

## Predictors of Long-term Functional Outcomes in Acute Stroke Patients

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### ตัวแปรพยากรณ์ผลลัพธ์ระยะยาวด้านความสามารถของผู้ป่วยโรคหลอดเลือดสมอง ในระยะเฉียบพลัน

รัชวรรณ สุขเสถียร, ธันยพร สุขพงษ์ไทย

ภาควิชาเวชศาสตร์ฟื้นฟู โรงพยาบาลมหาสารคามราชสีมา

#### ABSTRACT

**Objective:** To evaluate long-term functional outcomes and predictive variables for good and poor functional outcomes in acute stroke patients.

**Study design:** A retrospective study.

**Setting:** Stroke ward and units, Maharat Nakhon Ratchasima Hospital.

**Subjects:** Stroke patients with acute stroke between January 1 and December 31, 2015.

**Method:** We recorded patients' characteristic data: age, sex, premorbid status, diagnosis, comorbidities and complications, neurological examination, management, rehabilitation consultation, length of stay and functional level on admission using Barthel index (BI) score from electronic medical records. Long-term functional outcomes were evaluated with BI score at least 6 months after stroke onset by telephone interview and reviewing medical records. The predictors of long-term functional outcomes were determined with stepwise multiple logistic regression analysis.

**Results:** Nine hundred and seven patients were included in the present study. Of the 907 patients, 191 (21%) died during acute stroke admission, 117 (13%) died after and 210 (23%) were lost to follow-up and could not be contacted. There were 4 variables that were significantly correlated with good functional outcomes after multiple logistic regression analysis. Subjects aged < 55, Muscle power of the affected side grade > 2, normal consciousness and male gender had adjusted odds ratios of 11.46, 5.88, 5.15 and 3.88 respectively. Five variables that were correlated with poor functional outcomes were: muscle power grade 0-1, aged over 65, impaired consciousness, more than 3 comorbidities and admission BI score below 50. These resulted in adjusted odds ratios of 4.96, 4.85, 2.79, 2.33 and 2.13 respectively.

**Conclusion:** Long-term functional outcomes of stroke patients were associated with age, muscle power of the affected side, level of consciousness, gender, number of comorbidities and admission BI score.

**Keywords:** activities of daily living, functional outcome, long-term outcome, predictor, stroke

*J Thai Rehabil Med 2017; 27(3): 96-100.*

#### บทคัดย่อ

**วัตถุประสงค์:** เพื่อประเมินผลลัพธ์ระยะยาวและตัวแปรที่สัมพันธ์กับการพยากรณ์ผลลัพธ์ด้านความสามารถที่ดีและไม่ดีของผู้ป่วยโรคหลอดเลือดสมองในระยะเฉียบพลัน

**รูปแบบการวิจัย:** การศึกษาวิจัยย้อนหลัง

**สถานที่ทำการวิจัย:** หอผู้ป่วยและหน่วยโรคหลอดเลือดสมอง โรงพยาบาลมหาสารคามราชสีมา

**กลุ่มประชากร:** ผู้ป่วยโรคหลอดเลือดสมองที่เข้ารับการรักษาที่โรงพยาบาลมหาสารคามราชสีมาในระยะเฉียบพลัน ระหว่าง 1 มกราคม ถึง 31 ธันวาคม 2558

**วิธีการศึกษา:** เก็บข้อมูลผู้ป่วยจากประวัติการรักษาอิเล็กทรอนิกส์ ได้แก่ อายุ เพศ สภาวะก่อนการเจ็บป่วย การวินิจฉัยโรค โรคร่วมภาวะแทรกซ้อน การตรวจร่างกายทางระบบประสาท การให้การรักษา การปรึกษาเวชศาสตร์ฟื้นฟู วันนอน ระดับความสามารถในการทำกิจวัตรประจำวันในระหว่างนอนโรงพยาบาลใช้คะแนนบาร์เทิลผลลัพธ์ระยะยาวด้านความสามารถถูกประเมินอย่างน้อย 6 เดือนหลังป่วยเป็นโรคหลอดเลือดสมองด้วยแบบประเมินบาร์เทิลทางโทรศัพท์และข้อมูลจากประวัติผู้ป่วย ตัวแปรที่สามารถพยากรณ์ผลลัพธ์ระยะยาวทั้งผลลัพธ์ที่ดีและไม่ดีคือภาวะที่ด้วยการถดถอยโลจิสติกส์

