Original Article

Clinical Predictors of Good Functional Outcome in Patients with Acute Stroke

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ABSTRACT

Objectives: To evaluate clinical predictors related to good functional outcomes in acute phase stroke patients.

Study design: Prognostic research with prospective cohort design.

Setting: Stroke Unit, Maharat Nakhon Ratchasima Hospital, Nakhon Ratchasima Province, Thailand.

Subjects: Acute stroke patients age over 18 years who were admitted for conservative treatment

Methods: Patients were interviewed face-to-face regarding general information and were physically examined for clinical predictors related to good functional outcome such as premorbid status, diagnosis, comorbid conditions, complications, neurological condition, and bed mobility ability. The Barthel index score was used to determine functional outcome at acute phase admission. The patients were later interviewed by phone to determine their Barthel index score at 2 weeks, 1 and 3 months. Statistical analysis of acute clinical predictors of good functional outcome was conducted using multivariable logistic regression.

Results: Two hundred patients were recruited of whom 6.5% were excluded from the study. The average age (SD) was 63.5 (15.2) years and 51.9% were male. At the 3-month follow-up, 82.9% of stroke-survival patients had a good functional outcome (Barthel index > 75). Clinical predictors of a good functional outcome included the ability to change the body position from supine to sitting, independent walking before admission, age less than 65 years and normal consciousness in the acute phase, with adjusted odd ratios (95% CI) of 21.63 (2.13-218.76), 15.80 (2.90-86.11), 4.95 (1.50-16.35) and 3.88 (1.65-9.16), respectively.

Conclusions: Among the stroke patients, the ability to change body position from supine to sitting, the ability to walk independently without gait aids before admission, age less than 65 years and normal consciousness in the acute phase were related to good functional outcome.

Keywords: Barthel index, functional outcome, clinical predictors, stroke, rehabilitation

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Introduction

Stroke is a global health burden around the world, including Thailand.[1-5] It is a major cause of disability, functional decline and dependent living that represents a burden to the patient's family and to the social support system. Intensive inpatient rehabilitation has been known to help stroke patients return to their normal life effectively;[6,7] however, over-crowding problems in large hospitals allows only a very short period of admission for both acute treatment and rehabilitation.[8,9] With the limited availability of resources, clinical predictors of good functional outcome in stroke patients that can be identified in the acute phase could help in the selection of the appropriate rehabilitation program for each patient, depending on his/her potential and could help recruit potentiated patients who are at risk of becoming more disabled for early intensive inpatient rehabilitation programs.

A suggestion from a hospital accreditation surveyor is that due to the very short period of acute stroke care available at the stroke unit and the limited number of intensive rehabilitation beds (only 12 beds in Maharat Nakhon Ratchasima Hospital), physicians should develop criteria for effectively identifying the most potentiated patients for the in-patient intensive rehabilitation program. The selection criteria should be simple, require only a short time for assessment at the bedside and should be able to be used even by a non-physiatrist, e.g., asking the patient about premorbid ambulation or asking them to change their body position from supine to siting without help.[10-12] Previous studies have identified factors associated with a good functional outcome in stroke patients including male gender, younger age, no diabetes mellitus, married status, normal consciousness, good motor power of the weak side, and the ability to transition from supine to sitting independently; however, all those factors were studied during the period after the acute phase.[6,10,11] A study of acute phase predictors at Maharat Nakhon Ratchasima Hospital found that male patients, age younger than 55, with muscle power of the weak side more than grade 2, and normal consciousness were associated

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with a good functional outcome. However, that retrospective study had limitations related to the reliability of medical records covering the acute phase, recall bias on telephone interviews and many patients being lost to follow-up.[13]

The present study was conducted to evaluate acute phase predictors of good functional outcome at the 3-month follow-up of stroke patients using a prospective design that would provide clinicians the opportunity to use predictive factors to recruit potentiated stroke patients for early intensive rehabilitation. Another objective was to study the pattern of stroke recovery covering the acute to the subacute phase using Barthel's index (BI) scores.

Methods

Study design

This prognostic research using a prospective cohort design was approved by the Ethics Committee of Maharat Nakhon Ratchasima Hospital, clinical trial registration number 091/2020.

