PREDICTING THE GRADE OF DISABILITY 1 YEAR AFTER STROKE FOLLOWING REHABILITATION

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The purpose of this study was to identify predictors of grades of disability at least 1 year after stroke rehabilitation therapy. We recruited stroke patients from the inpatient rehabilitation department of a university hospital. The degree of disability was graded using the disability evaluation at least 1 year after stroke onset. Functional ability was evaluated using the Functional Independence Measure instrument on admission, on discharge from the inpatient rehabilitation program, and at the 6-month follow-up visit after discharge. Major sociodemographic, medical, and rehabilitative factors were also collected during the hospitalization period. Of the 109 patients surveyed, 64 (58.7%) had severe or very severe grades of disability. The correlates of severe or very severe disability in logistic regression analyses were bilaterally affected (odds ratio, OR, 10.8), impaired orientation (OR, 3.6), and poorer functional ability at discharge (OR, 7.6). Based on the significant predictors identified, the logistic regression model correctly classified severe or very severe disability in 68.0% of subjects. The higher frequency of severe or very severe disability in this study may have been due to the relatively more severely affected stroke patient population in the inpatient rehabilitation service and the use of unique disability evaluation criteria. These results may provide information useful in planning continuous rehabilitation care and setting relevant socio-welfare policies for stroke victims.

Key Words: disability, rehabilitation, stroke
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Although most stroke patients who receive rehabilitation may improve in function, the rate and quality of improvement vary [1,2]. Some patients may experience permanent disability and remain dependent in many ways [3, 4]. Their need for continuing care and management has significant impacts on family members and society, and is a major concern for health care policy makers. Early identification of the factors affecting the grade of disability after recovery will be helpful in establishing reasonable rehabilitation programs and relevant socio-welfare policies.

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Disability evaluation (DE) is an official measurement of disablement especially in type and grade/severity. Disablement is defined as "a collective term referring to any experience that is a consequence of disease and which may be identified as impairment, disability or handicap" [5]. The final determination of the disability grade represents a legal identification of the disabled person and specifies and classifies the level of need for assistance and compensation [6]. The purposes of measuring disablement include: planning for future services, monitoring patient care, evaluating intervention effects, epidemiology, and assessing eligibility for benefits [7]. The last purpose is different from the common medical outcome measurements such as basic or instrumental function of activities of daily living (ADL). Without official approval from the DE, a patient cannot be eligible for formal compensation, assistance, or legal

exemption despite ADL limitations.

In Taiwan, stroke patients with motor, cognition and/or language limitations usually have their DE by medical specialists 1 year after onset. Qualified stroke victims will receive their Physically and Mentally Disabled Manual as an identification document to apply for welfare, health, education, environmental accommodation, communication, vocational and financial assistance or exemptions [8]. The grade from the DE becomes a crucial functional outcome index because it represents the level of disability or handicap recognized by society. The purpose of this prospective follow-up study was to identify predictors of DE grades at least 1 year after stroke for victims in Taiwan.

Methods

Subjects

Participants were recruited from stroke patients consecutively admitted to the rehabilitation department of Kaohsiung Medical University Hospital. This study was approved by the Ethics Committee of the University. Informed consent was obtained from all participants prior to participation. Stroke was defined as a rapidly developing clinical manifestation of a focal loss of cerebral function lasting more than 24 hours [9]. Diagnosis was made by consultant physicians and neurologists based on clinical symptoms and confirmed by findings of neuroimaging studies. During the study period, 172 stroke patients were admitted consecutively to the department with a diagnosis of cerebrovascular disease (International Classification of Diseases, ICD-9-CM, codes 430–434, 436–438) [10]. Of these, nine (5%) were excluded because there was no written consent or the data were incomplete. To minimize the influence of potential confounding effects, 12 patients who had a diagnosis of dementia at discharge or coma in a persistent vegetative state because of recurrent stroke or deteriorating condition during hospitalization were excluded. The follow-up DE was conducted at a mean of 13.8 ± 2.6 months after discharge. Of the 151 participants, 42 dropped out before the completion of the DE due to death (20), loss to follow-up (4), or incomplete DE (18). A total of 109 patients completed the DE in the rehabilitative or neurological clinics during the follow-up period from January 1, 1998, to July 31, 1999.

