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Economic Evaluation of Rehabilitation Services for Inpatients with Stroke in Thailand: A Prospective Cohort Study

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ABSTRACT

Objective: Rehabilitation can restore function and prevent permanent disability in patients with stroke. There is, however, only one study on cost-effectiveness of rehabilitation in Thailand. Our objective was to evaluate the cost-utility of rehabilitation for inpatients with stroke under Thai settings. **Methods:** This was a prospective observational cohort study with a 4-month follow-up in two regional hospitals. The sample consisted of 207 first-episode stroke inpatients divided into rehabilitation and unexposed groups. Rehabilitation services during the subacute and nonacute phase were the intervention of concern. Main outcomes were patient's Barthel index for functional status and the EuroQol five-dimensional questionnaire as utility scores. A microcosting approach was employed considering a societal perspective. Effectiveness was defined as the improvement in functional status and quality-adjusted life-year (QALY). We used a longitudinal logistic model and multiple regressions. Cost-effectiveness ratios per QALY gained were presented. A probabilistic sensitivity analysis was conducted to estimate the uncertainty range. **Results:** Compared with the unexposed group, the Barthel index and QALY of patients with rehabilitation were significantly improved ($P < 0.010$). The incremental cost-effectiveness ratio of rehabilitation services for patients with stroke was 24,571 baht per QALY. Cost-effectiveness acceptability curves suggested that the rehabilitation services were likely to represent good value for money at the ceiling ratio of 70,000 baht per QALY (compared with the threshold of 1 time per-capita gross domestic product per QALY gain or 100,000 baht per QALY). **Conclusion:** The rehabilitation services for stroke survivors were cost-effective under the Thai health care setting.

Keywords: cost-effectiveness, cost-utility, rehabilitation, subacute and nonacute care.

Introduction

Stroke is a major health problem that imposes vast socioeconomic burdens on patients and caregivers [1]. Worldwide, stroke is the third leading cause of death, followed by heart disease and cancer [2]. In 2005, the World Health Organization reported that 6 million persons died from stroke each year or 11 persons every minute. Strokes cause 10% of total deaths. It is estimated that 20 million people will die from heart diseases and stroke in 2015 [3]. In addition, the rate of strokes is expected to continue to increase given that the population at risk is rapidly increasing. Because of advanced technologies, the number of survivors will also increase. The integrity of motor, sensory, and cognitive function is often affected in individuals who suffer a stroke [4]. The World Health Organization in 2002 found that stroke was the second cause of long-term impairment and disability [5].

In Thailand, stroke is the third common cause of illness after hypertension and diabetes mellitus. A 1983 study found that the prevalence of stroke in people older than 20 years was approximately 690 per 100,000, and 1.12% in people older than 60 years [2]. Currently, it is estimated that there are more than 150,000 stroke cases per year [6]. Although many people survive stroke because of modern technology, most of them live with impairment, disability, or handicap. Stroke is the third frequent cause of adult disability [7]. In 2007, disabled people increased to 1.9 million persons [8].

Rehabilitation reduces disability and maximizes functional ability for stroke survivors with disabilities. Research has indicated that multidisciplinary, early, and intensive rehabilitation significantly reduces disability [9–13]. In Thailand, hospital rehabilitation is very limited because of bed shortages, short duration of care, lack of human resources, and inadequate budget [14]; therefore, optimal rehabilitation services are not common. There was one study on cost-effectiveness of community rehabilitation in Thailand [15]. Within the constraints of the Thai health care system, there is a need for more evidence on the cost-effectiveness of the rehabilitative care model to recommend a rational payment system to stimulate higher consumption of rehabilita-

Conflicts of interest: The authors have indicated that they have no conflicts of interest with regard to the content of this article.

