# Cost-Effectiveness Analysis of Home Rehabilitation Programs for Thai Stroke Patients

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***Background***: *The individual home rehabilitation program for ischemic stroke patients was conducted in a Thai healthcare setting. The program demonstrated that it was statistically significantly more effective than the conventional method. However for policy makers to adopt this program, the question of cost-effectiveness must be answered.*
***Objective:*** *To compare the costs and effects of a home rehabilitation program versus conventional hospital care for ischemic stroke patients in Thailand.*
***Material and Method***: *Cost-effectiveness analysis was conducted alongside a clinical trial. An open-label randomized control trial was conducted to explore the efficacy of a home rehabilitation program for acute stroke care for three months after hospital discharge. The Barthel Index and Modified Rankin Scale were used to evaluate the outcome measures. Success was defined as improvement by at least one level of the outcome scales. An incremental cost-effectiveness ratio, including sensitivity analysis, was presented.*
***Results***: *Fifty-eight patients were included in the study. Patients were randomly assigned to the study and control groups (28 and 30, respectively). The cost and number of successful cases in the study group were higher than those of the control group. The incremental cost-effectiveness ratio (ICER) was lowest-13,644 Thai Baht (THB)-regarding the Modified Rankin Scale measurement. For patients achieving mild disability and no disability based on the Barthel Index, the ICERs were 14,212 THB and 24,364 THB, respectively. Sensitivity analyses regarding variations in number of patients and cost of home visits demonstrated more cost-effectiveness than the base case.*
***Conclusion***: *Providing a home rehabilitation program with higher cost resulted in a greater number of patients avoiding disability than via conventional hospital care. The hospital had to pay approximately 24,000 THB for each additional disability-avoided patient when switching from conventional hospital care to a home rehabilitation program. This was assumed to be cost-effective when compared to per capita gross domestic product.*

***Keywords***: *Cost-effectiveness analysis, Home rehabilitation program, Stroke*

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Stroke, with its attendant major mortality and morbidity rates, is a significant healthcare problem in many countries. It is one of the greatest public health concerns throughout the world[1]. In Thailand, public health statistics show that stroke has been on the increase[2]. Judging from an estimated 62.8 million Thai population in 2000, of which 9.2% were aged over 60 years[3], and a stroke prevalence rate of 1.12% among the elderly in 1998, it is estimated that more than 60,000 of the country's elderly are disabled by stroke[4].

In 2000, a systematic review on an economic evaluation of stroke concluded that rehabilitation was more efficient than other interventions[5]. Later, two studies concluded that rehabilitation is effective for stroke patients by producing functional gains beyond those attributable to spontaneous recovery and usual care[6,7]. However, the rehabilitation processes are time-consuming and costly. One study agreed that management in a stroke rehabilitation unit confers survival benefits for 10 years after a stroke, because

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long-term survival is related to early reduction in disability[8]. In addition, there is evidence that rehabilitation techniques enhance learning-related changes after a stroke, and contribute to recovery. Another study reported an association between earlier admission for rehabilitation and better outcome, and the likely relationship between therapy intensity and improvements in functional outcome[9]. Clinically, greater intensity of stroke rehabilitation has been associated with improved outcomes.

In most developed countries, including Thailand, there is a heavy reliance on hospitals for acute care, whereas home rehabilitation of patients with stroke is limited[4,10,11]. Because inpatient rehabilitation programs in Thailand are not widely available, the demand for home rehabilitation is increasing. Therefore, a model for effective home rehabilitation for stroke will help in improving stroke care, and may be applied to other countries. The financial cost of stroke rehabilitation is considerable, but few cost-effectiveness studies are available to guide clinical practice. In Thailand, home rehabilitation together with hospital care has been determined to have statistically significantly greater effectiveness than conventional hospital care alone. The intervention group has demonstrated more favorable outcomes than the control group at three months in all primary outcome measures. The Barthel Index (BI) was significantly improved in the intervention group, as opposed to the usual care group: $96.33 \pm 1.04$ vs. $66.25 \pm 1.58$, $p = 0.001$, with absolute risk reduction (ARR) 93.33% (95% CI, 84.41 to 102.26). The results are similar regarding the Modified Rankin Scale (MRS): ARR 90% (95% CI, 79.26 to 100.74). It did show a benefit in reducing disability, with a NNT of 2 (95% CI, 1.0 to 1.2). The utility index: $0.88 \pm 0.08$ vs. $0.53 \pm 0.12$, $p = 0.001$ and all dimensions of EQ-5D in the intervention group showed significant improvement of quality of life and generic health status over the control group ($p = 0.001$)[12].

