharge is needed to be identified, because the identification numbers of enrollees in the National Health Insurance Research Database (NHIRD) were encrypted to protect patient's privacy and it is not possible to link with death registry, The death records in the inpatient data files were also underestimated due to the Taiwanese's tradition of dying at home instead of dying in the hospital. Therefore, death status was assumed if there is lack of any subsequent medical utilization record after discharge; given the comprehensiveness of NHI coverage, it is rare for a stroke patient to use no medical services for the following years after discharge except when the person has died or emigrated.

To quantify a patient's preexisting or concurrent comorbidity, we used Charlson Comorbidity Index[18]. Its validity for use in stroke outcome studies has been reported[6,19]. Hemiplegia/paraplegia was omitted as a comorbidity item, since we have included hemiplegia as one of the variables to represent stroke severity. We also used the Clinical Classification System (CCS) ICD-9-CM to capture medical complications[7,20] and the categorization system used by Smith et al.[17] to identify the occurrence of infections or aspiration pneumonia.

Hospital characteristics included admission ward, hospital accreditation level, ownership and location. The hospital level was based upon hospital accreditation and classified as medical center, regional or district. Hospital ownership was categorized as public, nonprofit proprietary or private. Hospital location was based on the branch of Bureau of NHI to which the hospital belonged and categorized into the Taipei, Northern, Central, Southern, Kao-Ping region (the most southern part of Taiwan) and Eastern regions.

Statistical analysis

The Statistical Analysis System (SAS System for Windows, Version 8.2, SAS Institute, Cary, N.C.) was used for data management. In addition, the Statistical Package for Social Science (SPSS 11.0 for Windows, SPSS, Chicago, IL, USA) was used to carry out the subsequent descriptive analysis, univariate analysis, and multi-variate analysis. Chi-square tests were used to compare the proportion of PHS among patients of different patient and hospital characteristics. A multiple logistic regression analysis was then carried out to examine the relationship of patient and hospital characteristics with PHS. Due to the exploratory nature of this study, all the variables used in the univariate analysis were entered into the multiple logistic regression model. To deal with the potential problem of multi-collinearity among the independent variables, forward stepwise method was used.

RESULTS

Descriptive statistics

Briefly (Table 1), near two thirds (62.4%) of the stroke subjects were aged over 65 years with a mean of 66.9. The proportions of SAH, ICH, CI, and other unspecified stroke were 2.9%, 16.2%, 58.7%, and 22.2%, respectively. Regarding the various indicators of stroke severity, 9.4% of the patient had surgery, 5.1%

Table 1. *Basic characteristics (N=2358)*

Patient characteristics	N (%)	Hospital characteristics	N (%)
Age, y (Mean±SD)	66.9±13.5	Admission ward	
≤ 64	886 (37.6)	Neurological	1151 (48.8)
65-74	787 (33.4)	Internal medicine	805 (34.1)
≥ 75	685 (29.1)	Neurosurgical	293 (12.4)
Sex, Male	1348 (57.2)	Miscellaneous	109 (4.6)
Stroke type		Accreditation level	
SAH	68 (2.9)	Medical center	617 (26.2)
ICH	382 (16.2)	Regional	934 (39.6)
CI	1384 (58.7)	District	807 (34.2)
Others	524 (22.2)	Ownership	
Stroke severity proxies		Public	554 (23.5)
Received surgery	221 (9.4)	Nonprofit proprietary	1058 (44.9)
Use of mechanical ventilation	121 (5.1)	Private	746 (31.6)
Hemiplegia or hemiparesis	277 (11.7)	Location	
Physical /ADL dependency (indicated by receiving PT/OT)	680 (28.8)	Taipei	618 (26.2)
Speech / swallowing disorders (indicated by receiving ST)	71 (3.0)	Northern	361 (15.3)
Residual neurological deficits	46 (2.0)	Central	413 (17.5)
Dead at hospital discharge	223 (9.5)	Southern	430 (18.2)
Infections & aspiration pneumonia	368 (15.6)	Kao-Ping	456 (19.3)
CCI 0	1162 (49.3)	Eastern	80 (3.4)
1-2	1036 (43.9)		
≥ 3	160 (6.8)		

SAH: subarachnoid hemorrhage; ICH: intracerebral hemorrhage; CI: cerebral infarction; Others: TIA & unspecified CVD; PT: physical therapy; OT: occupational therapy; ST: speech therapy; ADL: activities of daily living; CCI: charlson comorbidity index.

