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Original Article

Cost-effectiveness analysis of reformative Bobath rehabilitation versus traditional rehabilitation in post-stroke syndrome

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Abstract: Objective: The aim of this study was to compare the cost utility of Bobath rehabilitation with that of traditional treatment of post-stroke syndrome in order to evaluate whether it can be applied to a generalized population in most regions in China. Methods: The Markov model was used to analyze the incremental cost-effectiveness ratios (ICERs) and 5-year quality-adjusted life years (QALYs). Data were obtained from a total of 2000 patients from 2 large-scale complex hospitals in Beijing, China. All eligible patients were aged between 18 and 80 years, in the post-stroke stage, and relatively serious. The clinical data were from 2 phase III clinical hospitals in Beijing. Moreover, the cost data were from the Chinese healthcare system and these hospitals. In the study, one-way sensitivity analysis, probabilistic sensitivity analysis (PSA), and Monte-Carlo analysis were performed. Result: In the study, the model suggested that the Bobath arm is better than the traditional one; the cumulative costs of the two arms were ￥136,782.85 and ￥33,597.94, respectively, and the QALYs were 1.222 and 0.279, respectively. The ICER was ￥109,421.96/QALY, which was less than threefolds of the mean gross domestic product of China, indicating the cost-effectiveness of Bobath rehabilitation. In the one-way analysis, the change in cost and utility did not influence the outcome. Moreover, in the Monte-Carlo analysis, the probability distribution of incremental cost, incremental utility, and ICER had a beta- and gamma-distribution. Conclusions: The Bobath arm, which could be popularized in China, has better cost utility.

Keywords: Bobath, post-stroke, rehabilitation, cost-effectiveness

Introduction

Stroke is a highly fatal event, which affects the patient's psychology and physiology and results in multitudinous sequelae including post-stroke events that induce chronic hemiplegia [1]. During a stroke, the brain does not receive enough oxygen or nutrients, causing brain cells to die. Strokes need to be diagnosed and treated as quickly as possible to minimize brain damage. Treatment depends on the type of stroke. The most effective way to prevent stroke is through maintaining a healthy lifestyle and treating underlying conditions that could be a risk factor [2].

Globally, the stroke burden was 38 million disability-adjusted life years (DALYs) in 1990, and this number is projected to increase to 61 million DALYs in 2020 [3]. Stroke is the fifth leading cause of death in the United States. Nearly 800,000 people have stroke each year. This equates to about one person every 40 s [4]. Recently, the Bobath rehabilitation improved symptoms compared to traditional rehabilitation [5, 6]. The Bobath concept that is applied in patient assessment and treatment is an approach to neurological rehabilitation (such as with patients after stroke). In 2018, a major review of upper limb interventions following stroke found significant positive effects of constraint and task-specific therapies and the supplementary use of biofeedback and electrical stimulation. However, they concluded that the use of Bobath therapy was not supported [7].

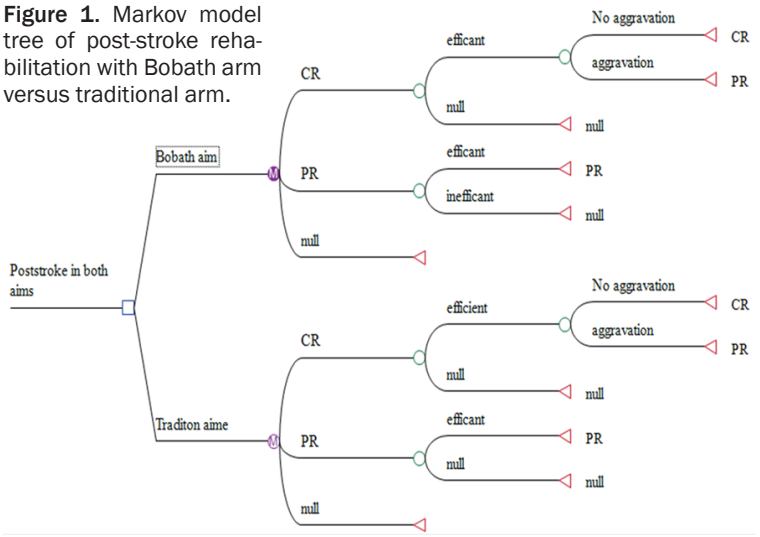

Figure 1. Markov model tree of post-stroke rehabilitation with Bobath arm versus traditional arm.

