

Inpatient Rehabilitation Utilization for Acute Stroke Under a Universal Health Insurance System

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The burden of stroke is set to rise over future decades because of the aging population.¹ Organized stroke care with timely multidisciplinary inpatient rehabilitation is associated with improved outcomes.²⁻⁵ Utilization and accessibility of inpatient rehabilitation services vary with age, race/ethnicity, geographic region, and country. Stroke type, stroke severity, complications, comorbidities, and physical and cognitive functioning have important roles in inpatient rehabilitation services, as well as nonclinical factors such as financial, structural, personal, and socioeconomic status.⁶⁻¹¹ However, utilization of inpatient rehabilitation services after stroke has been rarely explored at the healthcare system level.^{6,8-12}

Taiwan has a population of 23 million people, with a 2008 gross national product (GNP) of US \$17,941 per capita.¹³ In 1995, a universal National Health Insurance (NHI) program, financed in roughly equal shares by the government, employers, and households in a complex scheme that includes payroll taxes, subsidies, and individual premiums, commenced in Taiwan.^{14,15} The NHI program extended existing insurance coverage from 57% of the population to 98%, particularly to the most vulnerable populations (eg, children, older persons, and nonworking adults). Healthcare is delivered by a mixed system that includes private clinics, private nonprofit hospitals, and public hospitals, among which patients have full freedom of choice. Almost all medical institutions are contracted with the NHI program.

The benefits of the NHI program are comprehensive, including inpatient care, ambulatory care, laboratory tests, diagnostic imaging, prescriptions, certain over-the-counter drugs, dental care, alternative medicine, and other services. National health expenditure accounts for 6.2% of the GNP in Taiwan compared with 16% in the United States.¹⁶ Copayments (10% for inpatient care and 20% for outpatient care within 30 days of onset) are waived for patients experiencing acute stroke.^{14,15} Inpatient rehabilitation services are provided to patients with acute stroke in acute wards through coordination of rehabilitation physicians on request of the treating physicians. The NHI program sets its own fee schedule and pays hospitals for rehabilitation claims on a fee-for-service basis.

This study aimed to explore the utilization and factors associated with

the use of inpatient stroke rehabilitation services by a nationally representative cohort under a single-payer government-based universal health insurance pro-

Objective: To explore the population-level utilization and factors associated with the use of inpatient stroke rehabilitation services under a single-payer government-based National Health Insurance (NHI) program in Taiwan.

Study Design: Retrospective cohort study based on claims data.

Methods: Inpatients with stroke were sampled from a nationally representative cohort of 200,000 NHI program enrollees. Multiple inpatient claims for individuals were merged to create a patient-level file; the first-ever admission was considered the index stroke. Proxy indicators to represent stroke severity, comorbidity, and complications were constructed. Predisposing, need, and enabling characteristics associated with rehabilitation use were explored.

Results: Among 2639 identified patients with stroke from January 1, 1997, to December 31, 2002, the overall inpatient rehabilitation utilization was 34.0% (33.0% for physical therapy, 19.6% for occupational therapy, and 5.3% for speech therapy). Stroke type and stroke severity were immediate causes of rehabilitation use. Except in neurology wards, rehabilitation use was unaffected by physician or facility characteristics. Among 898 patients receiving rehabilitation services, the median number of treatment sessions was 8 (interquartile range, 4-19), and the total rehabilitation costs were US \$114.00 (interquartile range, \$47.80-\$258.30), with a mean (SD) length of stay of 22.2 (21.8) days.

Conclusions: In a setting in which ability to pay is neutralized, inpatient stroke rehabilitation service in this universal NHI program was equitable but inadequate relative to use elsewhere or estimated need. Less severe case mix and financial or human resources constraints might partially account for the low utilization. Further studies measuring stroke severity and functional status are needed to clarify the actual utilization, requirements, and cost-effectiveness of inpatient stroke rehabilitation services.