used mechanical ventilation, 28.8% had physical impairment or functional dependence in activities of daily living (ADL) and 3.0% had a speech or swallowing disorders. Only a few subjects (2.0%) were coded with residual neurological deficits, such as epilepsy, anoxic brain damage, encephalopathy, convulsions, or aphasia. In total, 223 subjects (9.5%) were assumed to die at hospital discharge. The case-fatality rate varied widely across stroke types. It was 48.5% for the SAH cohort, 27.2% for the ICH, 5.8% for the CI, and 1.1% for other stroke cohort. The rate of infections or aspiration pneumonia during hospital stay was 15.6%. About half (49.3%) of the stroke subjects did not have any comorbidity in term of CCI categories, while 43.9% had a CCI of 1-2, and only a few patients (6.8%) had a CCI of ≥ 3. Regarding the admitted hospital characteristics, a larger proportion of subjects were admitted to a neurological ward (48.8%), a regional hospital (39.6%), a nonprofit proprietary hospital (44.9%) or a hospital located in Taipei region (26.2%).

Although only 245 subjects (10.4%) had PHS, they accounted 38.9% of the total person-hospital bed days and 47.8% of the total inpatient medical expenses (Table 2). The average LOS for those with PHS was 40.1±21.2 days (37.5 days in acute beds, 2.5 days in chronic beds), while the average LOS for patients discharged within 22 days was 7.3±5.0 days (7.2 days in acute beds, 0.1 day in chronic beds).

Factors associated with PHS

The proportion of PHS was higher in aged 75 or above and female patients (Table 3). It varied in stroke type, several indicators of stroke severity, and complications or comorbidities. A higher proportion of PHS was found in SAH, followed by ICH, CI, and others. PHS was more frequent in patients who had surgery, used

Table 2. *LOS and costs in acute hospital stay: divided by PHS and Non-PHS*

		PHS (LOS ≥ 23 days)	Non-PHS (LOS < 23 days)
	Total	245 (10.4%)	2113 (89.6%)
Average LOS, Days (SD)			
Acute bed	10.4	37.5 ± 22.0	7.2 ± 5.0
Chronic bed	0.4	2.5 ± 11.5	0.1 ± 1.0
Total	10.7	40.1 ± 21.2	7.3 ± 5.0
Total person-hospital bed days (%)			
Acute bed	24,438	9,197 (37.6)	15,241 (62.4)
Chronic bed	832	622 (74.8)	210 (25.2)
Total	25,270	9,819 (38.9)	15,451 (61.1)
Average costs per discharge (NT$), Mean±SD			
Acute bed	54,964	251,140 ± 228,322	32,217 ± 42,931
Chronic bed	785	5,222 ± 30,311	270 ± 2,732
Total	55,748	256,362 ± 226,435	32,487 ± 42,831
Total inpatient medical expenses, NT$ (%)			
Acute bed	129,604,192	61,529,202 (47.5)	68,074,990 (52.5)
Chronic bed	1,849,857	1,279,412 (69.2)	570,445 (30.8)
Total	131,454,049	62,808,614 (47.8)	68,645,435 (52.2)

mechanical ventilation, had physical/ADL dependency, or had speech/swallowing disorders. Patients with infections or aspiration pneumonia, and Charlson Comorbidity Index of ≥ 3 were prone to have PHS. Patients who admitted to a neurosurgical ward, a medical center, a public hospital or a hospital in the Taipei region were prone to have PHS, too.

Multiple logistic regression analysis demonstrated several factors were independently associated with PHS (Table 4). The selected variables by the forward stepwise method were ranked by "effective size" as follows: surgical operation, physical/ADL dependency, infections or aspiration pneumonia, speech/swallowing disorders, admission to a hospital in the Taipei region, admission to a public hospital, stroke type, Charlson comorbidity index, gender, dead at discharge, and aged 75 or more (Nagelkerke R2 = 0.410, $p<0.001$). Of most importance, patients who had surgical procedures were 11.14 times risk to have PHS. Odds ratio (OR) of PHS was 4.53 and 4.23 for those with physical/ADL disorders and speech/swallowing disorders, respectively, compared to baseline. Occurrence of infections or aspiration pneumonia carried 5.24 times risk to have a PHS.

