

## Abstract

**Background:** Stroke is a common disease, causing disability or death leading to high treatment costs. It was found that there had been no official record about the actual medical expenses and the appropriate amount of reimbursement.

**Objective:** To investigate the actual medical expenses, the expenses requested for reimbursement from welfares, and the amounts of reimbursement. In addition, to study the factors affecting medical expenses.

**Methods:** A cross-sectional descriptive study was performed. The population consisted of patients who were older than 18 that admitted with acute strokes, from January 2017 to December 2021. The population were categorized into 5 groups: 1) ischemic stroke with r-tPA, 2) ischemic stroke without r-tPA, 3) hemorrhagic stroke requiring surgery, 4) hemorrhagic stroke not requiring surgery, and 5) transient ischemic attack. The information was retrieved from the electronic medical records using the Health Object system. The research tools were ICD10 and ICD9.

**Results:** We included 3,518 patients which reduced to 3,377 patients due to incomplete information. 57.28% were male, and 42.72% were female. The most common age range were 61-80-year-olds (53.27%). The most frequently used medical welfare was the universal coverage scheme (47.75%). The first 3 discovered comorbidities were hypertension, diabetes mellitus, and hyperlipidemia, respectively. The average costs of treatment (per head) in 5 groups had been 73,656.68-baht, 27,057.11-baht, 237,788.76-baht, 84,902.66-baht, and 17,277.78-baht, respectively. Two statistically significant factors affecting medical expenses were found: endotracheal intubation or mechanical

# Cost of Treatment for In-patient with Acute Stroke

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ventilation (p-value < 0.001) and blood transfusions (p-value 0.001).

**Conclusion:** Based on the difference between expenses requested for reimbursement and the amount of reimbursement, it was discovered that the hemorrhagic stroke requiring surgery had the greatest losses, while the ischemic stroke without r-tPA had the greatest profit.

**Keywords:** Acute stroke, Ischemic stroke, Hemorrhagic stroke, Transient ischemic attack, Medical expense, Reimbursement, Factors related expense, In-patient

## Introduction

Stroke is a common and chronic disease, which can cause disability or death. According to 2017-2018 studies, stroke is the second leading cause of death for the population over the age of 60. Globally, there are 6.5-80 million cases died from stroke.<sup>1,2</sup>

Thailand's Behavioral Health Surveillance Survey 2004<sup>3,4</sup> found that there had been 398,453 cases of stroke per year, with a mortality rate of 54 people per day, which had resulted in higher healthcare costs.

A previous study by the Institute of Neurology in 2019<sup>5</sup> found that the direct medical cost of acute stroke had been 44,200 baht per visit. Moreover, the studies on in-patient stroke rehabilitation cost<sup>6</sup> found that on average, it had resulted in a hospital stay of 37 days, with an average cost of 120,306.76 baht per person.

Currently, there are a growing number of stroke patients undergoing in-patient treatment and more are taking intravenous thrombolytic medications. Some patients may have multiple co-morbidities or complications, which will result in even greater medical expenses.

This study aimed at analyzing the cost of care for in-patient with acute stroke. The actual medical

costs of all in-patients, expenses requested for reimbursement and the amounts of reimbursement were investigated and analyzed in order to find out the differences. The results of the study will be used accordingly to improve medical expenses so that the burden on healthcare facilities and patients during the treatment of strokes can be reduced.

## Materials and Methods

A Cross-sectional descriptive study was conducted using data from medical records (ICD10, ICD9) from the Srinagarind hospital's electronic system database (Health Object: HO) January 2017 to December 2021.

The inclusion criteria were patient with acute strokes treated in the stroke unit of Srinagarind hospital and older than age of 18. The exclusion criteria were those whose data were incomplete.