(*Am J Manag Care.* 2010;16(3):e67-e74)

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Published as a Web Exclusive

www.ajmc.com

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Take-Away Points

This study explored inpatient stroke rehabilitation use based on claims data from a nationally representative cohort under a single-payer universal health insurance system.

- Considered equitable but inadequate, rehabilitation use was 34.0%, mainly related to stroke type and severity.
- On average, patients received 8 treatment sessions at a total cost of US \$114.00 for rehabilitation, initiated approximately 7 to 14 days after acute stroke admission, with a mean (SD) length of stay of 22.2 (21.8) days.
- Less severe case mix and financial or human resource constraints may partially account for the low utilization.
- Measurement of stroke severity and functional status is needed to clarify the utilization and cost-effectiveness of inpatient stroke rehabilitation services.

hemorrhage (codes 431 and 432) as the primary discharge diagnosis.

Key Variables of Interest

The dependent variable was whether the patient received rehabilitation services during acute hospitalization after stroke. Use of rehabilitation services was defined as reimbursement claims for physical therapy, occupational therapy, speech therapy, or a combination of these therapies. Factors associated with

the use and amount of rehabilitation services were stratified into categories of predisposing (age and sex), need (stroke type, stroke severity, comorbidity, and complications), and enabling (onset year and hospital characteristics) characteristics according to a behavioral model of healthcare use.^{19,20}

gram in Taiwan. The NHI program in Taiwan has weathered the challenges of a decade, and its stable costs and short wait times for healthcare have garnered worldwide attention.^{16,17} Analyses of service utilization from this program may be relevant to countries pursuing implementation of more equitable and efficient healthcare systems.

METHODS

Study Subjects

A longitudinal NHI claims cohort data set, constructed by the National Health Research Institute in Taiwan, was used to identify our stroke sample. The cohort data set consists of all inpatient and outpatient medical claims and the registration files of 200,000 NHI program enrollees from 1996 to 2006 and was developed to follow up a representative group of the population longitudinally. The cohort was randomly sampled from 23,753,407 persons insured by the NHI program from March 1, 1995, to December 31, 2000, using the sampling technique function (linear congruential random number generation) of Sun WorkShop C 5.0 (Sun Microsystems, Inc, Santa Clara, CA).¹⁸ The distributions of age, sex, and health services utilization among the cohort are representative of the entire population in Taiwan.¹⁸ For this study, admissions were extracted from January 1, 1997, to December 31, 2002, with a principal discharge diagnosis of acute cerebrovascular disease (*International Classification of Diseases, Ninth Revision, Clinical Modification* [ICD-9-CM] codes 430-437). Multiple inpatient claims for individuals were merged to create a patient-level file; the first-ever admission was considered the index stroke.

A total of 2639 patients (2092 with ischemic stroke and 547 with hemorrhagic stroke) comprised the study sample. Ischemic stroke denoted cerebral infarction (ICD-9-CM codes 433, 434, and 436) or transient ischemic attack or other unspecified cerebrovascular diseases (codes 435 and 437) as the primary discharge diagnosis. Hemorrhagic stroke denoted subarachnoid hemorrhage (code 430) or intracerebral

The following 4 proxy indicators to represent stroke severity were constructed based on secondary diagnoses or *Current Procedural Terminology* (CPT) codes²¹: (1) surgical operation (any surgical procedures reimbursed by the NHI program such as craniotomy, ventriculostomy with shunting for hemorrhagic disease, and tracheostomy for patients with ventilation failure); (2) use of mechanical ventilation (CPT codes 94656 and 94657 and ICD-9-CM code 96.7x); (3) hemiplegia or hemiparesis (ICD-9-CM code 342.xx); and (4) residual neurologic deficits (ICD-9-CM codes 345.40-345.51 and 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).