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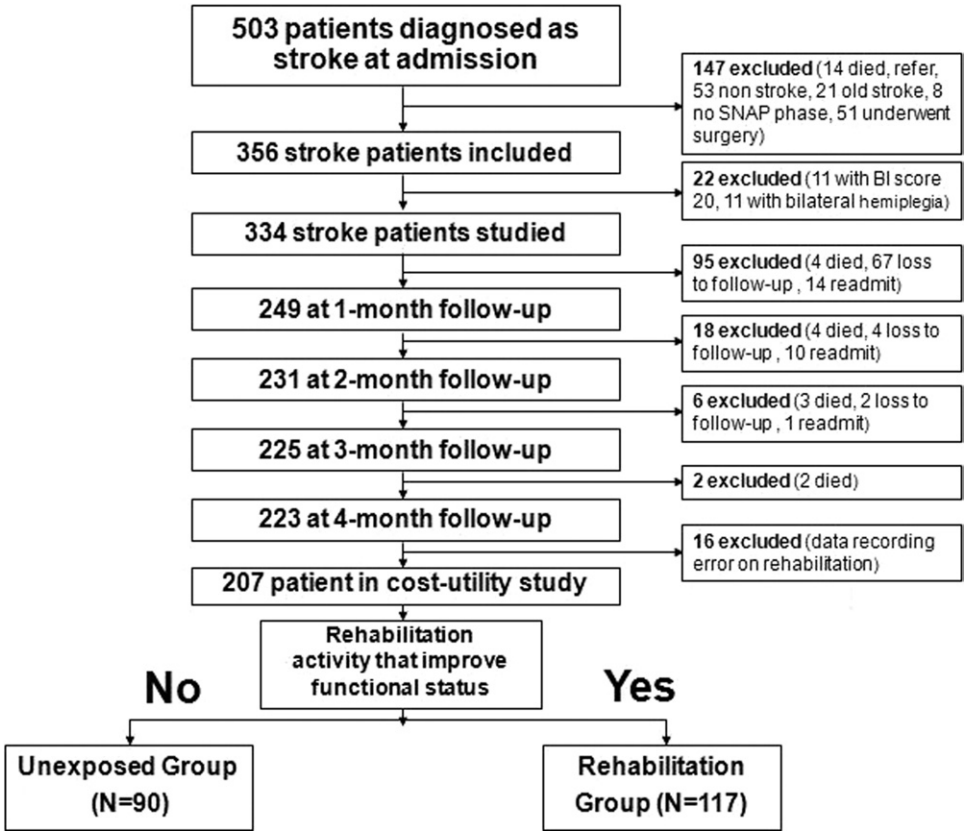

Fig. 1 – Participants in the study. BI, Barthel index; SNAP, subacute and nonacute phase.

tion services. It is also necessary to give evidence to health care payers that rehabilitation services offer good value for money, so that health care providers are encouraged to provide such services to facilitate access to care and quality of care. The objective of this study was to evaluate the cost-utility of rehabilitation for patients with stroke under Thai settings.

Methods

This study was a prospective observational cohort study approved by the Human Research Ethics Committee of the Naresuan University. The study was undertaken at two 800-bed regional hospitals (Udonthani in the northeast and Ratchaburi in the central region), each with a separate 20-bed rehabilitation ward. After signing consent forms, all patients with stroke were followed up for 4 months. The study period lasted from July 2008 until May 2009. The sample included adult patients older than 17 years with a first episode of stroke. A diagnosis of stroke was based on history and clinical examination and confirmed by computed tomography scan or magnetic resonance imaging. The inclusion criteria were 1) patients with a first episode of stroke within 2 weeks after the onset, 2) no other acute medical conditions requiring continued treatment, and 3) no preexisting disability. In addition, patients with the following conditions were excluded: 1) bilateral hemiplegia or brain stem pathology, 2) depression diagnosed by a psychiatrist, 3) a Barthel index (BI) score at admission higher than 19 out of 20, 4) surgery for stroke, 5) death, and 6) having a critical illness in the subacute and nonacute phase (SNAP). All eligible patients could be admitted to either rehabilitation wards or general wards. The doctor's decision to refer the patient to rehabilitation services for functional restoration signified that the patient entered the SNAP. A checklist was designed for the doctors to record when a patient changed to SNAP. During the study period, 503 patients were recruited with a diagnosis of stroke other than transient ischemic attack. Of these 503 patients with stroke, 169 were excluded and 334 patients were left eligible for the study. Only 223 patients (66.8% of 334 patients) completed the 4-month follow-up. There were 16 data recording errors on rehabilitation services. Finally, 207 patients were recruited for the cost-utility study as shown in Figure 1. This study concentrated on the first 4 months after stroke onset because the rehabilitation services appear to be most effective in such period [10,16].