In terms of economic aspects, the cost of stroke has been evaluated worldwide[13], including in Thailand[14]. Evers et al reviewed literature between 1966-1988 and found six studies on economic evaluation of rehabilitation for stroke[15]. Additionally, one study compared early discharge together with home-based rehabilitation versus conventional in-hospital rehabilitation together with community care[16]. Young et al showed the median cost over the first eight weeks. There were 620 pounds (interquartile range 555-730 pound) for the day hospital patients and 385 pounds (interquartile range 240-510 pound) for the home physical therapy group[17]. Kalra et al have compared alternative strategies in stroke care using a randomized controlled design. They found the total costs of stroke per patient over a 12-month period were □11,450 for the stroke unit, □9,527 for the stroke team and □6,840 for home care. More than half the total costs were incurred in the first three months[18].

To adopt this intervention, policy makers must know the costs compared to clinical achievement in a Thai health setting, where details of intervention and costs are different from other countries.

**Objective**

This study aimed to compare costs and effects of a home rehabilitation program versus conventional hospital care for ischemic stroke patients in a Thai healthcare setting.

**Material and Method**

This study was designed as a piggyback study in which cost-effectiveness analysis was conducted alongside a randomized controlled clinical trial[19].

***Randomized control trial***

The clinical trial was published elsewhere[12]. In brief, it was a prospective, randomized, clinical trial. Ischemic stroke patients were recruited from inpatient wards at a teaching hospital in Thailand from May 2007 to June 2008. They were screened for eligibility around three days after stroke onset. Screening was either based on a clinical diagnosis, or was performed exclusively with or aided by CT or MRI scanning. The main inclusion criteria of the trial were: stroke from middle cerebral artery infarction; patient and caregiver's willingness to participate; ability to provide informed consent; and living within 50 miles of the hospital. Patients were excluded if they had uncontrolled hypertension, severe dysphasia, or severe cognitive impairment; had already been discharged to residential care; had demonstrated previous disability in self-care; or had been living in a nursing home prior to the stroke (Table 1).

Patients were randomly assigned to intervention (study) or control groups. The intervention strategy, called a "home rehabilitation program", was based on principles of exercise physiology and motor learning, and was developed by experts, stroke patients, physical therapists, occupational therapists and speech therapists. It consisted of a home-based exercise program together with conventional hospital services. The home-based

**Table 1.** Subject characteristics and baseline measures

| | Intervention Group (n = 30) | Control Group (n = 30) |
|---|---|---|
| Age (yrs), mean (SD) | 67 (10) | 66 (11) |
| Male, n (%) | 14 (47) | 13 (43) |
| BMI, mean (SD) | 24.8 (1.6) | 24.6 (2.4) |
| Elementary education, n (%) | 28 (93) | 28 (93) |
| Length of stay in hospital before discharge, mean (SD) | 10 (1.7) | 10.9 (2.3) |
| Right hemisphere stroke, n (%) | 18 (60) | 12 (40) |
| Medical history | | |
| Hypertension | 17 (57) | 17 (57) |
| Diabetes | 16 (53) | 18 (60) |
| High cholesterol | 8 (27) | 6 (20) |
| Atrial fibrillation/Ischemic heart disease | 7 (23) | 8 (27) |
| National Institute of Health Stroke Scale (NIHSS), mean (SD) | 16.4 (4.1) | 17.8 (3.9) |
| Thai Mental State Examination (TMSE), mean (SD) | 24.4 (2.0) | 23.8 (1.9) |
| Hospital Anxiety and Depression Scale (HADs), mean (SD) | 16.1 (7.6) | 16.4 (4.9) |
| Barthel index, mean (SD) | 31.7 (5.9) | 33.2 (4.8) |
| Modified Rankin scale, n (%): | | |
| Minor strokes (Grade 0-2) | 0 | 0 |
| Major strokes (Grade 3-5) | 30 (100) | 30 (100) |
| Utility index, mean (SD) | -0.14 (0.08) | -0.11 (0.13) |

* p-value by independent sample t-test and Fisher's exact test, significant at $p < 0.05$

individual's exercise program was provided by a physical therapist one visit per month for three months. Each home visit took approximately one hour. Standard audiovisual materials of rehabilitation procedures were also given to patients and caregivers for self-care.