The sample population were categorized into 5 groups: 1) ischemic stroke with r-tPA, 2) ischemic stroke without r-tPA, 3) hemorrhagic stroke requiring surgery, 4) hemorrhagic stroke not requiring surgery, and 5) transient ischemic attack. The data to be studied included a diagnosis of medical welfares, co-morbidities, complications, and procedures as factors affecting medical expenses along with actual medical expenses, expenses requested for reimbursement, the amounts of reimbursement, and expenses patients had to pay.

Descriptive statistics were used consisting of percentages, average standard deviations, and 95% CI. This study was approved by the Human Research Ethics Committee, Khon Kaen University (HE 651436).

## Results

From a total of 3,518 patients, who met these terms. the population was reduced to 3,377 patients

due to incomplete data. the percentage of males was 57.28%, while the percentage of females was 42.72%. The most common age range was 61 to 80 (53.27%). The most used medical welfare was the universal coverage scheme (47.75%). The first 3 discovered co-morbidities were hypertension (59.8%), diabetes mellitus (29.4%), and dyslipidemia

(28.1%). The patients were diagnosed with the following: 1) ischemic stroke with r-tPA (15.66%), 2) ischemic stroke without r-tPA (71.69%), 3) hemorrhagic stroke requiring surgery (0.43%), 4) hemorrhagic stroke not requiring surgery (10.60%), and 5) transient ischemic attack: TIA (1.62%) as shown in Table 1.

**Table 1** Baseline characteristics of stroke patient

Characteristics	number of people	percentage
<b>1. Sex</b>		
- male	2,015	57.28
- female	1,503	42.72
<b>2. Age</b>		
- below than 20 years old	44	1.25
- between 21 to 40 years old	134	3.81
- between 41 to 60 years old	988	28.08
- between 61 to 80 years old	1,874	53.27
- more than 80 years old	478	13.59
<b>3. Medical welfares</b>		
- government enterprise officer scheme	1,414	40.19
- local government enterprise officer scheme	139	3.95
- universal coverage scheme	1,680	47.75
- social security scheme	133	3.78
- state enterprise officer	49	1.39
- self-pay	102	2.90
- other	1	0.03
<b>4. Co-morbidities</b>		
- diabetes mellitus	994	28.25
- dyslipidemia	1,000	28.42
- hypertension	2,116	60.14
- coronary artery disease	52	1.47
- atrial fibrillation	668	18.98
- chronic obstructive pulmonary disease	67	1.90
- chronic kidney disease	351	9.97
- sleep apnea	43	1.22
<b>5. Stroke subgroups</b>		
- ischemic stroke with r-tPA	551	15.66
- ischemic stroke without r-tPA	2,522	71.69
- hemorrhagic stroke with surgery	15	0.43
- hemorrhagic stroke without surgery	373	10.60
- transient ischemic attack	57	1.62

Annotation: some information may not be complete

Abbreviations: r-tPA, recombinant tissue plasminogen activator

Table 2 shows the medical expenses and reimbursement costs for each group. It demonstrates that the highest cost for treatment (237,788.76 baht) had been spent for the group with hemorrhagic strokes requiring surgery, while the group with the second costs had been those with hemorrhagic strokes not requiring surgery (84,902.66 baht). Meanwhile, the group with the third highest costs had been the group with ischemic strokes that had been treated with r-tPA (73,656.68 baht).

Table 3 shows the factors affecting the medical expenses. It demonstrates that the statistically significant factors had been endotracheal intubations and mechanical ventilation (p-value < 0.001, 95%CI 0.106 to 0.299) and blood transfusions (p-value 0.001, 95% CI 0.075 to 0.315).

In Table 4, after the factors affecting medical expenses for stroke patients had been classified to each subgroup, it demonstrates that the comorbidity

of coronary artery disease had, with statistical significance, affected the medical costs for patients with ischemic strokes without r-tPA, and those with hemorrhagic strokes not requiring surgery with p-values of 0.049 and 0.015, respectively. In the cardiovascular procedure group, echocardiograms and Holter monitoring were found to have had a statistical significance on medical costs for hemorrhagic stroke patients requiring surgery with p-values of 0.006 and 0.001, respectively. In the gastrointestinal procedures group, the costs for endoscopies were found to be statistically significant for patients with ischemic strokes, who had not received r-tPA with a p-value of 0.045. In the hematological procedures group, the costs for blood transfusions had been statistically significant in patients with ischemic stroke who had not received r-tPA with a p-value of 0.017.