Charlson Comorbidity Index (CCI) with hemiplegia and paraplegia excluded was used to quantify patients' preexisting or concurrent comorbidities.²² Clinical Classifications System software (ICD-9-CM [<http://www.hcup-us.ahrq.gov/toolssoftware/ccs/ccs.jsp>]) and the categorization system by Smith et al²¹ were used to identify infection or aspiration pneumonia. The identification of enrollees in the NHI research database was encrypted for privacy. Therefore, death status was based on "coded as dead at discharge" plus no additional healthcare utilization record after discharge.

Hospital characteristics included admission ward, hospital accreditation level, hospital ownership, and hospital location. Admission wards included neurology, general medicine, neurosurgery, rehabilitation, and miscellaneous. Based on the hospital bed size, sophistication of medical services, and teaching status, hospitals are classified into the following 3 accreditation levels: medical center, regional hospital, and district hospital. In Taiwan, there are more than 10 medical centers with thousands of beds, hundreds of physicians, and specialized stroke rehabilitation teams; more than 200

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regional hospitals with hundreds of beds and tens to a hundred physicians offering general rehabilitation programs; and hundreds of district hospitals of smaller bed size with basic rehabilitation services. Hospitals are broadly classified in the following 3 ownership categories: public hospitals (managed by the government, public enterprise, or universities), nonprofit hospitals (established by private universities or donations for the purposes of charity or medical research), and private hospitals (proprietary hospitals owned by physicians).²³ Hospital location was determined based on the NHI bureau to which the hospital belonged and was categorized as Taipei, Northern, Central, Southern, Kao-Ping (the most southern part of Taiwan), or Eastern regions.

The length of stay (LOS) per stroke episode was combined if a patient was transferred to other wards or hospitals for consecutive hospitalization or if the data were divided for administrative reasons. For patients who ever transferred to other wards or hospitals, the ward and hospital responsible for the care of index stroke admission and the main diagnostic category were adjudicated by 2 of us (H-CL and K-CC).

Statistical Analysis

SAS for Windows (version 8.2, SAS Institute, Cary, NC) and SPSS 11.0 for Windows (SPSS Inc, Chicago, IL) were used for data management and analysis. A multiple logistic regression analysis with all variables entered was performed to examine the factors associated with inpatient rehabilitation use simultaneously; the adjusted odds ratio (aOR) (95% confidence interval [CI]) was computed for each variable. One hundred forty patients ever admitted or transferred to the rehabilitation wards were excluded, leaving 2499 patients (1991 with ischemic stroke and 508 with hemorrhagic stroke) in the multivariate analysis. Goodness of fit was checked using Hosmer-Lemeshow test.

RESULTS

Among 2639 subjects with stroke (2092 ischemic and 547 hemorrhagic) with a mean age of 66.7 years, the proportions of subarachnoid hemorrhage, intracerebral hemorrhage, cerebral infarction, and other unspecified stroke were 3.1%, 17.6%, 58.8%, and 20.4%, respectively (Table 1). Mechanical ventilation was used in 5.6% of patients, and surgery was performed in 10.5% of patients. Fifteen percent had secondary hemiplegia or hemiparesis, while 2.0% had residual neurologic deficits such as epilepsy, anoxic brain damage, encephalopathy, convulsions, or aphasia. The rate of infection or aspiration pneumonia during the hospital stay was 16.1%. Almost half (49.1%) had no comorbidity, 29.4% had a CCI of 1, and 21.5% had a CCI of at least 2. The in-hospital mor-

tality was 9.2%. More subjects were admitted to neurology wards (46.5%), regional hospitals (38.7%), nonprofit hospitals (44.8%), and hospitals in Taipei (26.5%).