The control group received conventional hospital care, which included outpatient rehabilitation at the discretion of their physicians. Follow-up visits at an outpatient clinic were scheduled monthly for three months after the stroke. Patients and caregivers were interviewed and evaluated at an outpatient clinic by the same assessor in a blind test. Clinical outcomes were evaluated employing the Barthel Index and Modified Rankin Scale. The Barthel Index is a weighted scale of 10 items of basic activities of daily living. The range of possible scores of the Barthel Index is 0 to 100[20]. The Modified Rankin Scale provides an assessment of the degree of disability, ranging from 0 to 6[20].

***Cost-effectiveness analysis***

Cost-effectiveness analysis is an economic evaluation method to measure the value of money used for health intervention compared to the clinical outcome gained. The study can be based on various viewpoints (*e.g.* whose costs) or perspectives. This study was analysed from the provider perspective, capturing costs of hospital services[21]. Effectiveness was measured in the form of disability averted. Time horizon of the analysis was three months.

***Outcome measurement***

The clinical outcome evaluated by the Barthel Index is categorized based on scores of very severely disabled (0-20), severely disabled (> 20-45), moderately disabled (> 45-70), mildly disabled (> 70-95) and no disability (> 95)[22,23]. Goal achievement is classified into two types: BI 1 means achieving mild or no disability, and BI 2 means achieving no disability. The Modified Rankin Scale is categorized into three levels of disability: a minor stroke is considered grades 0 to 2; a major stroke, grades 3 to 5; while a fatal stroke is 6[20]. A patient is classified as a successful case (MRS) if his or her clinical status improves from major stroke to minor stroke.

***Cost measurement***

Costs of medical services received by a

patient, in both intervention and control groups, included costs of hospital care and home rehabilitation service. Home rehabilitation service was composed of teaching material development and production, and home visits. The cost of teaching material development is considered as capital cost[24]. By expert opinion, this material should be revised every five years. Therefore, useful years were assumed to be five years. Annualized economic cost[8] was calculated using a discount rate of 3%[21]. Then, the annualized cost of teaching material development, the cost of teaching material (CD) production and the cost of home visits by a physical therapist were calculated for an individual patient. To calculate the cost of conventional hospital care received by an individual patient, micro-costing was employed[25]. Based on this method, the number of hospital services were quantified and multiplied by their unit costs. The unit cost of medical services was based on the reimbursement rate for the Civil Servant Medical Benefit Scheme paid by Ministry of Finance[26]. Since the study hospital was a government hospital, this reimbursement rate was assumed to be the actual hospital cost.

***Statistical analysis and sensitivity analysis***

Cost-effectiveness and incremental cost-effectiveness ratios were calculated. The cost-effectiveness ratio is the cost per case in achieving the treatment goal. It was calculated for both intervention and conventional treatments. The calculation is conducted by dividing the total cost of the patient group by the number of successful cases. The incremental cost-effectiveness ratio is employed when both the cost and the number of successful cases in the intervention group are higher than those of the comparator (control) group. It is calculated by the following equation[27]:

ICER = (Ci-Cc)/(Ei-Ec)

Where Ci = cost of the intervention group (study group)

Cc = cost of the comparator group (control group)

Ei = number of effective cases in the intervention group

Ec = number of effective cases in the comparator group

Sensitivity analysis is conducted by varying parameters one at a time, considering other para meters to be constant at a base-case level[28]. In this study, parameters used in the sensitivity analyses were the number of patients and payment for physical therapists who provided home visits. The number of patients per year was assumed to be 200; then unit cost of CD production was decreased to 322.60 THB. This is because cost of content development per CD is reduced when number of CD produced is increased. Payment of physical therapists varied between 800 THB and 1,500 THB per visit.