Intervention program

The intervention program was inpatient rehabilitation services in the SNAP. Such rehabilitation services were shortlisted for functional improvement of patients with stroke according to literature reviews and expert opinions [9,17]. Therapists recorded interventions in each physical therapy session given to a patient across the episode of care. The rehabilitation services covered the full scope of activities that they used in their practice. Rehabilitation doctors, physiotherapists, occupational therapists, and nurses in the two hospitals were trained for 2 days on the data collection process, rehabilitation activities record, and functional status measurement. Each hospital developed internal auditing methods to ensure that the processes of data collection were correct. All data were subsequently checked and confirmed by the researcher. Data collection forms allowed therapists to describe treatment sessions in terms of categories of activities: ambulation training, positioning, balance training, gait training, and home program. Patients who received the rehabilitation services (listed in Table 1) more than once were assigned to the "rehabilitation group." The others were those who received rehabilitation services only once or did not receive at all, and they were assigned to the "unexposed group."

Table 1 – Effective physical therapy activities and occupational therapy activities for patients with stroke according to literature reviews and expert opinions.

Group of therapy	Categories of activity	Activities
Physical therapy (PT)	Exercise	ROM exercise, lower limb training, upper limb training, passive movement, endurance exercise, coordination exercise
	Trunk training	Postural training, ADL training, positioning, balance training
	Walking training	Ambulation training, gait training
	Home or ward program	Ward program, home program
	Physical assessment	Assessment and evaluation
Occupational therapy (OT)	Exercise	Sensorimotor components training, fine coordination/dexterity training, manipulative task skills training, muscle reeducation OT approach, normalized muscle tone
	Self-care training	Life skills training
	Cognitive training	Learning and applying knowledge, perception training, cognitive training OT approach
	Communication training	Functional communication, prespeech training
	Swallow training	Orofacial motor skills training, swallowing and eating therapy
	Home or ward program	Ward program, home program
	Assessment	General OT assessment, special OT assessment

ADL, activities of daily living; ROM, range of motion.

Outcomes

Outcome measurements were obtained prospectively at SNAP, discharge, and four monthly follow-up events. The primary response variable was the functional status, which was measured by the modified BI. The BI is the sum of three subtotal scores of self-care, mobility, and continence. The total score ranges from 0 to 20. This study classified the BI score into five disability categories: a BI of 20 stands for independent, 15 to 19 mild, 10 to 14 moderate, 5 to 9 severe, and 0 to 4 very severely disabled.

The long-term outcome was quality-adjusted life-year (QALY). It was collected at the onset of SNAP and during 4 months thereafter. QALY was measured by the EuroQol five-dimensional questionnaire. The EuroQol five-dimensional questionnaire is a widely used generic instrument for the measurement of health-related quality of life [18]. It has five dimensions of health: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Each dimension comprises three levels: no problems, some/moderate problems, and extreme problems. Quality of life was translated to a utility score based on the EuroQol time trade-off formula [19]. Based on these valuations, utility scores can be used in cost-utility analyses [20,21].

Costs

Costs were taken from a societal perspective. They were obtained prospectively for a period of 4 months after SNAP. Social cost includes direct medical costs and other costs borne by the patient and relatives as the consequences of stroke. Direct medical cost analyses were presented elsewhere [22]. Other costs involving patients and relatives were direct nonmedical costs and indirect costs. Direct nonmedical costs included cost of living during the stroke episode such as transport and food costs. Indirect costs included opportunity costs such as loss of income of patients and relatives for the whole illness episode. There were two types of income loss. First if the patient or relative stops working for a day, the opportunity cost equals income loss for 8 hours. If the patient or relative stops working for less than 1 day, the opportunity cost was calculated on the basis of time loss in hours. The opportunity cost was calculated on the basis of time loss multiplied by the standard labor cost per hour. Costs for each patient were collected and recorded in a cost diary. Patients and relatives were asked to keep a cost diary recording all the expenses caused by stroke such as drugs, treatments, transport, food, accommodation, and medical devices. The cost diary was designed for this study. It was used in the research after a validity test. The definition of each item in the diary was explained to the patients and relatives before any recording started. Moreover, the researcher and research assistants confirmed and checked the diary at follow-up visits. The total cost for each patient was computed by adding medical costs with the costs listed in the diary.