Participants

From July 2019 to January 2020, acute stroke patients who were admitted to the stroke unit at Maharat Nakhon Ratchasima Hospital and who met the criteria of age 18 years or over with non-surgical treatment were recruited into the study. All patients or an immediate family member were asked for informed consent. Patients who were diagnosed with transient ischemic attack or other diseases, who later had stroke-related surgical treatment, and who could not be followed up, e.g., patients with no known phone number or who were unable to speak, and those who lived without a close caregiver, were excluded. The sample size was estimated using the Peduzzi formula[14] N = (10k)/P, where N is the sample size to be studied, K is number of independent factors of interest (k = 13), and P is the prevalence of good functional outcome (0.79).[13] The calculated sample size for predicting functional outcome was 164 cases plus 10% to cover loss to follow up and an additional 10% to cover exclusion for other reasons. We therefore included 200 cases in the present study.

Intervention

Data was collected by face-to-face interview and the recruited patients were physically examined by one of two physiatrists (NI or RS) within 72 hours following the stroke. The data collected consisted of the following: sex, age, premorbid status, length of stay, diagnosis, comorbidities, history of previous stoke, muscle power of the affected side, associated abnormalities (consciousness, speech, swallowing), ability to change position from supine to sitting, in-hospital complications, and admission Barthel index score. Telephone interviews were conducted to re-assess the functional level using the Barthel index at 2 weeks, 1 and 3 months.[15,16]

In the present study, good functional outcome is defined to mean the stroke patient had a Barthel index score of 75 points or more at the 3-month follow-up. Patients with other functional results at the initial examination conducted during the first 72 hours post-stroke, including death due to stroke or stroke-related complications, were included in the poor functional outcome group. The data analysis was conducted after all of the data collection was completed. The category 'associated abnormalities' was recorded as either normal or abnormal. Abnormal consciousness included inability to follow commands, drowsiness and coma. Abnormal speech included inability to name simple objects such as pen, cup and watch, inability to repeat an eight-word sentence containing 11 syllables, and unclear articulation of speech. Abnormal swallowing means dysphagia. Patients who were endotracheally intubated or who could not follow commands at the time of the examination were marked as "cannot be evaluated for speech and swallowing problems".

The Barthel index is considered a reliable disability scale and is commonly used to determine disability and to follow up the functional recovery of stroke patients. It consists of 10 activities (5 basic activities of daily living, 3 of mobility and 2 continence functions). Each item is scored based on the patient's ability where 0 points means totally dependent and 100 points means totally independent. The Barthel index can be divided into 5 categories by severity of disability: 0 to 20 points = very severe disability, 25-45 points = severe disability, 50-70 points = moderate disability, 75-95 points = mild disability, and 100 points = no disability.[17]

Outcome measurements

The main purpose of this study was to identify predictors of a good functional outcome within 3 months after a stroke in patients admitted to the stroke unit, in particular, outcomes related to daily activity independence. We considered the outcome at 3 months to be favorable if the Barthel index score was 75 or more. The following independent variables in the acute phase were identified as good clinical predictors: age, sex, premorbid ambulation, type of stroke (ischemic/hemorrhagic), co-morbidities (0-1 vs. 2 or more co-morbidities), a history of previous strokes, complications, level of consciousness, muscle power of the affected side (0-2 vs. 3-5), presence of aphasia or dysphagia, ability to change body position from supine to sitting without help and the admission Barthel index score. The second objective was to study the pattern of stroke recovery from the acute to the subacute phase using Barthel index (BI) scores.

Statistical methods

Baseline clinical characteristics are reported as percentages, means and standard deviations (SD). The relationship between general clinical characteristics and good functional outcome were assessed using Fisher's exact test. The relationships between clinical predictors and good functional outcome were analyzed by univariable logistic regression and are reported as a crude odds ratio (cOR) and 95% confidence interval (95% CI). All of the independent variables were then analyzed by multivariable logistic regression and are reported as an adjusted odds ratio (AdjOR) and 95% CI. Statistical significance was set at $p < 0.05$. Statistical analysis was conducted using Stata version 11.0.