DISCUSSION

Stroke has been shown to be one of the most common causes of prolonged hospitalization in Taiwan[9,12,21]. This study has specifically addressed this by using Taiwan's NHI claims data. Patients with PHS constituted only 10.4% of the total stroke subjects but 38.9% of the total person-hospital bed days and 47.8% of the total in-hospital medical expenses. Even for those with PHS, the majority of the hospital bed days were spent in acute beds rather than chronic beds. The social-economic impact associated with PHS can be enormous. Given the health care resource constraints and limited supply of acute hospital beds, it is important to identify the factors that hamper discharge of stroke patients and how they can be modified to increase the efficient use of hospital services.

This study found surgical operation was the strongest factor associated with PHS after acute stroke. There are potentially important roles of surgery in acute stroke treatment[22]. Given the prolongation of hospital stay by surgical intervention, the benefit and harm associated with surgical management for acute stroke must

Table 3. *Comparison of proportion of PHS among patients of different characteristics (N=2358)*

	Total	Prolonged hospital stay		P-value
	N	N	%	
Total	2358	245	(10.4)	
Patient characteristics				
Age				0.020
≤ 64	886	82	(9.3)	
65-74	787	73	(9.3)	
≥ 75	685	90	(13.1)	
Gender				0.040
Male	1348	125	(9.3)	
Female	1010	120	(11.9)	
Stroke type				<0.001
SAH	68	16	(23.5)	
ICH	382	80	(20.9)	
CI	1384	138	(10.0)	
Others	524	11	(2.1)	
Stroke severity proxies				
Received surgery				<0.001
Yes	221	95	(43.0)	
No	2137	150	(7.0)	
Use of mechanical ventilation				<0.001
Yes	121	39	(32.2)	
No	2237	206	(9.2)	
Hemiplegia or hemiparesis				NS
Yes	277	29	(10.5)	
No	2081	216	(10.4)	
Physical /ADL dependency (indicated by receiving PT/OT)				<0.001
Yes	680	149	(21.9)	
No	1678	96	(5.7)	
Speech / swallowing disorders (indicated by receiving ST)				<0.001
Yes	71	33	(46.5)	
No	2287	212	(9.3)	
Residual neurological deficits				NS
Yes	46	5	(10.9)	
No	2312	240	(10.4)	
Dead at discharge				NS
Dead	223	25	(11.2)	
Alive	2135	220	(10.3)	
Infection or aspiration pneumonia				<0.001
Yes	368	98	(26.6)	
No	1990	147	(7.4)	
Charlson Comorbidity Index				0.047
0	1162	109	(9.4)	
1-2	1036	111	(10.7)	
≥ 3	160	25	(15.6)	
Hospital characteristics				
Admission ward				<0.001
Neurological	1151	112	(9.7)	
Internal medicine	805	55	(6.8)	
Neurosurgical	293	60	(20.5)	
Miscellaneous	109	18	(16.5)	
Hospital accreditation level				<0.001
Medical center	617	90	(14.6)	
Regional	934	108	(11.6)	
District	807	47	(5.8)	
Hospital wwnership				<0.001
Public	554	83	(15.0)	
Nonprofit proprietary	1058	113	(10.7)	
Private	746	49	(6.6)	
Hospital location				<0.001
Taipei	618	100	(16.2)	
Northern	361	27	(7.5)	
Central	413	36	(8.7)	
Southern	430	34	(7.9)	
Kao-Ping	456	42	(9.2)	
Eastern	80	6	(7.5)	

Table 3. *(Continue)*

be weighted.

In our study, PHS was associated with patient coded with physical/ADL dependency and speech/swallowing problems as indicated by receiving rehabilitation services. It implied that rehabilitation need might serve as one of the proxies of stroke severity, although validation from further study was still needed. The coding might be one of the proxies of the stroke severity. Initial stroke severity has been demonstrated to be most predictive of the length of acute hospital stay. Based on a hospital-based study in Taiwan, Chang et al.[4] found NIHSS at admission, the quadratic term of the initial NIHSS score; modified Barthel Index score at admission, small-vessel occlusion stroke, sex, and smoking were the main

Table 4. *Factors associated with prolonged hospital stay (LOS ≥ 23 days) by multiple logistic regression analysis* (N=2358)*