Instruments and procedure

Subjects underwent functional status assessment on admission, on discharge from the inpatient rehabilitation program, and at the 6-month follow-up visit after discharge. Functional status was assessed based on the ability to perform items of the Functional Independence Measure (FIM) [11]. All subjects were evaluated by the same senior physical therapist trained in using the FIM. The FIM is an 18-item, 7-level scale for assessing the patient's need for assistance (or devices) in six areas of daily activities: self care (eating, bathing, grooming, dressing upper body, dressing lower body, toileting); sphincter control (bowel, bladder); transfers (bed/chair transfer, toilet transfer, tub transfer); locomotion (walk/wheelchair, stairs); communication (comprehension, expression); and social cognition (social interaction, problem-solving, memory). Each FIM item is scored on seven ordinal levels, with 1 being the most disabled condition and 7 being the least. This makes a total possible FIM score of 18–126. In addition, orientation status at discharge was identified using the orientation scale of the Scandinavian Stroke Scale (SSS), which asks the patient to identify time (month), place (hospital name), and date of birth [12]. A patient answering correctly in all three items was regarded as having no disorientation.

Sociodemographic information, including gender, age at onset, years of education, occupation, living and marital status, and main caregiver, was collected using a questionnaire during hospitalization. Major medical data, including lesion area, side of paralysis, whether the attack was recurrent, stroke etiology, risk factors, medical complications, interval from stroke onset to rehabilitation commencement, rehabilitation stay, and whether the patient received continuous outpatient rehabilitation therapy, was collected from medical records within 1 month after discharge.

The Physically and Mentally Disabled Citizen Protection Law defines 14 official categories of disabilities with 3–4 grades (mild, moderate, severe, and very severe) under each category, and specifies a comprehensive evaluation procedure [8]. Disabled stroke victims might fit into one of three categories: limbs disabled, with irreversible limb dysfunction; voice\speech mechanism disabled, with difficulties in language comprehension or expression; and multi-disabled, with more than one category of disability. The evaluation of disability was determined by either a senior physiatrist or neurologist based on the criteria of the Physically and Mentally Disabled Citizen Protection Law and related regulations [8].

Statistical analysis

In order to strengthen the power of comparison, the grade of disability was grouped into mild/moderate and severe/

very severe. Repeated measures analysis of variance (ANOVA) was used to compare the functional status at admission, discharge, and 6-month follow-up after stroke between these two groups. Univariate analysis (Chi-squared test or Fisher's exact test, as appropriate) was used to examine the associations between categorical clinical and demographic factors among stroke patients and between the two disabled groups. For this reason, the discharge FIM score was pooled into either good (64–126) or poor-to-middle (18–63) categories [13]. Factors significant in the univariate analysis were then considered potential predictors of the grade of disability, and fitted into a stepwise logistic regression to construct a predictive model. All analyses were performed using the SAS statistical package version 6.12 for Windows (SAS Institute Inc, Cary, NC, USA). The level of significance was set at a p of 0.05 or less.

Results

Of 109 patients surveyed, there were 57 male (52%) and 52 female subjects. The mean age of stroke onset was 62.8 ± 11.7 years. The average number of years of education was 6.1 ± 4.8, equivalent to primary/elementary education. On average, the rehabilitation intervention started within a month of stroke onset (27.3 ± 21.1 days). All patients had at least limb disability on DE, in which five patients (5%), 59 (54%), 44 (40%), and one (1%) were graded as having very severe, severe, moderate, or mild disability, respectively. FIM scores were significantly different between the two groups at all time points (Table 1).

Various factors were examined to find out whether they were associated with the grade of disability (Tables 2–4). There were no obvious associations between severity and sociodemographic and general medical factors, except for the presence of medical complications (Tables 2 and 3). Among the stroke-related factors (Table 4), patients who had delayed rehabilitation therapy, did not receive continuous outpatient rehabilitation care, were bilaterally affected or orientation impaired, or had lower FIM score on discharge were more likely to be severely or very severely disabled. Except for the presence of medical complications, the delay of rehabilitation therapy, and no continuous outpatient rehabilitation care, only the following three factors remained significant in the logistic regression (Table 5): lower FIM score on discharge (odds ratio, OR, 7.6; 95% confidence interval, CI, 2.3–24.6), bilaterally affected (OR, 10.8; 95% CI, 1.3–91.9), and orientation impaired (OR, 3.6; 95% CI, 1.0–12.5); these were associated with a more severe grade of disability.

The resulting regression coefficients could be used to estimate the probability of developing severe or very severe disability at 12 months after stroke. This model correctly classified 68% of patients in this study as having severe or very severe disability. For example, for a stroke patient with bilateral hemiplegia due to brain stem infarction, intact orientation, and a 36-point FIM score on discharge, the probability of severe or very severe disability at 12 months after stroke may be estimated as follows:

$$\text{Probability} = 1/[1 + e^{-(-2.57 + A\times1 + B\times0 + C\times1)}]$$
$$= 1/[1 + e^{-(-2.57 + 2.38 + 0 + 2.02)}]$$
$$= 0.86$$

Where e is the exponential function, –2.57 is the regression coefficient constant, A is the regression coefficient of side of hemiplegia, B is the coefficient of orientation, and C is the coefficient of the discharge FIM score.