**ผลการศึกษา:** ผู้ป่วยในการศึกษานี้ทั้งหมด 907 ราย, 191 (ร้อยละ 21) เสียชีวิตในระหว่างนอนรักษาที่โรงพยาบาลในระยะเฉียบพลัน, 117 ราย (ร้อยละ 13) เสียชีวิตหลังจากนั้น และ 210 ราย (ร้อยละ 23) ไม่มาติดตามการรักษาและไม่สามารถติดต่อได้ มีตัวแปร 4 ตัวที่มีความสัมพันธ์อย่างมีนัยสัมพันธ์กับผลลัพธ์ด้านความสามารถที่ดีหลังการวิเคราะห์แบบการถดถอยโลจิสติกส์ ผู้ป่วยที่อายุน้อยกว่าหรือเท่ากับ

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55 ปี มีกำลังกล้ามเนื้อมากกว่าหรือเท่ากับ 2 มีระดับความรู้สึกตัวปกติ เพศชาย มีอัตราส่วนออก 11.46, 5.88, 5.15 และ 3.88 ตามลำดับ และมี 5 ตัวแปรที่มีความสัมพันธ์กับผลลัพธ์ด้านความสามารถที่ไม่ดี ได้แก่ มีกำลังกล้ามเนื้อระดับ 0-1 อายุมากกว่า 65 ปี มีระดับความรู้สึกตัวไม่ดี มีโรคร่วมมากกว่า 3 โรคและมีคะแนนบาร์เทลระหว่างนอนโรงพยาบาลน้อยกว่า 50 โดยมีอัตราส่วนออก 4.96, 4.85, 2.79, 2.33 และ 2.13 ตามลำดับ

**สรุป:** ผลลัพธ์ระยะยาวด้านความสามารถของผู้ป่วยโรคหลอดเลือดสมองมีความสัมพันธ์กับอายุ กำลังกล้ามเนื้อ ระดับความรู้สึกตัว เพศ จำนวนโรคร่วมและคะแนนบาร์เทลระหว่างนอนโรงพยาบาล

**คำสำคัญ:** กิจวัตรประจำวัน, ผลลัพธ์ด้านความสามารถ, ผลลัพธ์ระยะยาว, ตัวพยากรณ์, โรคหลอดเลือดสมอง

*เวชศาสตร์ฟื้นฟูสาร 2560; 27(3): 96-100.*

## Introduction

Stroke is one of the most common causes of disability in Asia<sup>(1,2)</sup> and around the world. Medical rehabilitation is the standard management of post-stroke care in all countries. In rural or regional areas, access to medical rehabilitation services remains problematic<sup>(3)</sup>. Limitations in resources and public health budgets meant below-standard management for some patients. Predictors of functional outcomes for stroke patients are important to provide efficient post-stroke care according to the type of impairments suffered. Previous studies of stroke outcomes usually used a stroke scale such as the National Institutes of Health Stroke Scale (NIHSS)<sup>(4,5)</sup> or the Scandinavian Stroke Scale (SSS)<sup>(6)</sup>. According to the Thai Stroke Rehabilitation Registry, motor power of the affected leg at discharge, having no diabetes mellitus, married and able to change position from supine to sitting on admission were associated with walking ability at 1-year after discharge from inpatient stroke rehabilitation<sup>(7)</sup>. However, this paper did not study about variables in acute stroke period. There would have some advantages if we know any variables that correlated with long-term functional outcomes during acute stroke care, so the authors analyzed data routinely recorded in acute stroke care wards to determine the variables associated with long-term functional outcomes of stroke patients.

The purpose of the present study was to evaluate long-term functional outcomes and their predictive variables for stroke patients admitted to a tertiary hospital acute stroke ward.

## Methods

The present analytic study was approved by the Ethics Committee of Maharat Nakhon Ratchasima Hospital.

The data were retrieved from the electronic medical records of stroke patients admitted to Maharat Nakhon Ratchasima Hospital with acute stroke between January 1 and December 31, 2015.

The sample size was calculated by using the Peduzzi formula<sup>(8)</sup>

$$N = \frac{10k}{P}$$

N = Sample size

k = Number of independent variables (12)

P = Prevalence of good functional outcome (0.37)

The calculated sample size, for measuring good functional outcomes, and total population were 324 and 876 cases respectively; therefore, we included 1,000 cases in the present study.

The inclusion criteria were aged over 18 years, diagnosis of ischemic, embolic, hemorrhagic stroke and subarachnoid hemorrhage from ruptured aneurysm. The one exclusion criterion was incomplete data from medical records. The patients' characteristics recorded age, sex, premorbid status, diagnosis, comorbidities and complications, neurological examination, management, rehabilitation consultation and length of stay. Admitted functional level using Barthel index (BI) score<sup>(9)</sup> was evaluated by ward nurses within 24 hours of admission.