Results

Two hundred stroke patients admitted to the acute stroke unit at Maharat Nakhon Ratchasima Hospital between July 2020 and January 2021 were recruited into this study, of whom thirteen (6.5%) were excluded: two had a recurrent stroke, three received a craniectomy, one had brain cancer, one was diagnosed with cerebral vasculitis, and six were lost to follow-up leaving 187 patients for analysis (Figure 1). Most (51.9%) were male, the average age was 63.5 years (SD 15.2), the median hospital stay was 3.8 days (IQR 18 hours to 6.4 days, min-max 6 hours and 143 days). Forty-seven (23.5%) died, most (19%) during the acute phase of admission. 81.3% had a current medical disease: the top three were hypertension (63.1%), dyslipidemia (25.7%) and diabetes mellitus (23.1%). Most (83.5%) could walk independently without any gait aid before admission, while only 5.9% could not walk before their stroke attack. Fifty-four patients (28.9%) had complications when they were admitted to the acute stroke unit; the top three were pneumonia (17.1%), acute renal failure (5.3%) and upper gastrointestinal hemorrhage (2.7%). Only 5.8% had good function (BI score 75 or more) when evaluated within the first 72 hours after the stroke; however, at the end of the study (at the 3-month follow-up), 118 patients (62.0%) had a good functional outcome as shown in Table 1.

Table 2 shows the relationship between clinical predictors in the acute phase and functional outcome at the 3-month follow-up using Fisher's exact test. It was determined that the factors of age 65 years old or less, independent premorbid ambulation, ischemic stroke, good consciousness, muscle power of the affected side grade 3 or more (useful muscle power), normal swallowing and speech, ability to change position from supine to sitting, and no complications at acute admission, were statistically significant predictors of a good functional outcome ($p < 0.05$). The variables associated with a good functional outcome are presented with odds ratios (95% CI) in Table 3. Admission BI scores could not be analyzed because there were no patients who had good function at acute admission which later regressed to poor function at the 3-month follow-up (n = 0). Using multivariable logistic regression, the ability to change body position from supine to sitting without help at acute admission, walking independently before admission, age 65 years or less, and normal consciousness were found to be significantly related to good functional outcome at the 3-month follow-up with AdjOR of 21.63 (95%CI 2.13, 218.76), 15.80 (95%CI 2.91, 86.11), 4.95 (95%CI 1.50, 16.35), 3.88 (95%CI 1.65, 9.16), respectively.

Table 4 shows the patterns of stroke recovery and disability level after the acute phase based on 3-month follow-up BI scores. The admission BI scores evaluated at the acute phase (72 hours or less after stroke) were found not to be related to the BI scores at the 3-month follow-up. At the acute phase, 33.7% were dependent stroke patients (very severe disability: BI scores 20 or less) but only 22.1% and 11.6% were dependent stroke patients at the 2-week and 1-month follow-up, respectively. Those numbers are close to the number of dependent stroke patients at the end of study (10%).

Discussion

The aim of this observational prospective study was to identify acute phase clinical factors that could predict good functional outcome at the 3-month follow-up after an acute stroke. Using multiple logistic regression, only four independent variables were found to be good functional predictors at

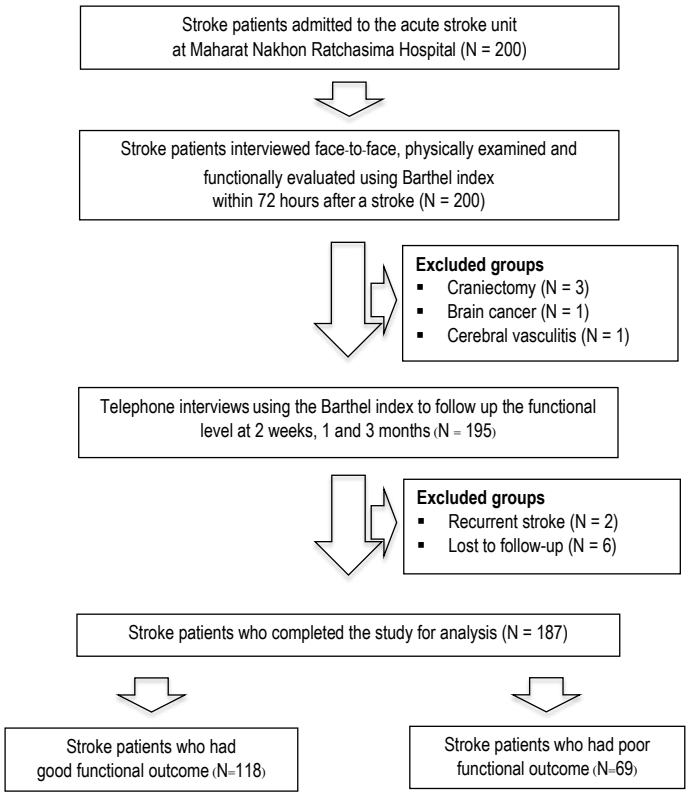

Figure 1. Flow of the study

Table 1. Demographic and clinical characteristics of the patients (n = 187)