## Results

***Outcome analysis***

Fifty-eight patients (28 and 30 for study and control groups, respectively) were included in the study. Results of the clinical trial were published elsewhere[12]. In summary, there was no significant difference in baseline characteristics between the two groups. However, the outcomes were statistically significantly different. There were no patients in either group whose clinical status achieved the levels set as the goals prior to the study period. After the study period, 5 and 3 patients in the control group achieved the BI 1 and MRS goals, respectively. No patient achieved the BI 2 goal. For the study group, 29, 14 and 28 patients achieved the BI 1, BI 2 and MRS goals, respectively.

***Cost analysis***

There were two parts of costs, *i.e.* hospital service cost and cost of individual home health care. Twenty-six out of 30 patients in the intervention group received hospital services during the three-month period of the experiment, while approximately half (16/28) of the control group received hospital services. The average hospital service costs were 4,616 THB (SD = 8,167) and 10,527 THB (SD = 11,556) for the control and study groups, respectively (Mann-Whitney test, $p < 0.01$). The cost of individual home health care was allocated equally among the study patients. It was composed of training material development and production, and home visits. The training material was designed by a physical therapist for a payment of 14,700 THB (9,800 THB x 1.5 months). Then an expert was consulted for a payment of 6,000 THB (2,000 THB x 3 working days). Thus the total cost of the training material development was 20,700 THB. This material was expected to be reviewed every five years. Therefore, it was annualized using standard economic concepts, specifying a 3% discount rate and five years of useful life[29]. This resulted in 4,520 THB, or 151 THB per patient. Teaching material production (12 CDs per set) cost 60,000 THB, or 2,000 THB per patient. For

individual home visits, a physical therapist was paid 1,000 THB per visit. This included an honorarium and transportation. Thus the total cost of home visits per patient was 3,000 THB (1,000 THB x 3 visits). The overall cost of the home visit program for the study group was 154,530 THB (5,151 THB x 30 patients). The total costs of the control and study groups were 129,243 THB and 470,333 THB, respectively. The exchange rate in 2008 was 33.36 THB for US$1[30].

### *Cost-effectiveness analysis*

Cost-effectiveness analysis results are demonstrated in Table 2. Firstly, the cost-effectiveness ratio (C/E) was calculated. C/Es of the BI 1 and MRS of the control group were 25,849 THB and 43,081 THB, respectively (there was no successful case regarding the BI 2). For the study group, C/Es were lower than those of the study group. They were 16,218 THB, 33,595 THB and 16,798 THB for the BI 1, BI 2 and MRS, respectively. Then ICERs were calculated. The lowest ICER was 13,644 THB for the MRS measurement, followed by those of the BI 1 and BI 2 (14,212 THB and 24,364 THB, respectively). For sensitivity analysis, the scenario was composed of variations in the number of patients and the payment for physical therapists who conducted home visits. Based on the hospital statistics, there were assumed to be 200 patients per year. With this number of patients, 800 THB and 1,500 THB per home visit were described as scenarios 1 and 2, respectively. Both scenarios resulted in greater cost-effectiveness than the base case (Table 3).

## Discussion

Regarding the study design, although cost-effectiveness analysis is normally conducted based on a societal perspective, other perspectives can be

**Table 2.** Cost-effectiveness analysis

| Patient (n) | Effectiveness (n) | | | Cost (THB) | Cost-effectiveness | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | BI 1 | BI 2 | MRS | | BI 1 | | BI 2 | | MRS | |
| | | | | | C/E | ICER | C/E | ICER | C/E | ICE |
| Control (28) | 5 | 0 | 3 | 129,243 | 25,849 | n/a | n/a | n/a | 43,081 | n/a |
| Study (30) | 29 | 14 | 28 | 470,333 | 16,218 | 14,212 | 33,595 | 24,364 | 16,798 | 13,644 |

BI 1 = Goal achievement to level of mild disabled based on the Barthel Index
BI 2 = Goal achievement to level of no disability based on the Barthel Index
MRS = Goal achievement to level of minor stroke based on the Modified Rankin Scale
C/E = cost-effectiveness ratio
ICER = incremental cost-effectiveness ratio
THB = Thai baht