Neurological examination data were recorded from best neurological status documented in the patient's record, progress notes, and rehabilitation consultation records. Consciousness problems included drowsiness, stupor or coma. If patients could not follow commands, a comprehension problem was recorded. Speech problem or dysarthria means difficult or unclear articulation of speech. A communication problem was recorded if there was aphasia. Rehabilitation consultation included patient evaluation and planning by physiatrist. Intensive rehabilitation in a rehabilitation ward was not included in the present study.

Long-term functional outcomes were evaluated with BI score at least 6 months after stroke onset with the authors conducting telephone interviews. The interval from stroke onset to long-term functional outcome evaluation, functional level and sources of information were recorded. Some data were retrieved from the electronic medical records, such as death during other admissions and functional status of patients who had follow-up with physiatrists. A good functional outcome was achieved when patients had a follow-up BI score of 75 or more (mildly disabled and independent). A poor functional outcome was recorded when patients had a follow-up BI score of 45 or less (very severely and severely disabled) or died after discharge. The variables were correlated to predict good and poor long-term functional outcomes.

## Statistical analysis

Data were analyzed using descriptive statistics for demographic and BI score. Bivariate analyses were performed to examine associations between all stroke-related variables and good or poor functional outcomes, using Student's t-test and Fisher's exact test, as appropriate, for continuous and dichotomous variables. Variables with significant ( $p < 0.10$ ) bivariate evidence of association with the outcomes were then evaluated using stepwise logistic regression to determine which of the variables contributed to multivariate prediction models for good and poor functional outcomes.

## Results

Nine hundred and seven patients were included in the present study. The clinical characteristics of the patient population are shown in Table 1. The mean age was 67 years (23-100). Fifty-five percent were female. Seventy-five percent of the patients had experienced ischemic stroke and 25% hemorrhagic stroke. Almost all patients (95%) received non-operative treat-

ment for acute stroke. The top five comorbidities were hypertension (51%), diabetes mellitus (24%), respiratory disease (23%), cardiovascular disease (18%) and dyslipidemia (18%). Eight percent had a history of dependency prior to stroke onset. Physical examination revealed about one third of the patients had abnormal consciousness, comprehension, communication and swallowing function. Around 40% of the patients had speech problems. Seventy percent had muscle power of at least grade 2. The rehabilitation team was consulted for 29% of the patients. The mean length of stay for acute stroke was 5 days (1-301). The mean admission BI score was 55 (0-100).

Results of functional outcomes are shown in Table 2. Of 907 patients, 191 (21%) died during acute stroke admission, 117 (13%) died afterwards and 210 (23%) were lost to follow-up and could not be contacted. In 389 patients who were alive at long-term follow-up, 79% were independent. The sources of follow-up information were patients' families (47%), medical records (33%), other relatives (12%) and patients themselves (8%). The mean interval from stroke onset to long-term follow-up by telephone was 13 months<sup>(6-21)</sup>. The mean follow-up BI score was 91 (0-100).

There were 332 patients who had good functional outcomes. The variables associated with good functional outcomes are presented with odds ratios as shown in Table 3. There were 4 variables with that showed significant correlation according to multiple logistic regression analysis. Patients aged 55 or less, those with muscle power at least grade 2, normal consciousness and male gender had adjusted odds ratios of 11.46 (95%CI 1.35, 97.48), 5.88 (95%CI 2.19, 15.78), 5.15 (95%CI 1.4, 19.02) and 3.88 (95%CI 1.49, 10.14) respectively.

The variables associated with poor functional outcomes are shown in Table 4. There were 147 patients who had poor functional outcomes. Five variables that were correlated with poor functional outcomes were muscle power grade 0-1, age over 65, impaired consciousness, more than 3 comorbidities and admission BI score 0-45 with adjusted odds ratios of 4.96 (95%CI 2.25, 10.92), 4.85 (95%CI 2.39, 9.82), 2.79 (95%CI 1.05, 7.41), 2.33 (95%CI 1.07, 5.09) and 2.13 (95%CI 1.13, 4.02) respectively. The comorbidities associated with poor functional outcomes ( $p$ -value <0.05) were previous stroke, hypertension, respiratory disease, cardiovascular disease and genitourinary disease.