	OR	95% CI for OR	P-value
Patient demographics			
Age (≤ 64)			
65-74	1.16	0.78 - 1.74	NS
≥ 75	1.69	1.13 - 2.52	0.010
Sex, Female	1.67	1.20 - 2.33	0.002
Stroke type (CI)			
SAH	3.04	1.38 - 6.67	0.006
ICH	1.74	1.13 - 2.69	0.012
Others	0.34	0.17 - 0.68	0.002
Stroke severity proxies			
Received surgery	11.14	7.12 -17.43	<0.001
Physical / ADL dependency (indicated by receiving PT/OT)	4.53	3.16 - 6.51	<0.001
Speech / swallowing disorders (indicated by receiving ST)	4.23	2.32 - 7.74	<0.001
Dead at discharge (alive)	0.47	0.26 - 0.83	0.009
Infections & aspiration pneumonia	5.45	3.81 - 7.80	<0.001
Charlson comorbidity index (0)			
1-2	1.87	1.31 - 2.67	0.001
≥ 3	2.72	1.53 - 4.83	0.001
Hospital characteristics			
Ownership (private)			
Public	2.06	1.28 - 3.31	0.003
Nonprofit proprietary	0.91	0.59 - 1.42	NS
Location (eastern)			
Taipei	3.91	1.43 -10.65	0.008
Northern	1.58	0.54 - 4.60	NS
Central	1.72	0.60 - 4.95	NS
Southern	1.22	0.43 - 3.47	NS
Kao-Ping	1.87	0.66 - 5.28	NS

Nagelkerke R Square = 0.410

* The following variables, in addition to the reported (significant) variables selected by the forward stepwise method, were entered into the model: use of mechanical ventilation, hemiplegia/hemiparesis, residual neurological deficits, admission ward, and hospital accreditation level.

explanatory factor for acute LOS. Appelros et al.[5] in Sweden found independent predictors of acute LOS were stroke severity (measured with the NIHSS), lacunar stroke, prestroke dementia, and smoking. By using a larger scale stroke samples with various patient or hospital attributes, our study might reinforce those findings by providing a more comprehensive picture. Further studies to verify our findings are mandatory.

In our study, functional disability delayed the discharge from acute care. It stressed the importance of finding efficient alternatives to deliver post-acute care for those occupied acute beds for long periods. Timely transfer to rehabilitation wards for those with residual disabilities requiring comprehensive inpatient rehabilitation care might be deemed necessary to release acute care beds and ensure a continuum of care. Long-term institutional care should be offered for frail elderly patients with severe disabilities or comorbidities[23,24].

With the introduction of inpatient payment reform (prospective-payment system based on Taiwan's Diagnosis-Related Groups) by the Bureau of NHI, a decrease of LOS might be expected. The availability of inpatient rehabilitation units or their alternative for the patients with acute stroke and accelerated discharge needs further exploration. In addition to inpatient rehabilitation care, community or home-based rehabilitation

should be provided for those with residual disabilities but do not need intensive inpatient rehabilitation care. In Taiwan, NHI covers outpatient rehabilitation services but not in-home ones. However, transportation barrier and lack of caregiver escort often preclude the patient from using such services[10]. Literatures suggested a mixed model of outpatient and home-based rehabilitation services may be the most cost-effective policy for community rehabilitation of elderly stroke patients. We propose that home rehabilitation services might be developed as an extension of early hospital discharge scheme and should be insured[10,21,25].

Occurrence of infections or aspiration pneumonia was also found to be significantly associated with PHS. Acute stroke predisposes to medical complications, such as pneumonia, urinary tract infections, malnutrition or volume depletion. Early supportive care and monitoring of physiological parameters may prevent such complications[26,27]. This is best done in a dedicated stroke unit with experienced staff. Early mobilization may prevent from infections, contractures, decubital ulcers, and thus shortens the hospitalization.

Stroke patients who stayed in hospital longer have complex care needs. A comprehensive care package is often needed after discharge to help them remained in the community successfully. Good discharge planning is crucial for effective and efficient hospital use and successful reintegration into the community. Discharge planning should be initiated as early as possible to have timely referral to the multidisciplinary team and early communication with the community services[14,24,28].

In conclusion, a few PHS patients accounted for disproportionately large share of the total patient-bed days and inpatient expenses. The social-economic impact associated with PHS can be enormous. In addition to age, gender, stroke type, surgery, comorbidity, and hospital characteristics; neurological impairment or functional disability was found to be associated with PHS after acute stroke. Occurrence of infections or aspiration pneumonia had also been shown to prolong hospital stay. An organized, multidisciplinary team approach should be initiated early after acute stroke to minimize functional disability, prevent complications and hence decrease the likelihood of PHS. NHI payment reform as well as establishment of a more integrated and affordable post-acute or long-term care system should be policy priorities to effectively reduce unnecessary acute hospital use and to ensure a seamless stroke care. Good discharge planning is crucial for effective and efficient hospital use and successful reintegration into the community.

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