The overall utilization of inpatient stroke rehabilitation services was 34.0% (33.0% for physical therapy, 19.6% for occupational therapy, and 5.3% for speech therapy) (Table 1). Utilization was similar irrespective of age, sex, or onset year. Utilization was higher among patients with intracerebral hemorrhage (aOR, 2.93; 95% CI, 1.88-4.55), cerebral infarction (aOR, 3.49; 95% CI, 2.49-4.90), or hemiplegia or hemiparesis (aOR, 3.04; 95% CI, 2.27-4.08) and among patients who survived (aOR, 5.59; 95% CI, 3.25-9.61) ($P < .01$ for all). Utilization was less among patients with use of mechanical ventilation (aOR, 0.54; 95% CI, 0.31-0.95; $P = .05$), residual neurologic deficits (aOR, 0.42; 95% CI, 0.21-0.85; $P = .05$), or infection or aspiration pneumonia (aOR, 0.68; 95% CI, 0.50-0.92; $P = .05$).

Rehabilitation services were used more among patients treated in neurology wards (aOR, 2.09; 95% CI, 1.56-2.80; $P < .01$) or in Eastern hospitals (aOR, 2.10; 95% CI, 1.16-3.81; $P = .05$) (Table 1). Rehabilitation services were less used in public hospitals (aOR, 0.71; 95% CI, 0.51-0.98; $P = .05$), while no differences were observed in use across hospital accreditation levels.

The mean (SD) LOS was 22.2 (21.8) days for 898 patients with use of inpatient stroke rehabilitation services and 8.5 (10.7) days for 1741 patients without use ($P < .001$). Overall, the mean (SD) LOS was 13.2 (16.7) days for all subjects with stroke. Among patients who received rehabilitation services, the median number of treatment sessions was 8 (interquartile range, 4-19), and the total rehabilitation costs were US \$114.00 (interquartile range, \$47.80-\$258.30) (Table 2). The total rehabilitation costs represented a mean (SD) of 9.8% (8.2%) of the total hospitalization costs.

DISCUSSION

Using claims data from a nationally representative cohort in Taiwan, this study presents population-level evidence regarding the utilization and factors associated with the use of inpatient stroke rehabilitation services. Based on a universal health insurance system, our study avoids the complexities of segmentation of insurance status or multiple payers such as in the US healthcare market.^{23,24} This may represent an ideal setting in which ability to pay is neutralized, allowing investigation of how physician and clinical factors may influence timely use of inpatient stroke rehabilitation services. Despite limited precision of clinical information and potential coding inaccuracies in the claims administrative data set,²⁵ our study provided population-based representation and included

Table 1. Description and Rehabilitation Use of Subjects With Stroke by Predisposing, Need, and Enabling Characteristics