Characteristics	Value
Average age (years), mean (SD, min-max)	63.5 (15.2, 29-94)
Age (years), n (%)	
Less than 65	99 (52.9)
65-75	45 (24.1)
More than 75	43 (23.0)
Gender: male, n (%)	97 (51.9)
Hospital length of stay (days), median (IQR, min-max)	3.8 (0.75 to 6.4, 0.3-143)
Type of stroke, n (%)	
Ischemic	106 (56.7)
Hemorrhagic	81 (43.3)
Co-morbidities, n (%)	
None	35 (18.7)
Diabetes mellitus	43 (23.0)
Hypertension	118 (63.1)
Dyslipidemia	48 (25.7)
Heart disease	38 (20.3)
Previous stroke	36 (19.3)
Premorbid ambulation status, n (%)	
Independent walking without gait aid	155 (82.9)
Independent walking with gait aid	21 (11.2)
Need assistance to walk or cannot walk	11 (5.9)
Consciousness, n (%)	
Followed command well	129 (69.0)
Drowsiness or coma	58 (31.0)
Muscle power of affected side, n (%)	
Grade 0-2	96 (51.3)
Grade 3-5	91 (48.7)
Swallowing, n (%)	
Normal	90 (48.1)
Abnormal	73 (39.0)
Could not be evaluated	24 (12.8)
Speech, n (%)	
Normal	110 (58.9)
Abnormal	51 (27.3)
Could not be evaluated	26 (13.9)
Able to change body position from supine to sitting, n (%)	73 (39)
Had in-hospital complications, n (%)	54 (28.9)
Received bedside rehabilitation service	51 (27.3)
Functional outcome at admission	
Good (Barthel index 75 or more)	11 (5.9)
Poor (Barthel index less than 75)	176 (94.1)
Functional outcome at the 3-month follow-up	
Good (Barthel index 75 or more)	116 (62.0)
Poor (Barthel index less than 75)	24 (12.8)

the 3-month follow-up: ability to change position from lying to sitting without help [21.63 (95%CI: 2.13-218.76)], independent premorbid ambulation [15.80 (95%CI: 2.91-86.11)], age 65 years or less [4.95 (95%CI: 1.50-16.35)] and normal consciousness [3.88 (95%CI: 1.65-9.16)].

From the multivariate analysis in this study, the ability to change body position from supine to sitting in the acute phase (within 72 hours from an acute stroke) and the premorbid ability of independent walking without any gait aid or assistance seem to be the strongest predictors of functional outcome, exceeding the predictive strength of the other two variables. These results are in line with previous studies.[10,11,18] This study helped confirm that the ability to change body position from supine to sitting is a very simple and useful observational indicator for predicting good functional outcome.[11] Asking a patient who is lying down to sit up requires only a few minutes. If they can do so independently, it indicates that they have a strong probability of a good functional outcome at the 3-month follow-up, 21.6 times greater than patients who cannot do so. Having less difficulty changing body position in bed, i.e., from supine to siting, may relate to having mild stroke symptoms, but we also found that some patients with useless muscle power (grade 0-2) on the affected side were still able to mobilize in bed with minimal difficulty, indicating that muscle weakness is not a significant predictive factor.

Premorbid walking ability of stroke patients is a significant

Table 2. Demographic and clinical characteristics of the patients (n = 187)