**Table 3.** Sensitivity analysis

| Patient | Cost-effectiveness | | | | | |
|---|---|---|---|---|---|---|
| | BI 1 | | BI 2 | | MRS | |
| | C/E | ICER | C/E | ICER | C/E | ICER |
| Scenario 1 | | | | | | |
| Control | 25,849 | n/a | n/a | n/a | 43,081 | n/a |
| Study | 13,707 | 11,177 | 28,392 | 19,161 | 14,196 | 10,730 |
| Scenario 2 | | | | | | |
| Control | 25,849 | n/a | n/a | n/a | 43,081 | n/a |
| Study | 15,879 | 13,802 | 32,892 | 23,661 | 16,446 | 13,250 |

employed[31]. This study chose a provider perspective, since hospital administrators have the authority to improve their services. In Thailand, there are three basic health insurance schemes: the Civil Servant Medical Benefits Scheme for government officials; the Social Security Scheme for private workers; and the Universal Health Coverage Scheme for the rest of the population[32]. Under this health insurance system, more than two-thirds of the Thai populations are covered by either the Social Security Scheme or the Universal Health Coverage Scheme. These two schemes allocate budgets to hospitals by the capitation method (a fixed amount per registered person). This means that hospitals have to absorb all treatment costs by fixed payment from the payers (insurance schemes). If an intervention can prevent disability, it will save future costs of further disability care by the hospital. Therefore this study, based on a provider perspective, provides information for hospital administrators to make decisions regarding adopting intervention methods.

To measure the success (effectiveness) of stroke rehabilitation, we found studies measured in terms of: unit of functional gain[33]; Barthel Index; Glasgow Outcome Scale; Functional Independence Measure; National Institute of Health Neurological Scale; Nottingham Health Profile[15]; Modified Rankin Scale [20]; and quality of life (SF36)[16,34]. We used the Barthel Index and Modified Rankin Scale because they are conventional practice in Thailand and correspond to international studies. For cost analysis, this study employed cost at charge in the analysis. Although it is not real economic cost, it is acceptable as one method of resource valuation[21]. Cost at charge was also used in another stroke study[33].

The intervention was a combination of individual home health care and conventional hospital services. The improvement of clinical outcomes was not solely the result of home health care. It should be an effect of an increase of hospital service utilization as well. This is proved by the number of patients receiving hospital services during the experimental period: 50% (14/28) and 86% (26/30) for the control and intervention groups, respectively. In addition, the average hospital cost of the intervention group was significantly higher than that of the control group. Therefore, in addition to direct effect, the home rehabilitation program also played a role in motivating patients to come to the hospital to receive services.

Acceptance of the intervention method by policy makers is dependent on willingness to pay. There are no specific recommendations on willingness to pay for these effectiveness measures. However, there are guidelines for economic evaluation in Thailand. An intervention that adds 1 quality-adjusted life year (QALY) for less than 100,000 THB (gross domestic product per capita) is considered to be cost-effective[35]. Generally, disability has a high negative influence on quality of life. Therefore, based on BI 2, a disability avoided in one additional patient costs 24,364 THB. This cost is only one-fourth of the Thai national guidelines. Therefore, the home-rehabilitation program was considered cost-effective.

This study did not cover indirect cost, since we did not apply a societal perspective. Disability causes absence from work, resulting in indirect costs such as loss of productivity. The disability avoided by intervention therefore reduces indirect cost. Therefore, intervention tends to be cost-effective based on a societal perspective. If the study had been conducted based on a societal perspective, intervention might have been found to be even more cost-effective. This is because societal perspective covers, in addition to direct medical cost, the cost of informal care, and productivity loss due to absence from work caused by disability and death. One study indicated that the cost of informal care for disabled stroke survivors was 4,643 THB per month in 2006 prices[36]. Direct cost was found to amount to 117,448 THB per patient per year (in 1999 prices)[14]. Therefore the control group with more disabled patients would have higher cost, resulting in more cost-effectiveness than that of the provider perspective study.

Sensitivity analysis has shown that if the program were expanded to cover more patients, the cost of teaching materials per patient would be decreased due to their being a part of the fixed cost of development. Thus the intervention would be even more cost-effective.

However, this study had some limitations. It was an efficacy study targeted at ischemic stroke, and the results may not be applicable to all stroke rehabilitation. Severe stroke patients were also excluded. Regarding the time horizon, or the period of time spent observing the cost and effect of the intervention, normally it is recommended that the time horizon be designed to cover the consequences of the intervention[27]. This study observed the effects of the intervention for three months, at which time the clinical outcome might not yet be stable. Ideally it should be evaluated at six months after the stroke attack[37-40]. If we observed the results at the sixth month, we might expect better clinical outcomes. The number of

patients achieving their treatment goal might increase, and the intervention might be found to be more cost-effective.