| Variable | Univariate Analysis (N = 2639) | | P | Multivariate Analysis Adjusted Odds Ratio (95% Confidence Interval) (n = 2499) ^a |
|---------------------------------------------------|--------------------------------|---------------------------------|-------|------------------------------------------------------------------------------------------------------|
| | Total | Rehabilitation Use (n = 898) | | |
| Predisposing Characteristics | | | | |
| Age group, y, No. (%) | | | .144 | |
| ≤64 | 1006 (38.1) | 352 (35.0) | | 1.00 [Reference] |
| 65-74 | 885 (33.5) | 313 (35.4) | | 0.94 (0.73-1.20) |
| ≥75 | 748 (28.3) | 233 (31.1) | | 0.77 (0.59-1.01) |
| Sex, No. (%) | | | .199 | |
| Male | 1518 (57.5) | 532 (35.0) | | 1.00 [Reference] |
| Female | 1121 (42.5) | 366 (32.6) | | 0.97 (0.78-1.20) |
| Need Characteristics | | | | |
| Stroke type, No. (%) | | | <.001 | |
| Subarachnoid hemorrhage | 82 (3.1) | 13 (15.9) | | 0.62 (0.25-1.56) |
| Intracerebral hemorrhage | 465 (17.6) | 188 (40.4) | | 2.93 (1.88-4.55) ^b |
| Cerebral infarction | 1553 (58.8) | 636 (41.0) | | 3.49 (2.49-4.90) ^b |
| Other | 539 (20.4) | 61 (11.3) | | 1.00 [Reference] |
| Stroke severity proxies, No. (%) | | | | |
| Underwent surgery | | | .03 | |
| Yes | 276 (10.5) | 110 (39.9) | | 0.68 (0.44-1.04) |
| No | 2363 (89.5) | 788 (33.3) | | 1.00 [Reference] |
| Use of mechanical ventilation | | | .121 | |
| Yes | 149 (5.6) | 42 (28.2) | | 0.54 (0.31-0.95) ^c |
| No | 2490 (94.4) | 856 (34.4) | | 1.00 [Reference] |
| Hemiplegia or hemiparesis | | | <.001 | |
| Yes | 396 (15.0) | 259 (65.4) | | 3.04 (2.27-4.08) ^b |
| No | 2243 (85.0) | 639 (28.5) | | 1.00 [Reference] |
| Residual neurologic deficits | | | .327 | |
| Yes | 54 (2.0) | 15 (27.8) | | 0.42 (0.21-0.85) ^c |
| No | 2585 (98.0) | 883 (34.2) | | 1.00 [Reference] |
| Infection or aspiration pneumonia, No. (%) | | | .329 | |
| Yes | 424 (16.1) | 153 (36.1) | | 0.68 (0.50-0.92) ^c |
| No | 2215 (83.9) | 745 (33.6) | | 1.00 [Reference] |
| Charlson Comorbidity Index, No. (%) | | | .946 | |
| 0 | 1296 (49.1) | 437 (33.7) | | 1.00 [Reference] |
| 1 | 776 (29.4) | 266 (34.3) | | 1.12 (0.88-1.44) |
| ≥2 | 567 (21.5) | 195 (34.4) | | 0.98 (0.74-1.29) |
| Dead at discharge, No. (%) | | | <.001 | |
| Yes | 243 (9.2) | 21 (8.6) | | 1.00 [Reference] |
| No | 2396 (90.8) | 877 (36.6) | | 5.59 (3.25-9.61) ^b |

(Continued)

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Table 1. Description and Rehabilitation Use of Subjects With Stroke by Predisposing, Need, and Enabling Characteristics (*Continued*)

| Variable | Univariate Analysis (N = 2639) | | P | Multivariate Analysis Adjusted Odds Ratio (95% Confidence Interval) (n = 2499) ^a |
|-----------------------------------------------------------|--------------------------------|---------------------------------|-------|------------------------------------------------------------------------------------------------------|
| | Total | Rehabilitation Use (n = 898) | | |
| Need Characteristics (<i>Continued</i>) | | | | |
| Length of stay | 13.2 (16.7) | | <.001 | |
| ≤7 | 1318 (49.9) | 162 (12.3) | | 1.00 [Reference] |
| 8-15 | 676 (25.6) | 309 (45.7) | | 5.97 (4.63-7.70) ^b |
| 16-30 | 392 (14.9) | 236 (60.2) | | 12.76 (9.15-17.80) ^b |
| ≥31 | 253 (9.6) | 191 (75.5) | | 28.74 (17.78-46.44) ^b |
| With transition to other ward or hospital, No. (%) | | | <.001 | |
| Yes | 173 (6.6) | 109 (63.0) | | 1.26 (0.81-1.95) |
| No | 2466 (93.4) | 789 (32.0) | | 1.00 [Reference] |
| Enabling Characteristics, No. (%) | | | | |
| Onset year | | | .459 | |
| 1997-1999 | 1346 (51.0) | 449 (33.4) | | 1.00 [Reference] |
| 2000-2002 | 1293 (49.0) | 449 (34.7) | | 1.10 (0.89-1.36) |
| Admission ward | | | <.001 | |
| Neurology | 1226 (46.5) | 463 (37.8) | | 2.09 (1.56-2.80) ^b |
| General medicine | 830 (31.5) | 169 (20.4) | | 1.00 [Reference] |
| Neurosurgery | 342 (13.0) | 108 (31.6) | | 1.56 (0.99-2.46) |
| Rehabilitation | 124 (4.7) | 121 (97.6) | | — |
| Miscellaneous | 117 (4.4) | 37 (31.6) | | 1.55 (0.91-2.66) |
| Hospital accreditation level | | | <.001 | |
| Medical center | 778 (29.5) | 349 (44.9) | | 0.91 (0.64-1.31) |
| Regional hospital | 1021 (38.7) | 345 (33.8) | | 0.82 (0.60-1.12) |
| District hospital | 840 (31.8) | 204 (24.3) | | 1.00 [Reference] |
| Hospital ownership | | | <.001 | |
| Public | 635 (24.1) | 219 (34.5) | | 0.71 (0.51-0.98) ^c |
| Nonprofit | 1183 (44.8) | 458 (38.7) | | 1.19 (0.88-1.61) |
| Private | 821 (31.1) | 221 (26.9) | | 1.00 [Reference] |
| Hospital location | | | NS | |
| Taipei | 700 (26.5) | 247 (35.3) | | 0.77 (0.55-1.09) |
| Northern | 409 (15.5) | 143 (35.0) | | 1.06 (0.73-1.54) |
| Central | 461 (17.5) | 138 (29.9) | | 1.00 [Reference] |
| Southern | 460 (17.4) | 153 (33.3) | | 1.28 (0.89-1.82) |
| Kao-Ping | 518 (19.6) | 178 (34.4) | | 1.18 (0.82-1.68) |
| Eastern | 91 (3.4) | 39 (42.9) | | 2.10 (1.16-3.81) ^c |