## Discussion

The primary purpose of the present study was to evaluate long-term functional outcomes of stroke patients admitted to Maharat Nakhon Ratchasima Hospital. The mortality rates of acute stroke patients and after discharge were 21% and 13% respectively, meaning one third of stroke patients died which is higher than previous studies showed around a 10% mortality rate<sup>(1)</sup>. Stroke care, including post-acute rehabilitation and long-term care has some problems<sup>(3)</sup>. The consultation rate of the rehabilitation team in acute stroke admissions had been increasing since the last three years<sup>(3)</sup> but was still only 30%. The proportion of hemorrhagic and ischemic stroke may indicate that Asians have a higher proportion of hemorrhagic stroke<sup>(1-3)</sup> when compared to Caucasian populations<sup>(10)</sup>. For patients still alive 6 months after stroke onset, 21% needed assistance and lived with dependency.

Age is a strong predictor for long-term functional outcomes of stroke patients in most studies<sup>(11-14)</sup>. In this study, age was

**Table 1.** Clinical characteristics of the patient population (n=907)

Characteristics	Value
Age (years), mean (min-max)	67 (23-100)
Gender: female, n (%)	471 (52)
Diagnosis, n (%)	
Ischemic stroke	676 (75)
Hemorrhagic stroke	231 (25)
Treatment, n (%)	
Non operative	862 (95)
Operative	45 (5)
Comorbidities, n (%)	
Hypertension	460 (51)
Diabetes mellitus	218 (24)
Respiratory disease	205 (23)
Cardiovascular disease	167 (18)
Dyslipidemia	160 (18)
Previous stroke	135 (15)
Electrolyte/ metabolic disease	135 (15)
Genitourinary disease	119 (13)
Premorbid status: Dependency	71 (8)
Physical examination, n (%)	
Consciousness problem	263 (29)
Comprehension problem	271 (30)
Communication problem	302 (33)
Swallowing problem	259 (29)
Speech problem	389 (43)
Muscle power: 0-1	265 (29)
2-3	207 (23)
4-5	435 (48)
Rehabilitation consultation	263 (29)
Length of stay (days), mean (min-max)	5 (1-301)
Admitted BI score, mean (min-max)	55 (0-100)

**Table 2.** Results of functional outcomes

Characteristics	Value
Death during acute stroke admission, n (%)	191 (21)
Death after discharge from acute stroke, n (%)	117 (13)
Functional status: Independent status, n (%)	307 (34)
Dependent, n (%)	82 (9)
Interval from stroke to follow-up (months), mean (min-max)	13 (6-21)
Follow-up BI score, mean (min-max)	91 (0-100)
Lost to follow-up or incomplete data, n (%)	210 (23)

a variable that correlated to both good and poor functional outcomes. Age of 55 years or less was associated with good functional outcome, with adjusted odds ratio of 11.46 (Table 3), whereas age over 65 years was associated with poor functional outcomes with an adjusted odds ratio of 4.85 (Table 4).

Muscle power and level of consciousness in acute stroke admissions were significant predictors for long-term functional outcomes. Muscle power of at least grade 2 and normal consciousness were correlated with good functional outcome with adjusted odds ratios of 5.88 and 5.15. Whereas, muscle power grade 0-1 and impaired consciousness were correlated with

**Table 3.** Unadjusted and adjusted odds ratio of good functional outcome

Factors	Unadjusted odd ratio (95% CI)	p-value	Adjusted odd ratio (95% CI)
Age (year): < 55	11.09 (1.49, 82.7)	0.019	11.46 (1.35, 97.48)
Gender: Male	3.75 (1.59, 8.88)	0.003	3.88 (1.49, 10.14)
Diagnosis: Ischemic	2.33 (0.92, 5.93)	0.075	
Management: Surgery	0.34 (0.08, 1.4)	0.132	
Comorbidities: >3	2.56 (0.94, 6.99)	0.066	
Premorbid status: independent	5.75 (1.47, 22.48)	0.012	
Muscle power: grade 2-5	7.57 (3.34, 17.19)	<0.001	5.88 (2.19, 15.78)
Normal consciousness	12.66 (4.19, 38.17)	<0.001	5.15 (1.4, 19.02)
No swallowing problem	5.29 (2, 14.01)	0.001	
No speech problem	2.21 (1.08, 4.55)	0.031	
No rehab consultation	1.96 (0.97, 3.93)	0.06	
Admitted BI score: 50-100	4.45 (2.14, 9.22)	< 0.001	