**Table 2** Medical expenses and reimbursement costs for each group as baht (S.D)

Subgroups	Medical expenses	Expenses requested for reimbursement	Amounts of reimbursement	Expenses patients had to pay
IS with r-tPA	73,656.68 (69,828.95)	72,190.18 (61,487.70)	70,566.25 (47,442.57)	9,702.03 (30,313.82)
IS without r-tPA	27,057.11 (48,867.86)	26,140.89 (48,563.63)	27,087.98 (43,664.18)	7,890.93 (30,747.98)
HS with surgery	237,788.76 (274,098.10)	234,280.15 (287,127.37)	216,790.64 (190,082.51)	40,897.00 (62,478.08)
HS without surgery	84,902.66 (123,912.95)	82,279.78 (124,442.52)	63,842.12 (82,044.74)	14,134.80 (43,938.09)
Transient ischemic attack	17,277.78 (19,520.12)	16,347.70 (19,205.85)	16,044.25 (15,901.03)	5,393.00 (11,417.62)

Annotation: Abbreviations: IS, ischemic stroke; HS, hemorrhagic stroke; S.D, standard deviation; r-tPA: recombinant tissue plasminogen activator

Table 3 Factors affecting the cost of medical care

Data	Number	%	Coefficients (95%CI)	p value
Co-morbidities				
Diabetic mellitus				
- yes	994	29.4	0.023 (-0.051 to 0.098)	0.536
- no	2,383	70.6		
Dyslipidemia				
- yes	949	28.1	0.020 (-0.055 to 0.096)	0.595
- no	2,428	71.9		
Hypertension				
- yes	2,020	59.8	0.015 (-0.054 to 0.084)	0.064
- no	1,357	40.2		
Coronary artery disease				
- yes	52	1.5	0.124 (-0.151 to 0.399)	0.376
- no	3,325	98.5		
Atrial fibrillation				
- yes	645	19.1	-0.005 (-0.091 to 0.081)	0.901
- no	2,732	80.9		
COPD				
- yes	64	1.9	-0.028 (-0.277 to 0.221)	0.826
- no	3,313	98.1		
Chronic kidney disease				
- yes	333	9.9	0.036 (-0.078 to 0.150)	0.533
- no	3,044	90.1		
Sleep apnea				
- yes	41	1.2	0.125 (-0.184 to 0.435)	0.427
- no	3,336	98.8		
Neurological procedures				
Ventriculostomy and shunting				
- yes	29	0.9	0.305 (-0.062 to 0.672)	0.104
- no	3,348	99.1		
Brain imaging				
- yes	3,073	91.0	0.004 (-0.114 to 0.123)	0.942
- no	304	9.0		
Embolectomy and thrombectomy				
- yes	6	0.2	-0.398 (-1.203 to 0.406)	0.332
- no	3,371	99.8		
Cardiovascular procedures				
Echocardiogram				
- yes	135	4.0	0.141 (-0.032 to 0.314)	0.111
- no	3,242	96.0		

Table 3 Factors affecting the cost of medical care (cont.)