Table 1. The price and fees in one cycle/yuan

Bobath arm		
Curative	Price per unit/yuan	Fee in one cycle/yuan
Cerebroprotein hydrolysate	22.84	2000
Sodium ferulate injection	14.4	500
Ginkgo biloba leaf extract	14.72	1500
Bobath	30	900
Tradition arm		
Curative	Price per unit/yuan	Fee in one cycle/yuan
Cerebroprotein hydrolysate	22.84	2000
Sodium ferulate injection	14.4	500
Ginkgo biloba leaf extract	14.72	1500
Rehabilitation	20	600

Table 2. The utility of both arms

Bobath arm		
CR	PR	Null
0.781	0.513	0
Tradition arm		
CR	PR	Null
0.563	0.442	0

Table 3. Average improvement rate of both arms in two hospitals

Bobath arm		
CR	PR	Null
22.5%	77.4%	0.1%
Tradition arm		
CR	PR	Null
2.5%	74.4%	11.75%

However, Bobath rehabilitation needs long-term and unremitting endeavor, which signifies the need of a large expenditure, which also would bring about financial burden to patients and their family. Therefore, cost performance analysis of reformative Bobath rehabilitation is greatly significant [8-11]. Bobath rehabilitation will help improve mobility using a combination of techniques involving passive and active movements in a functional way in order to obtain functional independence. Bobath rehabilitation will help make everyday tasks totally easier and improve quality of life.

However, cost-effectiveness analyses of Bobath rehabilitation in post-stroke syndrome were seldom published. Therefore, we collected data from more than 2000 clinical cases from 2 large-scale complex hospitals in Beijing, China, to analyze the cost performance of Bobath rehabilitation in post-stroke syndrome, in order to evaluate whether it fits the generalized population in most regions in China.

Method

Patients and treatment

Data were collected from a total of 2000 patients from 2 large-scale complex hospitals in Beijing, China. All eligible patients were aged between 18 and 80 years, in the post-stroke stage, and relatively serious. These 2000 eligible patients were divided equally into 2 arms: 1000 reformative Bobath rehabilitation arm and 1000 traditional arm. Patients with Bobath arm received systematic Bobath rehabilitation, such as reflex inhibition rehabilitation and beating percussion massage. Moreover, the patients with traditional arm received traditional massage. Furthermore, cerebroprotein hydrolysate, ginkgo biloba leaf extract, and sodium ferulate injection were administered to prevent stroke recurrence.

Disease modeling

The Markov model was established to analyze three states of transition, including complete

Table 4. The One-way analysis of the better arm

The factors	Mumber value	Outcomes (￥)	WTP (￥)	Economical
CR in Bobath arm (cost)	5390	110,026.55	166,237.47	YES
	4900	109,421.96	166,237.47	YES
	4410	108,736.10	166,237.47	YES
CR in tradition arm (cost)	5060	108,882.96	166,237.47	YES
	4600	109,421.96	166,237.47	YES
	4140	109,879.72	166,237.47	YES
PR in Bobath arm (cost)	5390	123,235.82	166,237.47	YES
	4900	109,421.96	166,237.47	YES
	4410	955,26.86	166,237.47	YES
PR in Tradition Arm (cost)	5060	106,318.16	166,237.47	YES
	4600	109,421.96	166,237.47	YES
	4140	112,444.52	166,237.47	YES
CR in Bobath arm (Utiltiy)	0.072	110,267.03	166,237.47	YES
	0.065	109,421.96	166,237.47	YES
	0.059	108,396.49	166,237.47	YES
CR in Tradition Arm (Utiltiy)	0.052	109,989.08	Ditto	YES
	0.047	109,421.96	Ditto	YES
	0.042	108,803.72	Ditto	YES
	0.047	97,770.79	Ditto	YES
PR in Bobath arm (Utiltiy)	0.043	109,421.96	Ditto	YES
	0.039	122,548.28	Ditto	YES
	0.041	106,681.81	Ditto	YES
PR in Tradition Arm (Utiltiy)	0.037	109,421.96	Ditto	YES
	0.033	112,528.55	Ditto	YES