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## *การวิเคราะห์ต้นทุน-ประสิทธิผลของโปรแกรม ในการฟื้นฟูสมรรถภาพที่บ้านสำหรับผู้ป่วยโรคอัมพาตครึ่งซีกจากการขาดเลือด*

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***ภูมิหลัง**: ได้มีการศึกษาการฟื้นฟูสมรรถภาพเฉพาะบุคคลที่บ้านสำหรับผู้ป่วยหลอดเลือดสมอง จากการขาดเลือดในประเทศไทย ผลจากการศึกษาพบว่าการฟื้นฟูสมรรถภาพเฉพาะบุคคลที่บ้านให้ผลในการบรรลุเป้าหมายของการฟื้นฟูมากกว่า ระบบการดูแลโดยสถานพยาบาลอย่างเดียว อย่างนัยสำคัญทางสถิติ อย่างไรก็ตามในการตัดสินใจทางนโยบายว่าจะยอมรับโปรแกรมการดูแลดังกล่าวหรือไม่นั้นมักจะต้องมีคำถามว่าคุ้มค่าหรือไม่ในการดำเนินการโปรแกรมการดูแลผู้ป่วยดังกล่าว*

***วัตถุประสงค์**: เพื่อเปรียบเทียบต้นทุนและประสิทธิผลของโปรแกรมการฟื้นฟูสมรรถภาพที่บ้านกับการรักษาปกติที่โรงพยาบาลสำหรับผู้ป่วยหลอดเลือดสมองขาดเลือดในประเทศไทย*

***วัสดุและวิธีการ**: เป็นการวิเคราะห์ต้นทุนและประสิทธิผลร่วมกับการวิจัยทางคลินิกซึ่งดำเนินการเป็นเวลา 3 เดือน ทำการประเมินประสิทธิผลโดย The Barthel Index และ Modified Rankin Scale การบรรลุผลวัดการที่ผู้ป่วยมีอาการดีขึ้นหนึ่งระดับของการวัดดังกล่าว การวิเคราะห์ผลดำเนินการในรูปแบบอัตราส่วนต้นทุนประสิทธิผลส่วนเพิ่ม (incremental cost-effectiveness ratio:ICER) และการวิเคราะห์ความไว*

***ผลการศึกษา**: ผู้ป่วย 58 คนในการศึกษานี้ ถูกสุ่มแบ่งออกเป็นกลุ่มศึกษาและกลุ่มทดลอง (28 คน และ 30 คน, ตามลำดับ) ต้นทุนและจำนวนผู้ป่วยที่ประสบความสำเร็จในการฟื้นฟูสมรรถภาพในกลุ่มทดลองสูงกว่ากลุ่มควบคุม โดยในการวัดด้วย the Modified Rankin Scale ค่าอัตราส่วนต้นทุนประสิทธิผลส่วนเพิ่ม มีค่าต่ำสุดเท่ากับ 13,644 บาท ในการประเมินการบรรลุผลที่ระดับคความพิการระดับน้อย และที่ระดับไม่มีความพิการเหลืออยู่ด้วย the Barthel Index พบว่า the ICERs มีค่าเท่ากับ 14,212 บาท และ 24,364 บาท ตามลำดับ ในส่วนของการวิเคราะห์ความไวที่สถานการณ์จำนวนผู้ป่วยเพิ่มมากขึ้น และต้นทุนของโปรแกรมเพิ่มขึ้นพบว่าโปรแกรมมีความคุ้มค่ากว่าผลการวิเคราะห์จากกรณีฐาน (base case)*

***สรุป**: การให้โปรแกรมการฟื้นฟูสมรรถภาพที่บ้านมีต้นทุนมากกว่า แต่ก็สามารถลดความพิการได้มากกว่าเมื่อเปรียบเทียบกับการรักษาปกติที่โรงพยาบาลอย่างเดียว ทั้งนี้โรงพยาบาลจะต้องจ่ายประมาณ 24,000 บาทต่อผู้ป่วยหนึ่งคนเพื่อหลีกเลี่ยงความพิการจากโรคหลอดเลือดสมอง*