Data	Number	%	Coefficients (95%CI)	p value
Coronary angiography				
- yes	9	0.3	0.129 (-0.529 to 0.786)	0.701
- no	3,368	99.7		
Arterial or venous catheterization				
- yes	68	2.0	0.180 (-0.061 to 0.421)	0.144
- no	3,368	98.0		
Holter monitoring				
- yes	34	1.0	0.031 (-0.309 to 0.371)	0.858
- no	3,309	99.0		
CPR, defibrillation, cardioversion				
- yes	19	0.6	-0.022 (-0.045 to 0.432)	0.926
- no	3,358	99.4		
Respiratory procedures				
Non-invasive ventilation				
- yes	95	2.8	0.063 (-0.142 to 0.268)	0.549
- no	3,282	97.2		
ET intubation and mechanical ventilation				
- yes	486	14.4	0.202 (0.106 to 0.299)	<0.001
- no	2,891	85.6		
Tracheostomy				
- yes	24	0.7	0.175 (-0.228 to 0.578)	0.395
- no	3,353	99.3		
Nephrology procedures				
Hemodialysis				
- yes	27	0.8	0.268 (-0.113 to 0.648)	0.168
- no	3,350	99.2		
Gastrointestinal procedures				
Endoscopy				
- yes	30	0.9	0.174 (-0.187 to 0.535)	0.344
- no	3,347	99.1		
Irrigation				
- yes	57	1.7	0.027 (-0.236 to 0.290)	0.841
- no	3,320	98.3		
Hematological procedures				
Blood transfusion				
- yes	293	8.7	0.195 (0.075 to 0.315)	0.001
- no	3,084	91.3		

Abbreviations: CI, confident interval; COPD, chronic obstructive pulmonary disease; CPR, cardiopulmonary resuscitation; ET, endotracheal

Annotation: The number of analyzed patients was 3,377.

Table 4 Factors affecting medical expenses in each subgroup

Data	IS with r-tPA	IS without r-tPA	HS with surgery	HS without surgery	TIA
Co-morbidities					
Diabetic mellitus					
- yes	162	715	3	100	14
- no	379	1,709	10	244	41
- (p value)	(0.571)	(0.898)	(0.069)	(0.597)	(0.188)
Dyslipidemia					
- yes	166	667	3	91	22
- no	375	1,757	10	253	33
- (p value)	(0.583)	(0.536)	(0.650)	(0.822)	(0.874)
Hypertension					
- yes	334	1,452	10	196	28
- no	207	972	3	148	27
- (p value)	(0.469)	(0.811)	(0.392)	(0.332)	(0.280)
Coronary artery disease					
- yes	12	34	0	5	1
- no	529	2,390	13	339	54
- (p value)	(0.492)	(0.049)	(-)	(0.015)	(0.569)
Atrial fibrillation					
- yes	103	466	3	63	10
- no	529	1,958	10	281	45
- (p value)	(0.786)	(0.738)	(0.737)	(0.451)	(0.544)
COPD					
- yes	10	48	0	5	1
- no	531	2,376	13	339	54
- (p value)	(0.521)	(0.565)	(-)	(0.694)	(0.610)
Chronic kidney disease					
- yes	57	239	1	33	3
- no	484	2,185	12	331	52
- (p value)	(0.933)	(0.406)	(0.428)	(0.667)	(0.361)
Sleep apnea					
- yes	5	29	0	5	2
- no	536	2,395	13	339	53
- (p value)	(0.427)	(0.090)	(-)	(0.731)	(0.668)
Neurological procedures					
Ventriculostomy and shunting					
- yes	4	20	0	5	0
- no	537	2,404	13	339	55
- (p value)	(0.233)	(0.141)	(-)	(0.123)	(-)
Brain imaging					
- yes	511	2,207	12	292	51
- no	30	217	1	52	4
- (p value)	(0.617)	(0.713)	(0.762)	(0.771)	(0.785)
Embolectomy and thrombectomy					
- yes	1	5	0	0	0
- no	540	2,419	13	344	55
- (p value)	(0.691)	(0.296)	(-)	(-)	(-)
Cardiovascular procedures					
Echocardiogram					
- yes	23	100	2	8	2
- no	518	2,324	11	336	53
- (p value)	(0.507)	(0.146)	(0.006)	(0.612)	(0.094)

Table 4 Factors affecting medical expenses in each subgroup (cont.)