Statistical analysis

Effectiveness was defined as an improvement in functional status and quality of life. Baseline characteristics such as sex, stroke pathology, cognitive problems, functional score, utility score, patient's age, and length of stay were presented with descriptive statistics, and the differences between two groups were assessed

Table 2 – Cost and utility distribution used for sensitivity testing.

Parameters	Parameter description	Distribution	Mean	Standard error
1. Hospital cost of unexposed group	Cost of stroke without inpatient rehabilitation services in 4 mo	Gamma	11,401	1737
2. Hospital cost of rehabilitation group	Cost of stroke with inpatient rehabilitation services in 4 mo	Gamma	16,993	1803
3. Societal cost of unexposed group	Cost of stroke without inpatient rehabilitation services in 1 y	Gamma	61,918	7867
4. Societal cost of rehabilitation group	Cost of stroke with inpatient rehabilitation services in 1 y	Gamma	68,798	4655
5. Quality of life of unexposed group	Utility score gained of stroke without inpatient rehabilitation services in 4 mo	Normal	0.384	0.023
6. Quality of life of rehabilitation group	Utility score gained of stroke with inpatient rehabilitation services 4 mo	Normal	0.633	0.019

Table 3 – Patients characteristics.

Characteristics	Unexposed group (n = 90)	Rehabilitation group (n = 117)	Total (n = 207)	P
Sex, n (%)				
Men	53 (58.9)	67 (57.3)	120 (58.0)	0.887*
Women	37 (41.1)	50 (42.7)	87 (42.0)	
Pathology, n (%)				
Infarction	45 (50.0)	72 (61.5)	117 (56.5)	0.000*
Hemorrhagic stroke	45 (50.0)	45 (38.5)	60 (43.5)	
Initial Barthel index score, n (%)				
0–4 (very severe)	30 (33.3)	54 (46.2)	84 (40.6)	0.266*
5–9 (severe)	31 (34.4)	35 (29.9)	66 (31.9)	
10–14 (moderate)	21 (23.3)	22 (18.8)	43 (20.8)	
15–19 (mild)	8 (8.9)	6 (5.1)	14 (6.8)	
Cognitive problem, n (%)				
Has cognitive problems	37 (58.9)	53 (54.7)	117 (56.5)	0.547*
Good cognitive	53 (41.1)	64 (45.3)	90 (43.5)	
Length of stay in subacute phase,* mean ± SD	4.5 ± 5.9	7.0 ± 8.2	5.9 ± 7.4	0.013†
Patient's age, mean ± SD	60.8 ± 12.9	61.1 ± 12.5	60.9 ± 12.6	0.868†
Initial Barthel index score, mean ± SD	7.1 ± 4.9	5.8 ± 5.2	6.4 ± 5.1	0.093†
Baseline utility score,* mean ± SD	0.112 ± 0.447	0.005 ± 0.371	0.056 ± 0.409	0.034†

* Pearson chi-square test.
† Two-sample *t* test.

by a two-sample *t* test or chi-square test. To account for correlations in repeated observations over time, a longitudinal logistic model for cumulative ordinal data was used.

QALYs were estimated by controlling differences in baseline between the two groups by using a multivariate regression analysis [23]. An incremental cost-effectiveness ratio was calculated by dividing the difference in costs between groups by the difference in QALY gains between groups. This study adopted a threshold of societal cost of not higher than 100,000 baht per QALY gain (or 1 time per-capita gross domestic product) to accept as a cost-effective intervention [24].

A probabilistic sensitivity analysis and cost-effectiveness acceptability curves were used to test for uncertainty on costs and outcomes. A Monte Carlo simulation was employed to generate 1000 rounds of simulation by using a gamma distribution for cost uncertainties and a normal distribution for utility parameters. Table 2 summarizes all the important parameters to test uncertainty. Cost of rehabilitation services and QALY were collected over 4 months. The annual cost was calculated by multiplying a 4-month cost with 3, assuming that the cost incurred evenly. Conversely, the annual gain of utility score was calculated by multiplying the 4-month utility gain with 4/12 [25].