^aPatients ever admitted or transferred to the rehabilitation ward were excluded from the multivariate analysis, as the main reason was for rehabilitation. Independent variables in the multivariate analysis were age, sex, onset year, stroke type, stroke severity, complications, Charlson Comorbidity Index, in-hospital mortality, admission ward, hospital accreditation level, hospital ownership, hospital location, length of stay, and ever transfer to other ward or hospital.

^bP < .01.

^cP < .05.

Table 2. Number of Treatment Sessions and Costs of Rehabilitation Use Among 898 Stroke Patients Receiving Rehabilitation Services

| Variable | No. of Treatment Sessions | Total Rehabilitation Costs, US \$ | Mean Cost per Session, US \$ | Total Rehabilitation Costs as % of Total Hospitalization Costs |
|---------------------------------------|---------------------------|-----------------------------------|------------------------------|----------------------------------------------------------------|
| Rehabilitation (n = 898) | | | | |
| Mean (SD) | 15.7 (22.0) | 225.00 (326.80) | 13.70 (3.60) | 9.8 (8.2) |
| Median (IQR) | 8 (4-19) | 114.00 (47.80-258.30) | 14.70 (10.90-16.50) | 7.6 (3.7-14.4) |
| Range | 1-269 | 2.90-2654.00 | 2.90-23.00 | 0.2-74.0 |
| Physical therapy (n = 872) | | | | |
| Mean (SD) | 9.1 (10.9) | 138.70 (175.80) | 14.80 (4.00) | 6.6 (4.7) |
| Median (IQR) | 6 (3-10) | 77.20 (36.80-156.90) | 16.10 (12.30-18.40) | 5.7 (2.8-9.4) |
| Range | 1-142 | 2.90-1346.00 | 2.90-18.40 | 0.1-39.2 |
| Occupational therapy (n = 516) | | | | |
| Mean (SD) | 10.3 (12.4) | 134.50 (155.30) | 13.00 (3.10) | 5.5 (4.0) |
| Median (IQR) | 6 (3-12) | 88.30 (38.60-155.10) | 14.00 (10.00-14.70) | 4.7 (2.3-7.6) |
| Range | 1-127 | 5.80-1089.80 | 4.30-26.40 | 0.2-34.8 |
| Speech therapy (n = 140) | | | | |
| Mean (SD) | 6.4 (6.9) | 82.50 (96.40) | 12.20 (2.60) | 2.2 (1.9) |
| Median (IQR) | 4 (2-8) | 46.60 (22.10-108.70) | 13.20 (9.80-14.70) | 1.6 (0.7-3.2) |
| Range | 1-41 | 5.80-595.80 | 5.80-14.70 | 0.1-9.9 |

IQR indicates interquartile range (25th to 75th percentiles).

heterogeneous patient and facility characteristics.