Data	IS with r-tPA	IS without r-tPA	HS with surgery	HS without surgery	TIA
Coronary angiography					
- yes	1	7	0	1	0
- no	540	2,417	13	343	55
- (p value)	(0.931)	(0.542)	(-)	(0.702)	(-)
Arterial or venous catheterization					
- yes	11	46	0	9	2
- no	530	2,378	13	335	53
- (p value)	(0.336)	(0.196)	(-)	(0.528)	(0.361)
Holter monitoring					
- yes	3	28	1	1	1
- no	538	2,396	12	343	54
- (p value)	(0.213)	(0.306)	(0.001)	(0.990)	(0.999)
CPR, defibrillation, cardioversion					
- yes	0	16	0	3	0
- no	541	2,408	13	341	55
- (p value)	(-)	(0.915)	(-)	(0.212)	(-)
Respiratory procedures					
Non-invasive ventilator					
- yes	10	68	1	15	1
- no	531	2,356	12	329	54
- (p value)	(0.348)	(0.337)	(0.373)	(0.577)	(0.422)
ET intubation, mechanical ventilation					
- yes	96	329	2	51	8
- no	445	2,095	11	293	47
- (p value)	(0.814)	(<0.001)	(0.548)	(0.202)	(0.746)
Tracheostomy					
- yes	3	13	1	7	0
- no	538	2,411	12	337	55
- (p value)	(0.967)	(0.739)	(0.528)	(0.325)	(-)
Nephrology procedures					
Hemodialysis					
- yes	4	18	0	4	1
- no	537	2,406	13	340	54
- (p value)	(0.692)	(0.304)	(-)	(0.165)	(0.588)
Gastrointestinal procedures					
Endoscope					
- yes	5	23	0	1	1
- no	536	2,401	13	343	54
- (p value)	(0.549)	(0.045)	(-)	(0.487)	(0.610)
Irrigation					
- yes	11	40	1	3	2
- no	530	2,384	12	341	53
- (p value)	(0.921)	(0.563)	(0.373)	(0.488)	(0.415)
Hematological procedures					
Blood transfusion					
- yes	54	191	2	40	6
- no	487	2,233	11	304	49
- (p value)	(0.451)	(0.017)	(0.548)	(0.645)	(0.134)

Abbreviations: COPD, chronic obstructive pulmonary disease; CPR, cardiopulmonary resuscitation; ET, endotracheal; HS, hemorrhagic stroke; IS, ischemic stroke; r-tPA, recombinant tissue plasminogen activator; TIA, transient ischemic attack

Annotation: The number of analyzed patients was 3,377.



## Discussion

According to the study, the group with ischemic strokes without r-tPA was the only group that had received more reimbursement than the costs paid. The reimbursement was 103.62%. However, the other four groups had received less compensation than the costs paid. The least reimbursement was the group with hemorrhagic strokes not requiring surgery, which had received 77.59% of the cost paid. The second was the group with hemorrhagic strokes requiring surgery, who received 92.53% of the cost paid. This may be because the disease has severe complications, which required inpatient treatment for lengthy periods of time without adequate procedures that could be used to reimburse treatment costs. In contrast, the patients with ischemic strokes with r-tPA had received 97.75% of the cost paid, and the patients with transient ischemic attack had received 99.98% of the cost paid. This may be due to the shorter hospital-stay period.

The study conducted by Namfon Sribundit<sup>7</sup> from Mahidol University investigated the medical expenses of ischemic stroke patients. The findings revealed that patients with ischemic stroke with r-tPA had had an average medical expense of 111,620 baht, while the patients without ischemic stroke with r-tPA had an average medical expense of 40,490 baht. Those costs were higher than the costs found in this study. It is because of the larger number of procedures performed at Mahidol University's Hospital than those conducted at Srinagarind Hospital because Mahidol University's Hospital is a medical school with more specialist doctors and more specialized medical equipment. Another study was conducted by Orathai

Khiaocharoen<sup>8</sup> from The Phitsanulok Provincial Public Health Bureau. The findings revealed that the average cost of treatment for ischemic stroke patients had been 19,840 baht each, and for hemorrhagic stroke patients, it had been 66,812 baht each. These costs were less than the costs found in this study. This may have been because provincial hospitals have lower treatment costs and fewer tools.