Results

Patient characteristics

The patients in rehabilitation and unexposed groups were comparable, such as more than half were men (58.0%) with a mean age of 61 years (Table 3). The rehabilitation group was more represented with cerebral infarction (61.5%) than was the unexposed group ($P > 0.05$). The rehabilitation group was more severe than the unexposed group by baseline utility score (0.005 and 0.112; $P = 0.034$) but not by BI group. The average length of stay for the rehabilitation group was 7.0 days but for the unexposed group was 4.5 days ($P = 0.013$).

Outcome

Although the rehabilitation group started with a poorer health state than the unexposed group, the functional status improvements as measured by the modified BI showed almost the same rate of increase (Fig. 2). The more precise analysis of outcome employed regression analysis of the repeated measures with an ordinal scale outcome as a predictive model (Table 4). Patients in the rehabilitation group had 2.292 times [Exp. (0.410 +0.419)] more chances of having a better outcome a month later (95% confidence interval of odds ratio 1.865–2.818) as compared with the unexposed group. However, the odds ratio of the unexposed group having better outcome a month versus a month later was 1.507 [Exp. (0.410)]. This suggests that patients in the rehabilitation group had a higher chance of improvement over time at a much faster rate than did patients in the unexposed group. The *P* value for the test of significance of the change between patients with rehabilitation and patients without rehabilitation for the interaction (rehabilitation × month variable) was 0.000.

Quality-adjusted life-year

The results show that the variables rehabilitation service, patient's age, and utility score at baseline using multiple regression analysis were significant in predicting the utility improvement at 4

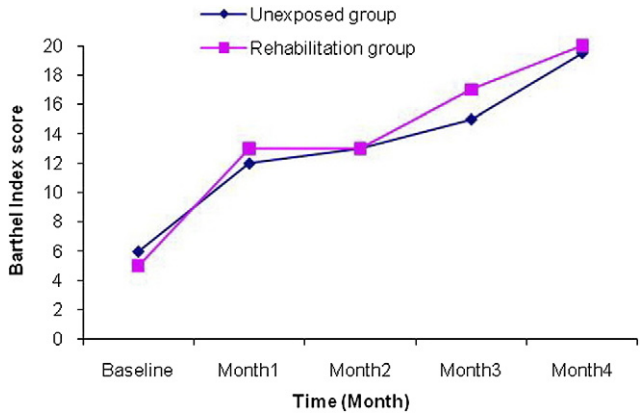

Fig. 2 – Median Barthel index score at baseline and at 1- to 4-month follow-up of both the unexposed and rehabilitation groups.

Table 4 – Relationship between independent variables and three disability levels using longitudinal logistic regression for cumulative ordinal data (GEE approach) on 207 patients with stroke (outcome = no disability and mild).

Variables	Coefficients	Standard error	95% CI for coefficients		Z	P
			Lower	Upper		
Intercept 1	0.290	0.546	−0.781	1.361		
Intercept 2	1.595	0.575	0.468	2.723		
Hemorrhagic stroke	0.370	0.337	−0.291	1.031	1.100	0.273
Age group 2 (45–54 y)	0.737	0.528	−0.299	1.773	1.390	0.163
Age group 3 (55–64 y)	0.172	0.495	−0.797	1.142	0.350	0.728
Age group 4 (65–74 y)	−0.444	0.483	−1.391	0.502	−0.920	0.357
Age group 5 (≥75 y)	−0.627	0.521	−1.647	0.393	−1.200	0.228
Female	−0.436	0.309	−1.041	0.170	−1.410	0.158
Length of stay at subacute phase	−0.022	0.016	−0.052	0.009	−1.410	0.160
Initial severe disability (BI score 5–9)	1.150	0.334	0.495	1.805	3.440	0.001
Initial moderate disability (BI score 10–14)	2.310	0.500	1.330	3.289	4.620	0.000
Initial mild disability (BI score 15–19)	4.271	0.920	2.468	6.074	4.640	0.000
Rehabilitation	−0.039	0.389	−0.803	0.724	−0.100	0.919
Month	0.410	0.069	0.276	0.545	5.970	0.000
Interaction (rehabilitation × month)	0.419	0.117	0.191	0.648	3.600	0.000