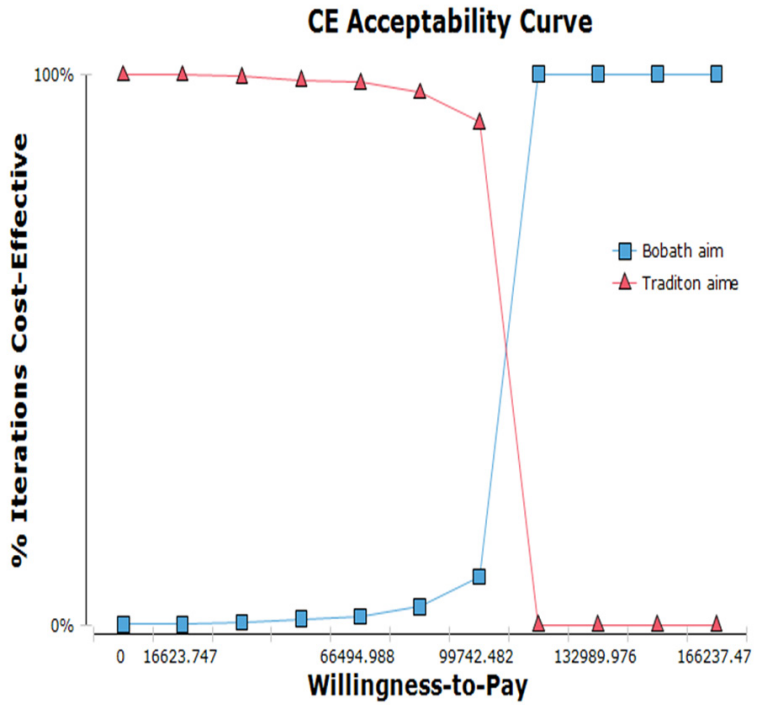

Figure 2. Cost-utility acceptability curve, showing that when the WTP was more than 99,742.48 yuan the Bobath arm was the better choice.

rehabilitation (CR), partial rehabilitation (PR), and inefficacy (**Figure 1**). We analyzed the improvement rate in both arms in the three abovementioned states in one year to calculate annual transition probability according to $P_t=1-e^{-rt}$ [12]. The time horizon was set to 5 years (total of 60 stages). All states were in the absorbing state, which meant that all patients could be in only one state at the same time.

Costs

Only direct costs were considered in this study, because the indirect costs were uncertain and some of which were variable. The costs here were provided by the Chinese healthcare system, which mainly contained drugs fee, rehabilitation fee, etc.

The price was ￥2000.00/cycle for cerebroprotein hydrolysate, ￥1500.00/cycle for ginkgo biloba leaf extract, and ￥500.00/cycle for sodium ferulate injection. One cycle needs 30 days.

Health utility value

In this study, the health utility value was set by literatures. The utility value for post-stroke patients was lacking so we asked 10 specialists from two large-scale complex hospitals in Beijing to provide the utility value of post-stroke disease. Besides, the factors of ADRs