Discussion

This prospective study is the first to investigate the grade of disability in stroke victims according to the DE in Taiwan. We also established a model to predict severe or very severe disability.

Among the 109 stroke victims surveyed, 64 (58.7%) had severe or very severe disability. This percentage is considerably higher than that reported in the Copenhagen study (20%) [2].The main reason for the difference may be

Table 1. Mean Functional Independence Measure (FIM) scores in the two disability groups at different time points

Grade of disability	Admission FIM*	Discharge FIM*	Follow-up FIM*	p
Mild/moderate (n = 45)	65.4 ± 21.2	87.4 ± 17.4†	100.1 ± 19.6‡	int = 0.016
Severe/very severe (n = 64)	46.7 ± 22.7	65.3 ± 27.4†	69.7 ± 33.9	grp = 0.000

*$p < 0.0001$ between disabled groups; †$p < 0.0001$ from admission after Sharpened Bonferroni adjustment; ‡$p < 0.0001$ from discharge after Sharpened Bonferroni adjustment. int = interaction; grp = group.

Table 2. Associations between demographic factors and severe or very severe disability

Demographic factor	*N*	Severe or very severe disability, %	χ^2	*p*
Gender				
Male	36	63.2		
Female	28	53.9	0.97	0.32
Age (yr)				
< 65	32	56.1		
≥ 65	32	61.5	0.33	0.57
Education (yr)				
< 7	43	58.1		
≥ 7	21	60.0	0.04	0.85
Literate				
No	13	48.2		
Yes	51	62.2	1.65	0.20
Occupation				
Labor	25	59.5		
Others	39	58.2	0.02	0.89
Living with family members				
No	3	25.0		
Yes	61	62.9	—	0.01*
Marital status				
Married	44	59.5		
Single/divorced/widowed	20	57.1	0.05	0.82
Main caregiver during hospitalization				
Family members	37	53.6		
Professional	27	67.5	2.01	0.16

*Fisher's exact test.

Table 3. Associations between general medical status and severe or very severe disability

General medical status	*N*	Severe or very severe disability, %	χ^2	*p*
Prior hypertension				
No	6	46.2		
Yes	58	60.4	0.96	0.33
Prior diabetes				
No	42	62.7		
Yes	22	52.4	1.13	0.29
Prior heart disease				
No	42	56.8		
Yes	22	62.9	0.37	0.55
Other medical complications				
No	36	50.0		
Yes	28	75.7	6.65	0.01

that all subjects recruited in this study were referred to the inpatient rehabilitation service in a medical center. These patients might have more severe neurologic and physical impairments. Moreover, the present study used DE to define the grade of disability, which is very different from previous studies that used Barthel Index (BI) scores (0–20 and 25–45) to define very severe and severe disabilities [2,14, 15]. Under the limbs category, the grade of disability was

Table 4. Associations between stroke-related factors and severe or very severe disability

Stroke-related factor	*N*	Severe or very severe disability, %	χ^2	*p*
Onset to rehabilitation therapy				
< 31 days	42	52.5		
≥ 31 days	22	75.9	4.80	0.03
Rehabilitation stay				
< 31 days	24	53.3		
≥ 31 days	40	62.5	0.92	0.34
Received continuous outpatient rehabilitation care				
Yes	20	46.5		
No	44	66.7	4.36	0.04
Number of attack				
First	44	54.3		
Recurrent	20	71.4	2.51	0.11
Brain lesion area				
Cortical	33	62.3		
Subcortical	31	55.4	0.54	0.46
Type of stroke				
Infarction	36	58.1		
Hemorrhage	28	59.6	0.03	0.87
Side of hemiplegia				
Unilateral	52	54.2		
Bilateral	12	92.3	6.87	0.009
Orientation				
Normal	42	50.6		
Impaired	22	84.6	9.45	0.002
Discharge FIM score				
18–63 points	28	87.5		
64–126 points	36	46.8	15.5	0.001

FIM = Functional Independence Measure.

judged according to the patient's "impairments" as loss or abnormality of psychologic, physiologic, or anatomic structure or function at the organ or system level. However, BI scores focus on the levels of daily activity functions, which measure "disability". Impairment of the limbs does not necessarily lead to self-care dysfunction. The DE under the Social Security system in the USA has been amended to assess stroke victims' disability rather than impairment [16]. Since one of the aims of DE is to decide the appropriate level of services and benefits, it should reflect the degree of difficulty in activity performance. From this viewpoint, measurement of disability in terms of comprehensive ADL score might better serve this purpose than impairment [17].