Note. Dependent variable = this study used three disability levels (no disability and mild, moderate, and severe and very severe).
BI, Barthel index; CI, confidence interval; GEE, generalized estimating equations.

months after SNAP onset. This meant that even patients with no rehabilitation but with a higher utility score at entry to SNAP were more likely to have a better utility score 4 months later. Furthermore, older patients were more likely to have poorer utility improvement 4 months later. From the multiple regression analysis (Table 5), the utility score was estimated by controlling baseline with the following formula:

$$\text{Utility score at 4 months} = 0.241 - 0.008(\text{age}) + 0.548(\text{utility score at SNAP}) + 0.220(\text{rehabilitation})$$

After baseline controlling, the average utility score gained by the rehabilitation group was statistically higher than that gained by the unexposed group using independent t test at $P < 0.050$. The incremental utility score at 4-month follow-up was 0.280 (the rehabilitation group gained 0.632 score while the unexposed group also gained at 0.352) (Table 5).

Costs

Table 6 indicates that the cost of hospitalization of the rehabilitation group was significantly higher than that of the unexposed group (16,993 and 11,401 baht per case, respectively). Patient costs of the unexposed group were also significantly lower than those of the rehabilitation group. The societal cost per year (hospital costs and patient costs) for the rehabilitation group was higher than that for the unexposed group. The incremental cost under the provider perspective was 5592 baht and under the societal perspective was 6880 baht.

Economic evaluation: Cost-utility analysis

Table 5 presents the incremental cost per QALY of the rehabilitation program based on a deterministic result. It provides the mean output for a given set of parameters. When only the government or hospital perspective was compared, the incremental cost per QALY gained from rehabilitation was 19,971 baht. When the societal perspective was compared, the incremental cost per QALY gained from rehabilitation was 24,571 baht.

Uncertainty analysis

The cost-effectiveness acceptability curves in Figure 3 show the robustness of the model regarding the uncertainty estimation of the program costs and outcomes for each treatment. The cost-effectiveness acceptability curve based on the net benefit approach was also included to present the association between the values of the ceiling ratio (willing to pay for a unit of QALY gained) and the probability of favoring each treatment. Between the two perspectives (government and societal), the results showed that the rehabilitation costs under the government perspective at 50,000 baht per QALY gained would have an 80% probability of being cost-effective. Under the societal perspective, however, to

Table 5 – Utility improvement at 4 months after SNAP onset by stepwise multivariate regression analysis.

	Unstandardized coefficients		T	Significance	95% CI for B	
	B	Standard error			Lower bound	Upper bound
Constant	0.241	0.150	6.171	0.000	0.510	1.134
Utility score*	0.548	0.073	7.491	0.000	0.199	0.604
Rehabilitation*	0.220	0.058	3.759	0.000	0.114	0.343
Age*	−0.008	0.002	−3.578	0.000	−0.013	−0.004

CI, confidence interval; SNAP, subacute and nonacute phase.
* $P < 0.01$.

Table 6 – Incremental cost per QALY gained under government and societal perspectives (deterministic results).

	Unexposed group	Rehabilitation group	Incremental values
Program cost using government perspective	11,401	16,993	5,592
Program cost using societal perspective	61,918	68,798	6,880
Program effectiveness (QALY)	0.352	0.632	0.280
Cost per QALY using government perspective			19,971
Cost per QALY using societal perspective			24,571

QALY, quality-adjusted life-year.

achieve 80% likelihood of being cost-effective, the cost of rehabilitation would be higher than 70,000 baht per QALY gained.

Discussion

This is the first cost-effectiveness study with prospective data collection looking at the rehabilitation services system in two regional hospitals in Thailand. Because of limited medical rehabilitation services, only some patients with stroke have access to care. The findings show that rehabilitation is a more expensive option but likely to provide a better outcome in terms of quality of life than doing nothing. Because of the differences in costing methodology and the delivery of rehabilitation services, these results cannot be directly compared with those of other studies in Thailand or other countries. For instance, two studies showed that in-hospital rehabilitation was more expensive than home-based rehabilitation [26,27]. Other studies indicated that the costs of hospital and home rehabilitation were the same [28,29].