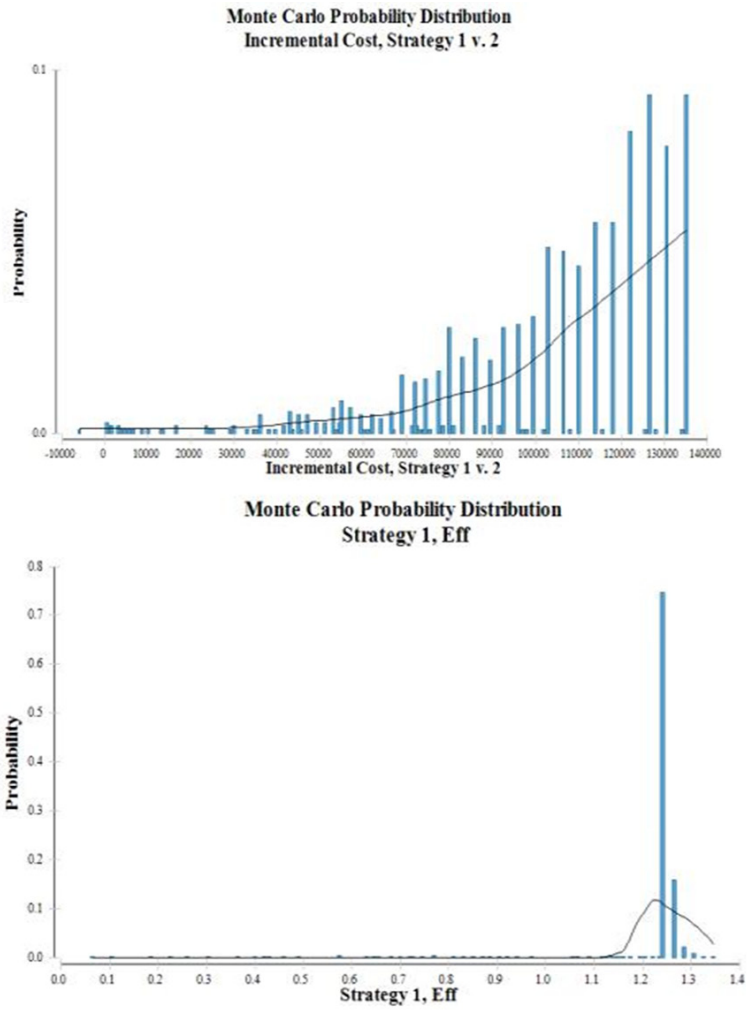

Figure 3. The incremental cost and effectiveness distributions, showing that the incremental costs manifested Beta distribution and the incremental effectiveness manifested gamma distribution. This illustrated that the Markov model and the outcomes were stable.

should be taken into account. According to the specialists, utility values of CR and PR were 0.781 and 0.512, respectively, and the values of CR and PR were 0.563 and 0.442, respectively.

Calculation

The detailed costs are presented in **Table 1**. The utility values are shown in **Table 2**. The improvement rates in the two hospitals are presented in **Table 3**. Then, every parameter was entered into the TreeAge Pro 2011 software to perform the one-way sensitivity analysis and PSA at the same time. Moreover, the willingness to pay (WTP) would be analyzed in this study. In this study, we used the mathematical model according to data from phase III hospitals in Beijing, which fits to ethics restrictions.

Statistical 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 cost-effectiveness analysis (CEA) in this study defined as the average costs for decreasing disability level. Cost of rehabilitation services in this study was analyzed in both provider and patient perspectives. Effectiveness was assessed using change of Barthel index of disability level.

Results

The medical investment and health outcomes for 5 years

We imported these parameters into the TreeAge Pro 2011 software to obtain the baseline of clinical outcomes and effectiveness for 5 years. The results showed that the QALYs were 1.222 in the Bobath arm and 0.279 in the traditional arm. Accumulated medical costs were ￥136,782.85 and ￥33,597.94, respectively. Furthermore, the results of the rock back showed that the Bobath arm was better.

In addition, according to WHO's recommendations, when the ICER was less than the gross domestic product (GDP), it was significantly cost-effective; when it was less than threefolds of the GDP, it was still cost-effective; when it was more than threefolds of the GDP, it was not cost-effective [13-18]. According to the formula $ICER=(C_1-C_2)/(U_1-U_2)$ [13-16, 18-20], ICER=￥109,421.96, which is between the mean GDP and threefolds of the mean GDP. It means that the Bobath arm could be popularized.