In addition, trends in healthcare costs in other Asian countries showed that after the costs had been compared in the same currency, China<sup>9</sup>, India<sup>10</sup>, Malaysia<sup>11</sup>, and Indonesia<sup>12</sup> had higher treatment costs than Thailand as shown in Table 5. However, neither of the studies mentioned above had actually classified the expenses request for reimbursement, the compensation received, and the differences that patients had had to pay for additional medical expenses based on the costs of the different types of strokes. Therefore, these were investigated in this study.

The limitations of this study may be the incomplete medical records, which resulted in the conclusion that the medical expenses had been less than the actual amount. The study did not cover the severity of the disease among the different groups, which could have resulted in changes to the medical expenses. Therefore, the research team suggests that the medical records system for the patients should be reviewed before finalizing the costs. This would contribute to developing a system for collecting medical expenses, creating an accurate and appropriate reimbursement of expenses, and reducing the burden of additional expenses that the patients would have to pay for each medical treatment.

**Table 5** medical expenses of stroke patients compared with other studies.

Medical expenses	IS with r-tPA	IS without r-tPA	HS with surgery	HS without surgery	TIA
Present study	73,656.68	27,057.11	237,788.76	84,902.66	17,277.78
THB (USD)	(2,120.84)	(779.07)	(6,846.78)	(2,444.65)	(497.49)
Sribundit N. <sup>7</sup>	111,620	40,490	-	-	-
THB (USD)	(3,213.94)	(1,165.85)	-	-	-
Khiaocharoen O. <sup>8</sup>	19,184	-	66,812	-	-
THB (USD)	(551.34)	-	(1,923.75)	-	-
Wei JW <sup>9</sup>	10,689	-	13,089	-	-
CNY (USD)	(1,529.25)	-	(1,872.61)	-	-
Rajasulochana SR. <sup>10</sup>	40,360	-	-	-	-
INR (USD)	(488.59)	-	-	-	-
Nor Azlin MN. <sup>11</sup>	3,767.6	-	3,774.2	-	-
MYR (USD)	(851.44)	-	(852.93)	-	-
Hadning I. <sup>12</sup>	-	52,364,700	-	-	-
IDR (USD)	-	(3,360.48)	-	-	-

Annotation: “-” means the information was not covered in the study; The currency exchange rate was 1 USD to 34.60 THB on 27<sup>th</sup> December 2022, 10.15 pm.

Abbreviation: IS, ischemic stroke; HS, hemorrhagic stroke; TIA, transient ischemic attack; r-tPA, recombinant tissue plasminogen activator; USD, United State Dollar; THB, Thai Baht; CNY, Chinese Yuan; INR, Indian Rupee; MYR, Malaysian Ringgit; IDR, Indonesian Rupiah

## Conclusion

In this study, the largest age group of stroke patients was 61-80 years. Most were patients with ischemic stroke (71.69%). The first three discovered comorbidities were hypertension, diabetes, and hyperlipidemia, respectively. The group of patients with hemorrhagic strokes requiring surgery had the highest actual medical bills (237,788.76 baht) and the highest average reimbursements (216,790.64 baht). The most profitable group when compared the amount of reimbursement with the actual costs paid was ischemic stroke without r-tPA (103.62%). The least reimbursement was the group with hemorrhagic strokes not requiring surgery (77.59%) causing either the patients or hospital having to pay some additional medical expenses. The results

can be used as a reference that can lead to the optimization of medical bills involving strokes and to the reduction of economic losses.

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