Clinical characteristics	Good functional outcome	Poor functional outcome	*p*-value[a]
Gender, n (%)			
Male	58 (50.0)	39 (54.9)	0.55
Female	58 (50.0)	32 (45.1)	
Age (years), n (%)			
65 or less	76 (65.5)	24 (33.8)	< 0.001
More than 65	40 (34.5)	47 (66.2)	
Premorbid ambulation status, n (%)			
Independent walking without gait aid	105 (90.5)	50 (70.4)	0.001
Need gait aid or assistance or cannot walk	11 (9.5)	21 (29.6)	
Co-morbidities, n (%)			
0-1	22 (19.0)	12 (17.1)	0.846
2 or more	94 (81.0)	58 (82.9)	
Previous stroke, n (%)			
No	96 (82.8)	55 (77.5)	0.445
Yes	20 (17.2)	16 (22.5)	
Diagnosis, n (%)			
Ischemic stroke	73 (63.5)	31 (44.3)	0.014
Hemorrhagic stroke	42 (36.5)	39 (55.7)	
Consciousness, n (%)			
Follow commands well	102 (87.9)	27 (38.0)	< 0.001
Drowsiness or coma	14 (12.1)	44 (62.0)	
Muscle power of affect side, n (%)			
Grade 0 to 2	40 (34.5)	56 (78.9)	< 0.001
Grade 3 to 5	76 (65.5)	15 (21.1)	
Swallowing, n (%)			
Normal	81 (69.8)	9 (12.7)	< 0.001
Abnormal	31 (26.7)	42 (59.1)	
Could not be evaluated	4 (3.5)	20 (28.2)	
Speech, n (%)			< 0.001
Normal	89 (76.7)	21 (29.6)	
Abnormal	22 (19.0)	29 (40.8)	
Could not be evaluated	5 (4.3)	21 (29.6)	
Ability to change body position from supine to siting, n (%)			< 0.001
Able	71 (61.2)	69 (97.2)	
Unable	45 (38.8)	2 (2.8)	
In-hospital complications, n (%)			
No	93 (80.2)	40 (56.3)	0.001
Yes	23 (19.8)	31 (43.7)	
Admission functional outcome, n (%)			
Good (Barthel index 75 or more)	11 (9.5)	0 (0.0)	0.007
Poor (Barthel index less than 75)	105 (90.5)	71 (100)	

[a]Fisher's exact test, $p < 0.05$

predictor of good functional outcome with an adjusted odds ratio of 15.8, a value which is in line with previous studies,[12,18] although it differs from Yamakuchi's study which showed only a small relationship. However, the Yamakuchi study was conducted in an older age group (average age of 71.7 years)[12] than the present study.

Age is a strong clinical outcome predictor which is related to good functional outcome as reported in many studies.[12,13,18-23] The younger the patient, the higher the probability of having a better functional recovery. Suksatien's study at Maharat Nakhon Ratchasima Hospital found that stroke patients aged 55 or less had a very good long term functional outcome (adjusted odds ratio 11.46)[13] but the mean age of this study was 62.5, and the mean age in previous studies in Thailand were 62 to 67 years old.[5,8,13,19] To include more stoke patients, we used the age of 65 years or more to evaluate the relationship. The adjusted odds ratio was 4.95. This could allow physiatrists with limited resources to recruit older stroke patients into intensive rehabilitation programs with the expectation of a good functional outcome.

Other independent factors such as a diagnosis of ischemic stroke, no complications at acute admission, useful muscle power of the affected side, normal verbal communication and swallowing, have also been found to be useful as predictors of good functional outcome[12,22] although in this study we did not find them to be good predictors at the 3-month follow-up.

Table 3. Clinical predictors related to a good functional outcome

Clinical predictors	Univariable Logistic Regression		Multivariable Logistic Regression	
	cOR (95%CI)	*p*-value[a]	AdjOR (95%CI)	*p*-value[b]
Gender: male	0.82 (0.45-1.48)	0.513	0.64 (0.21-1.98)	0.438
Age 65 years or less	3.72 (2.00-6.94)	< 0.001	4.95 (1.50-16.35)	0.009
Independent premorbid ambulation	4.01 (1.80-8.95)	< 0.001	15.80 (2.91-86.11)	0.001
Comorbidities less than 2	1.14 (0.63-2.06)	0.673	0.65 (0.19-2.12)	0.471
No previous stroke	1.40 (0.67-2.92)	0.374	0.63 (0.14-2.88)	0.556
Ischemic stroke	2.18 (1.19-4.01)	0.011	1.31 (0.41-4.16)	0.646
Normal consciousness	7.18 (3.90-13.23)	< 0.001	3.88 (1.65-9.16)	0.002
Muscle power grade 3 or more	7.09 (3.57-14.09)	< 0.001	2.00 (0.58-6.96)	0.275
Normal verbal communication	5.59 (2.69-11.59)	< 0.001	1.80 (0.54-5.98)	0.338
Normal swallowing	12.19 (5.31-27.98)	< 0.001	2.77 (0.74-1.39)	0.132
Ability to change body position from supine to sitting	54.43 (12.71-233.13)	< 0.001	21.63 (2.13-218.76)	0.009
No complications at acute admis-sion	3.13 (1.63-6.03)	0.001	1.62 (0.53-4.75)	0.381