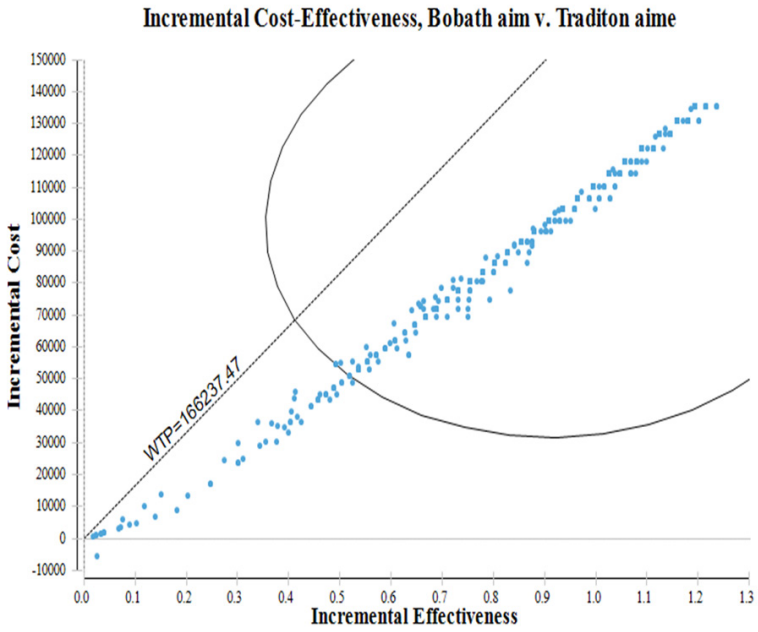

Figure 4. The ICE scatter. The scatter located in the circle represents the better arm. In this figure, most of the scatters are in the circle, which means that the Bobath curative is the better arm.

Sensitivity analysis

One-way analysis: We upregulated and downregulated the prices and utilities of PR and CR by 10% to evaluate whether these factors affect the performance, which is presented in **Table 4**. In the table, we could find that even if the factors change, the performance would not change. It showed that the results were stable.

PSA: We conducted a PSA to examine the cost-utility acceptable curve under different WTPs. It showed that, when the WTP was less than ¥132,989.98 (2.4-fold of the mean GDP), the traditional strategy would be the better choice. When it was more than ¥132,989.98, the results were overturned. The acceptability curves are shown in **Figure 2**.

Monte-Carlo sensitivity analysis: Under the baseline, we used 1000 samples to analyze distributions of incremental cost and effectiveness. As shown in **Figure 3**, the incremental costs manifested a beta-distribution, and the incremental effectiveness manifested a gamma-distribution, which illustrated that the Markov model and outcomes were stable. Meanwhile, ICE scatter showed that the Bobath arm was economical and would be popularized (**Figure 4**).

Discussion

To the best of our knowledge this is the first study to estimate the costs of stroke in a rural setting of China [21]. The major strength of this study is its use of predominantly local data sources both epidemiological and cost data. Previous studies on economic costs of stroke in china are difficult to generalize as they vary with regards to cost categories included, number of patients assessed, duration of patient follow-up and unit costs of treatment procedures [22].

The present study gathered information on traditional rehabilitation in post-stroke syndrome incurred by patients from a developing country, adding valuable knowledge to current information on the known costs of stroke [23]. To the best of our knowledge, the present study is the first to describe the direct costs incurred by reformative Bobath rehabilitation and traditional rehabilitation upon discharge from a hospital in Malaysia. Although several studies have established the effect of stroke severity on the cost of inpatient care [24, 25], the present study highlighted that stroke severity also influences the cost of outpatient care following a stroke. We found that patients who experienced more severe strokes required more medical aids and nursing help, attended outpatient therapy more frequently, and were more likely to seek alternative therapies.

To date, it was the first time to analyze the cost utility of Bobath versus traditional treatment for post-stroke syndrome. The result of ICER showed that it merely increased ¥109,421.96 per QALY, which was less than threefolds of the mean GDP, which could be borne by Chinese people. Besides, the outcome of the one-way sensitivity analysis showed that the change of cost and utility could not affect the final outcome. Moreover, the probability distribution of incremental cost, incremental effect, and ICER had beta- and gamma-distribution, which me-

ans that it had a stable and reliable outcome [26].

Certainly, The study have some limitations. First, The utility value for Chinese population was lacking, so we have to acquire specialists to estimate the value. Second, It could only simulate a trend of cost-effectiveness, and the authenticity could not be compared with a long-term clinical trial.

The analyses conducted in the present study generated data that could be useful for the future planning of health services that aim to meet the needs of patients and families affected by stroke [27]. Future research should examine the stroke-related costs incurred by the government, as well as the indirect costs. The addition of a quality-of-life component to cost-related research should also be considered.

In conclusion, the costs of outpatient stroke care were found to be significantly influenced by stroke severity. The cost of attendant care was the main cost incurred by patients during the first three months after hospital discharge, while the cost of travelling to the hospital was the main cost incurred when attending outpatient stroke rehabilitation therapy. Bobath arm was more cost-effective than the traditional arm in post-stroke treatments and could be popularized in most regions of China.

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Disclosure of conflict of interest

None.

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