Although not directly comparable, our utilization rates of inpatient stroke rehabilitation were lower than those observed in the United States,^{8,11} Canada,⁹ United Kingdom,¹⁰ and Austria,⁶ ranging from 59% to 75% for in-hospital physical therapy, 16% to 39% for occupational therapy, and 10% to 23% for speech therapy. Because of universal coverage and comprehensive benefits, the NHI claims data set fully captures the use of inpatient stroke rehabilitation services among subjects with stroke. The low utilization rates might suggest a less severe case mix in Taiwan, as the NHI program provides complete reimbursement for evaluation and management of all patients with suspected stroke. Rehabilitation therapy is a burgeoning medical profession in Taiwan, with professional licensure laws enacted for physical therapy in 1994, for occupational therapy in 1997, and for speech therapy in 2009. Based on official health statistics in Taiwan,²⁶ there were 3084 registered physical therapy personnel (1942 physical therapists and 1142 physical therapy assistants) in 2002; most worked at various levels in hospitals and primary care clinics. There were an estimated 1.4 physical therapists per 10,000 Taiwanese in 2002 (3084 physical therapy personnel among a population of 22 million) compared with 4.3 in the United States in 1999 and 5.0 in Canada in 2000.²⁷ Health services utilization has been shown to be associated with the supply of healthcare providers²⁰; therefore, too few rehabilitation

personnel and rationed rehabilitation services could partially account for the lower utilization in Taiwan.

Consultation between treating physicians in acute wards and rehabilitation physicians is required by the NHI program before the administration of stroke rehabilitation therapies along with considering the size and location of the cerebral lesion, severity of impairment, comorbidities, and patient age.²⁸ This dual-gatekeeper referral system might result in greater patient selection and more prudent utilization of rehabilitation services but also limited accessibility. Furthermore, the NHI program pays all types of hospitals for rehabilitation claims using fixed schedules on a fee-for-service basis rather than a prepaid basis; this mitigates concerns about payment-driven differential use of inpatient rehabilitation services. The attending physician's philosophy or knowledge about rehabilitation services could also affect rehabilitation use, as reflected by our finding that patients with stroke treated in neurology wards were more likely to receive rehabilitation services. Therefore, it is speculated that a less severe case mix, dual-gatekeeper reimbursement policy, rehabilitation resource constraints, and attending physician philosophy all had some role in the low utilization of stroke rehabilitation services in Taiwan. Measures to facilitate timely multidisciplinary rehabilitation for patients with stroke represent a challenge in the management of stroke care.

Timing of rehabilitation referral or initiation is important in the optimal provision of rehabilitation services.^{11,29} Al-

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though not directly measured in this study, it was estimated that rehabilitation programs were initiated 7 to 14 days after acute stroke admission, given a median of 8 (interquartile range, 4-19) treatment sessions during a mean (SD) LOS of 22.2 (21.8) days among 898 patients with use of inpatient stroke rehabilitation services. The delayed timing might suggest that rehabilitation care was being rationed because of inability to meet demand. Because timely rehabilitation is important to success in the modern stroke unit care,^{5,30-33} potential negative effects of insufficient accessibility and availability or delayed timing of rehabilitation services on the functional outcome of patients with stroke at discharge were suspected but were not ascertained from this study.