In this study, functional status was significantly different between the two disabled groups, as assessed by the FIM instrument. The changes in FIM scores indicate that the severe/very severe disability group had significant improvement during the rehabilitation stay, but less significant improvement at later stages of recovery (discharge to 6-month follow-up). However, patients in the mild/moderate disability group, who had higher admission FIM scores, not only improved significantly during rehabilitation stay but also showed continued improvement at the 6-month follow-up visit. This finding is consistent with previous reports showing that most recovery occurs within the first 3–6 months [2,14]. Therefore, DE should be held at least 6 months after stroke onset [16,18].

On the other hand, bilateral hemiplegia, impaired orientation, and lower discharge FIM scores were found to be connected to the grade of disability. We found that bilateral stroke involvement was an important predictor of severe or very severe disability. The neurologic impairment

Table 5. Significant predictors influencing the results of disability evaluation

Factor	Regression coefficient (β)	Standard error	*p*	Odds ratio	95% CI
Side of hemiplegia					
Bilateral	2.38	1.09	0.0299	10.8	1.26–91.9
Left or right	—	—	—	1.00	—
Orientation					
Impaired	1.28	0.64	0.0442	3.60	1.03–12.5
Normal	—	—	—	1.00	—
Discharge FIM score					
18–63 points	2.02	0.60	0.0008	7.55	2.32–24.6
64–126 points	—	—	—	1.00	—
Constant	–2.57	0.75	0.0006	—	—

CI = confidence interval; FIM = Functional Independence Measure.

or physical disability left by a prior stroke will affect motor recovery from a subsequent stroke. Bilateral involvement in motor function of various severities was common in our patients after recurrent stroke. Apart from the impaired physical ability due to the present neurologic insult, the loss of ability to compensate for such loss from the sound side may also increase the dependency of stroke patients. The present study supports the findings of Pedersen et al that impaired orientation during hospitalization exerts a marked, negative influence on basic ADL and social function and subsequently leads to severe or very severe disability [12].

In this study, clinical and demographic data were collected before discharge instead of at admission, as in previous studies [19,20]. The total FIM score at discharge, divided into poor-to-middle (18–63) and high (64–126) score categories, was a useful predictor of the grade of disability. Although there was no universal agreement on score-ranking, and bias might also have been generated by differences between raters when conducting FIM measurements, FIM in general seems to be a useful tool not only to assess function but also to predict the grade of disability.

Although no related literature can be referred to in predicting the outcome of DE, the three predictors from the current study seem to be similar to those that predict functional outcome in the Western literature [2,14,15,19]. Many studies have shown that psychologic and social variables (which were not used in the current study) are important correlates of disability in post-stroke patients [21–23]. Future studies using a standardized psychologic and social support instrument and exploring the impact of related factors on the grade of disability will further improve the accuracy of the prediction in this study. A limitation of this study was that the duration of the continuous outpatient rehabilitation care after discharge was not investigated, which might be a very important factor affecting the results of this study. Further studies involving a larger sample from multiple district hospitals as well as medical centers are needed.

In summary, using logistic regression, models can be constructed to predict the probability of severe or very severe disability. The results of this study indicated that bilateral involvement, impaired orientation, and poorer functional ability at discharge were independent correlates of the grade of disability. Recognizing these factors may be helpful in selecting potential patients for aggressive rehabilitative treatment and preparing early relevant socio-welfare policies for stroke victims. Prospective studies to evaluate the usefulness of such a model are required.

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腦中風病人復健治療預後身心障礙等級的預測

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本研究目的是追蹤探討腦中風患者復健治療出院一年後身心障礙等級的預測因子。研究對象徵召某醫學大學附設醫院因腦中風住院在復健病房接受復健治療之患者。病發一年後身心障礙鑑定資料結果做為評量障礙等級的依據。在剛住院復健科、出院前和出院六個月後的訪視時，分別使用功能獨立自主量表 (**Functional Independence Measure**，**FIM**) 來評估日常生活功能，並且收集患者主要社會人口學及住院期間臨床診斷和評估資料做為預測變項。完成 **109** 位個案追蹤調查，結果發現有 **64** 位 (**58.7%**) 身心障礙等級為重度或極重度。邏輯迴歸分析顯示重要預測因子包括兩側肢體動作功能皆受損者 (勝算比值 **10.8**) 對比單側肢體受損者，出院時定向功能異常者 (勝算比值 **3.6**) 及日常生活功能情況較差者 (勝算比值 **7.6**)。根據這些重要預測因子所建立邏輯迴歸分析模式，可以正確歸類出 **68.0%** 的重度或極重度患者。本研究有較高比例的重度或極重度等級的身心障礙患者可能研究對象是相對較嚴重住院接受復健治療之中風患者和使用特定的身心障礙鑑定量表。這些結果可以提供有用的資料做為規劃中風患者後續復健醫療和擬訂相關社福政策的參考。

關鍵詞：身心障礙，復健，腦中風

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