[a]Univariable Logistic Regression, $p < 0.05$; [b]Multivariable Logistic Regression, $p < 0.05$
cOR, crude Odds Ratio; adjOR, adjusted Odds Ratio; CI, confidential interval

Table 4. Pattern of stroke disability from acute phase to 3-month follow-up based on Barthel index (BI) scores (n = 187)

Category of disability by Barthel index	At acute admission n = 187 (%)	Two-week fol-low-up n = 154 (%)	One-month follow-up n = 147 (%)	Three-month fol-low-up n = 140 (%)
Very severe disability (BI = 0-20)	63 (33.7)	34 (22.1)	17 (11.6)	14 (10.0)
Severe disability (BI = 25-45)	22 (11.8)	13 (8.4)	8 (5.4)	4 (2.8)
Moderate disability (BI = 50-70)	58 (31.0)	18 (11.7)	15 (10.2)	6 (4.3)
Mild disability (BI = 75-95)	11 (5.9)	40 (26.0)	54 (36.7)	69 (49.3)
No disability (BI = 100)	0 (0.0)	42 (27.3)	46 (31.3)	47 (33.6)
Death at follow-up	33 (17.6)	7 (4.5)	7 (4.8)	0 (0.0)

BI is frequently used around the world to explore the domain of activities and functional outcomes of stroke in both acute care and rehabilitation, especially in stroke care in Thailand. The cut-off level of BI for assessing positive patient outcome varies from 50 to 95 points. In the present study, the authors used the cut-off level of a BI score of 75 or higher as the definition of a satisfactory outcome as relates to the performance of activities of daily living. This measurement has been studied in acute phase patients and this cut-off point has been used as a standard BI score to demonstrate the effectiveness of stroke care in both acute and rehabilitation in Thailand.[16,24,25] There have been many studies of the ability of BI score to act as a predictor of long-term functional outcome [17,23,24,26] including the present study. It can be concluded that a high BI score in the acute phase relates to a good long term functional outcome. However, if the acute stroke patient has a low BI score, that might not be an accurate predictor of poor long term functional outcome because in the acute phase, especially if the BI score is evaluated during the first few days, most patients are effectively bedbound, either by the effect of the active stroke symptoms or as a result of medical treatment. Thus, these patients rarely have the opportunity to engage in activities of daily living by themselves and early intensive rehabilitation may cause more harm than good. A low BI score recorded in the early acute phase may not reflect true functional ability. Most studies have indicated, however, that BI scores evaluated after the first to third weeks can be used as a predictor of long-term functional outcome.[26]

This study found that most of the patients (63.1% of all cases and 82.9% of stroke-survival cases at the 3-months follow-up) had a good functional outcome (BI scores 75 or more) and were able to live their lives independently or with only mild disability, which correlates with our previous study.[12] The mortality rate of acute stroke patients in hospital in this study was 19% which is slightly higher than the average of previous studies (7.5% to 26%).[9,12,17] This could be due to the fact that the present study was conducted in a tertiary or A-level hospital as classified by the Ministry of Public Health where more severe cases are frequently referred to our hospital from community hospitals. The tertiary hospital's resource limitations have resulted in mild cases being transferred out sooner than would be otherwise desired.

A limitation of this study is that it was conducted in a tertiary hospital with inpatient overcrowding problems that resulted in many acute stroke patients having a very short length of hospital stay (the minimum length of hospital stay was only six hours) before being referred to a community hospital. As a result, some patients were not invited to join the study. The patients that remained in hospital may have had more severe symptoms, resulting in the mortality rate of this study (25.3%) being higher than the usual stroke death rate of this hospital (18.2%). Some elements related to functional outcome, e.g., stroke area of brain, normal cognition and perceptual, learning capacity, acute medical care, family and social support, were not included in the present study. Another limitation is that the type of rehabilitation services

which these stroke patients received after discharge from the acute stroke unit, i.e., whether they received intensive or less intensive inpatient rehabilitation, an outpatient rehabilitation or home-based rehabilitation program, were not reported, factors which can affect the functional outcome evaluation at the 3-month follow-up.

Conclusions

The ability to change body position from supine to sitting, the ability to walk independently without gait aid before admission, age less than 65 years and normal consciousness are good clinical predictors of 3-month functional outcome after an acute stroke. Physiatrists as well as other clinicians working in an acute care ward can easily observe and assess these factors and use that information in planning an appropriate post-acute rehabilitation program.

Disclosure

The authors declare no conflicts of interest.

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