Probabilistic sensitivity analyses to test uncertainty (Fig. 3) confirmed that the rehabilitation group was more cost-effective than the unexposed group in terms of QALY gained. The acceptability curves presented the probability of cost-effectiveness for different valuations of QALY gained. The results showed that the cost per QALY under the societal perspective was 70,000 baht per QALY, lower than the threshold of 100,000 baht per QALY [24]. When informal care costs or patient costs were excluded, the result was even more cost-effective (the incremental cost-effectiveness ratio of 50,000 baht per QALY gained) because a third to half of the societal costs was attributable to informal care [30].

Most studies showed that rehabilitation provides a better outcome in terms of reducing disability, maximizing functional ability, and improving quality of life [31–33]. This study used a prospective observational cohort study with 4-month follow-up design to compare outcomes between a rehabilitation group and an unexposed group that received no or inadequate rehabilitation intervention. The results show that rehabilitation services did improve functional status and quality of life. Because randomized controlled trials seem to be unethical and difficult [34,35], this study employed the method that was weaker than randomized controlled trials on internal validity. Such study better represented actual conditions in everyday practice, and cost less and took shorter time [36].

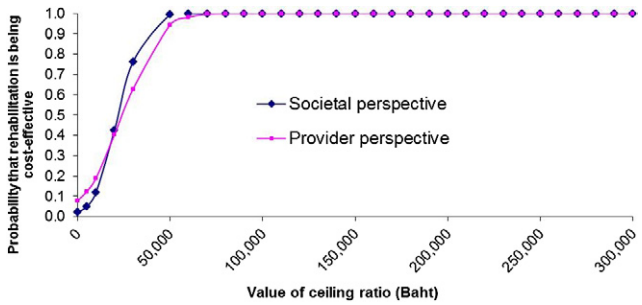

Fig. 3 – Cost-effectiveness acceptability curves for quality-adjusted life-year gained using the net benefit approach.

The uniqueness of the methodology of this study is the use of a comparison group that is different from previous studies [12,37]. This study included all patients with the first episode of stroke entering SNAP over a 4-month period. There was a wide age range, and male and female patients were equally represented. Moreover, the patients in this study had a varied level of disability: very severe, severe, moderate, and mild disability.

Because utility scores at baseline of two patient groups were different, this could have influenced the utility scores at the end of the study. Therefore, advanced statistical analysis (generalized estimating equations) was used to control for potential biases in the rehabilitation and unexposed groups [36]. An observational study using bivariate and multivariate associations among patient characteristics, process steps, and outcomes can answer questions in the real world, where multiple variables and factors can affect the outcomes. Ordinal logistic model was used when the outcome was the BI, which was an ordinal rather than a continuous scale.

Major limitations of this study should be mentioned. Selection bias is a major concern when patients were not randomly assigned to certain treatment arms. This study urged consecutive allocation of patients, but it was likely that the patients in the rehabilitation group were more severe with the hope that rehabilitation would improve their functional status. This study also tested the associations between the intervention and outcome before cost-utility analysis to ensure that the rehabilitation was related to the outcome. This study observed improvements only for 4 months and assumed that the annual cost and the annual functional gain would be linear to the 4-month observation, which may not be true. Last, the generalization of the results to the whole of Thailand is not appropriate because only two hospitals were included.

Conclusion

This study was a prospective observational cohort study with a 4-month follow-up. The objectives were to evaluate the cost-utility of rehabilitation for patients with stroke in Thai hospital settings. The results showed that rehabilitation is a more expensive option, but it is likely to provide a better outcome. Compared with the no-rehabilitation group, QALYs of patients with rehabilitation were significantly improved ($P < 0.010$). The incremental cost-effectiveness ratio to provide rehabilitation services to patients with stroke was 24,571 baht per QALY. Cost-effectiveness acceptability curves ensure that the rehabilitation services are likely to represent good value for money at the ceiling ratio of 100,000 baht per QALY. Therefore, policymakers should use cost-utility information showing that rehabilitation services offer a good value for money and support hospitals to provide it to the patients who need these services.

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