**Table 4.** Unadjusted and adjusted odds ratio of poor functional outcome

Factors	Unadjusted odd ratio (95% CI)	p-value	Adjusted odd ratio (95% CI)
Age (year): >65	5.54 (3.41, 8.99)	<0.001	4.85 (2.39, 9.82)
Diagnosis: Ischemic	0.55 (0.34, 0.91)	0.019	
Comorbidities: >3	3.87 (2.3, 6.5)	<0.001	2.33 (1.07, 5.09)
Premorbid status: Dependent	5.58 (2.63, 11.85)	<0.001	
Muscle power: grade 0-1	6.83 (4.2, 11.11)	<0.001	4.96 (2.25, 10.92)
Conscious problem	8.24 (4.67, 14.54)	<0.001	2.79 (1.05, 7.41)
Communication problem	5.54 (3.43, 8.94)	<0.001	
Swallowing problem	7 (4, 12.18))	<0.001	
Speech problem	3.11 (2.07, 4.65)	<0.001	
Admitted BI score: 0-45	4.96 (2.97, 8.3)	< 0.001	2.13 (1.13, 4.02)

poor functional outcomes with adjusted odds ratios of 4.96 and 2.79. Level of consciousness and muscle power were included in stroke severity assessment. Because NIHSS was used in limited groups of patients and was not an assessment for all stroke patients, the authors decided to use each part of the neurological assessment instead. The data may be incomplete and make it difficult to interpret stroke severity but it could be applied to routine service.

The BI score was used to demonstrate the global function of stroke patients. Because of its feasibility and familiarity, nurses and other health care professionals could use it routinely. In previous studies, cut-off value of BI score varied from 50-95<sup>(15)</sup>. The authors used BI score of 50 for cut-off value to predict long-term functional outcomes. A BI score between 0-45 was associated with poor functional outcomes with an odds ratio of 2.13, whereas a BI score between 50-100 did not show statistical significance for predicting good functional outcomes. The limitations and pitfalls for using BI score in a routine acute stroke service were human error evaluating BI score. The BI score should predict long-term functional outcomes if it was evaluated correctly by experienced health care professionals.

Stroke severity scales were the best option for evaluating acute stroke patients. However, in hospitals where stroke severity scales were unavailable for routine practice, the level of consciousness, muscle power grading and BI score could be used to predict long-term functional outcomes, instead of stroke severity scale.

Gender was a predictor for good functional outcomes but not for poor functional outcomes in the present study. Male

gender was associated with good functional outcome with an odds ratio of 3.88. Previous studies had conflicting data about gender difference and stroke outcome. Some studies found that women were more likely to have poor outcomes<sup>(16-18)</sup> while others found that men had worse outcomes<sup>(19,20)</sup>.

Comorbidities that were associated with poor functional outcomes were dependency, previous stroke, hypertension, and respiratory, cardiovascular and genitourinary diseases. Similar data were also seen in previous studies<sup>(20,21)</sup>. This study used an accumulation of comorbidities, more than 3 diseases, for multiple logistic regression analysis. Not surprisingly, comorbidities were associated with functional outcomes and also associated with advanced age, which is a strong predictor for long-term functional outcomes in other studies<sup>(11-14)</sup>.

The previous studies showed significant improvement of functional ability after intensive stroke rehabilitation<sup>(22,23)</sup>. However, this study did not show correlation between rehabilitation consultation and long-term functional outcome. It may be due to rehabilitation teams were consulted in severely affected patients who had multiple impairments including pulmonary problem that need pulmonary rehabilitation. Patients who had mild or moderate impairments were mostly referred to community hospitals and did not consult physiatrist for rehabilitation, therefore the benefit of rehabilitation can not be evaluated in this study. All stroke patients should be evaluated and received proper rehabilitation program to improve long-term functional outcomes.

There were some limitations of this study. Firstly, this study was retrospective. Secondly, nearly one fourth of the patients

could not be evaluated for long-term functional outcomes because they were lost to follow-up. Thirdly, the completeness and data quality of long-term functional outcomes evaluated by telephone interview may be questioned when compared to direct face-to-face assessment; however, previous studies have shown that BI scores from telephone interviews had good reliability<sup>(24,25)</sup>. Finally, the BI score could not assess the details of each function such as gait quality. Quality of life and social restrictions were not evaluated in the present study.

In conclusion, long-term functional outcomes of stroke patients were associated with age, muscle power, consciousness, gender, number of comorbidities and admission BI score.

## Acknowledgements

The authors wish to thank Dr. Kunyalak Na Rungsri and Mr. Jason Cullen for their help with statistical analysis and English correction.

## Conflict of interest

The authors declare no conflicts of interest.

## Funding

This research received no grant.

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