The greater likelihood of receiving inpatient stroke rehabilitation services in the Eastern region, the least developed area in Taiwan, was unexpected. Rehabilitation use is believed to be associated with the availability of rehabilitation providers and with the sophistication of stroke rehabilitation services in hospitals of different accreditation levels.^{20,34} Physical therapy resources were found to be abundant in the urban Eastern region³⁴; therefore, the observed regional differences might be explained by greater availability of rehabilitation providers and by more hospitals with sophisticated stroke rehabilitation services. The finding of lower utilization in the public hospitals after adjusting for case mix and other facility characteristics could be because of the heterogeneous composition of public hospitals or because of overfitting of the multivariate logistic regression modeling and requires further clarification.

The LOS among patients with stroke receiving rehabilitation services was significantly longer compared with that among patients not receiving rehabilitation services. Although the total direct rehabilitation costs constituted only 9.8% of the total hospitalization costs, the accompanying prolonged LOS can result in enormous hospitalization costs.³⁵ During the study period, inpatient services were mainly reimbursed on a fee-for-service basis rather than a prospective payment system based on diagnosis-related groups. The longer LOS for the patients with rehabilitation use might have reflected their stroke severity or functional disability, but some patients may have stayed longer than necessary to obtain postacute rehabilitation.³⁵ Nevertheless, long-term stroke costs might be reduced by early and careful triage in case management and by case-dependent investment in initially costly inpatient rehabilitation.²⁸ Further study of causal relationships between rehabilitation use and LOS validated by outcomes at discharge is needed to prove the effectiveness of early inpatient rehabilitation.

A limitation of administrative data is that ICD-9-CM and CPT codes used to define stroke severity might be imprecisely or incompletely recorded; therefore, misclassification bias is un-

avoidable in studies analyzing claims data sets.²⁵ Reform of the reimbursement system to require documentation based on neurologic deficits or daily activity scales along with ICD-9-CM codes could improve the usefulness of claims data sets. Despite these limitations, patient-level and hospital-level characteristics of this cohort have been shown to capture a large variation in hospital LOS and costs,^{35,36} and their usefulness is believed to outweigh some potential weaknesses of claims data sets.

In conclusion, stroke type and stroke severity proxies were the most immediate causes of inpatient rehabilitation use. Demographics and physician or facility characteristics did not notably affect rehabilitation use, except for an overall greater likelihood to receive rehabilitation services in neurology wards. Inpatient rehabilitation utilization for acute stroke in Taiwan is considered equitable but inadequate relative to what is available elsewhere and to the estimated need. Less severe case mix and financial or human resource constraints may partially account for the low utilization of stroke rehabilitation services in Taiwan. Further prospective clinical studies with stroke severity and functional status measured at admission and discharge are needed to clarify the actual utilization, requirements, and cost-effectiveness of inpatient stroke rehabilitation services.³⁷⁻³⁹

Acknowledgment

We thank Ms Yu-Chiao Wang for her technical help with data management of the National Health Insurance claims database.

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Funding Source: This study was supported in part by grant NSC 92-2314-B-010-028 from the National Science Council, Taiwan, and was based in part on data derived from the National Health Insurance claims database in Taiwan. The findings and opinions reported herein are those of the authors and do not necessarily represent the views of any other organizations.

Author Disclosure: The authors (H-CL, K-CC, Y-CH, C-FL, J-JC, S-HW) report no relationship or financial interest with any entity that would pose a conflict of interest with the subject matter of this article.

Authorship Information: Concept and design (H-CL, K-CC, C-FL, J-JC, S-HW); acquisition of data (H-CL); analysis and interpretation of data (H-CL, K-CC, Y-CH, S-HW); drafting of the manuscript (H-CL, K-CC, Y-CH); critical revision of the manuscript for important intellectual content (H-CL, K-CC, Y-CH, C-FL, J-JC); statistical analysis (H-CL, Y-CH, S-HW); obtaining funding (H-CL); administrative, technical, or logistic support (K-CC, Y-CH, C-FL, J-JC); and supervision (C-FL, J-JC, S-HW).

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