

# Estimating Patient-Level Costs for Acute and Sub-Acute Inpatient Services in Thailand

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## ABSTRACT

**Objective:** To determine patient-level cost of acute and sub-acute inpatient services and to examine factors predicting cost for patients requiring sub-acute care.

**Methods:** The study design was prevalence-based cost-of-illness approach. Subjects were 2,419 inpatients requiring sub-acute care in 2 regional hospitals. The costs of services were calculated employing standard costing methods. Inpatient costs were prospectively recorded from July 2008 to February 2009. Micro-costing approach was employed under a provider perspective. Paired-t test was used to evaluate the significant difference.

**Results:** The average cost during the sub-acute phase was much lower than that in the acute phase (14,877 vs. 23,089 Baht). Nursing service constituted the highest cost (42.6%) in sub-acute phase, whereas direct rehabilitation costs was only 2%. Burn with low physical function had the highest average costs (67,243 Baht). The average cost was significantly higher than the average charge ( $p < 0.001$ ). The physical function at admission, Rehabilitation Impairment Category (RIC) and length of stay (LOS) were the key determinants of sub-acute service costs (adjusted  $R^2 = 0.688$ ;  $p < 0.001$ ).

**Conclusion:** The cost in sub-acute phase was lower than the cost in acute phase. Physical function, RIC and LOS could be used to predict cost of sub-acute inpatient services.

**Keywords:** Patient-level costing, sub-acute inpatient, rehabilitation cost, Thailand

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## INTRODUCTION

Estimating cost is important in the assessment for improvement of health system performance.<sup>1</sup> Most published studies present the average costs per hospitalisation or cost per inpatient day. However, different patients have different health care needs depending upon their health conditions. Therefore, a patient-level costing system is needed for proper resource allocation.

Sub-acute care covers a variety of services provided to patients who recover from acute illness and need additional support to recuperate before discharge from the hospital such as rehabilitation, palliative, and geriatric care. Sub-acute care is increasingly in demand due to increases in the number of elderly,<sup>2</sup> chronic diseases,<sup>3</sup> accidents and gains in survival of patients with catastrophic injury.<sup>4</sup> This has become an important concern in most health care systems.<sup>5</sup>

Currently, sub-acute inpatient service in Thailand is included in acute care services. Payment for sub-acute inpatients is inadequately covered within the diagnosis related group (DRG) payment which has been designed for acute inpatient care. In addition, information on patient-level cost of sub-acute service is lacking. This paper aimed to present the cost of sub-acute care compared with cost of acute care for inpatients who needed rehabilitation after acute care. Moreover, factors that predicting cost of sub-acute care were explored. The relationship between cost and charge was also examined.

## MATERIALS AND METHODS

This study was designed as a prevalence-based cost-of-illness from a provider perspective.<sup>6</sup> This study focused on inpatient rehabilitation services after acute episodes. Doctors' decisions to refer patients to rehabilitation services for functional restoration were used as a criterion for triggering sub-acute care. The Naresuan University Ethics Committee for Research on Humans approved this study.

### Data source and study population

This study was conducted in two regional hospitals

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in Thailand from July 2008 to March 2009. Each hospital had about 800 beds with a separate rehabilitation ward. Both have more than 1,500 outpatient visits per day and 60,000 inpatient admissions per year with occupancy rates about 90 percent.

Data were obtained from multiple sources: 1) administrative data both from computerized databases and paper documents covered patient demographic characteristics, medical treatments including operations, discharge diagnoses and costing data, 2) additional data using forms unique to this study included case summary, nursing activities, rehabilitation services, and functional status data.

For functional status data the Barthel Index (BI) and the Mini-Mental State Examination Thai 2002 version were used. The BI score ranged from 0 to 20 and total MMSE score ranged from 0 to 30. For each subject, BI and MMSE were performed at the beginning of the sub-acute phase, at discharge from the hospital only BI was performed.

The data of laboratory investigation, medical procedures, medical devices and drugs delivered to patients were prospectively collected during the study period. Total nursing activities of concerned wards and total rehabilitation services were collected from the recording books of each ward and each rehabilitation unit. Charge data of all patients in the hospital came from the hospital's electronic data set.

The subjects were patients older than 17 years old diagnosed with diseases which needed intensive rehabilitation care and stayed in hospitals more than 2 days after acute care. Patients who were referred to other hospitals or died during the study period were excluded. There were 2,419 inpatients with diagnoses at admission as mentioned, 222 patients were excluded because they stayed in hospital less than three days after acute care, 7 died, 31 were referred to other hospitals, and 126 were excluded because their diagnoses were not confirmed at discharge. Finally 2,033 subjects remained. (Table 2)

### Cost analysis

The methodology used to estimate the cost of individual patients was the micro-costing or bottom-up method.

First, the *standard top-down costing* method using financial data, and total hospital costs were allocated down to the department level. Each hospital department was classified as supporting (non-patient care) or patient-care cost centres (medical departments and wards). The direct cost of each cost centre was the sum of capital, material and labour costs. The labour cost was the sum of salaries, wages, overtime payments and all fringe benefits (such as housing) of personnel in each cost centre. For persons who worked in more than one cost centre, a proportion of working time in each cost centre from self-reporting was used to apportion the labour cost. Material costs consisted of utilities and other materials consumed by each cost centre. Other materials were office materials, household materials, maintenance materials, medical materials (drugs excluded), and scientific materials. Capital costs were depreciation of office area and durable goods used in each cost centre. The direct costs of supporting cost centres were transferred to be indirect costs of patient-care cost centres using a simultaneous cost allocation method. Finally in each patient-care cost centre, there were direct and indirect costs of capital, material, and labour costs and the total costs were the sum of all these costs. The total costs of these cost centers were reallocated to service groups based

on reimbursement schedules of the Civil Servant Medical Benefit Scheme.<sup>7</sup>

Second, unit cost was calculated. An average method<sup>8</sup> was applied for the service groups with one service or homogeneous service, e.g. hotel cost per day. For service groups with heterogeneous services, the ratio of cost to charge (RCC), and relative value unit (RVU)<sup>9</sup> were applied. The RCC for each group was directly computed from the total cost and total charge, and then the actual service charges were multiplied by the RCC to get the service costs. The costs of drug, laboratory, and other service groups were calculated via RCC. The costs per activity for nursing and rehabilitation were estimated by RVU. A service with RVUs 2 would require twice as many resources as compared to a service with RVU 1.

The final step was a *micro-costing approach*. It is a bottom-up method to accumulate all costs for each patient. The cost for each service was estimated in the second step. Finally, the cost of services in acute and sub-acute phases of care for each patient was identified by adding up the cost of services provided in each phase.

### Statistical analysis

Descriptive statistics including mean, and standard deviation were employed to explain unit costs. Stepwise multiple regression analysis was employed to analyse the relationship between the costs of sub-acute care (dependent variable) and several potential explanatory variables. Independent variables were the predictors of Sub-Acute and Non-Acute Patient Classification (SNAP) case mix such as RIC, functional score at admission to sub-acute phase measured by the Barthel Index, patient age, and length of stay in the sub-acute phase.<sup>10</sup> An RIC is a collection of diagnoses related to conditions needing intensive rehabilitation care which are different from each other (Table 2). Altogether, 2,295 ICD-10 codes were defined for the 19 RICs. Paired-t test was employed to evaluate the difference between cost and charge.

## RESULTS

### Hospital costs

The total cost of Ratchaburi Hospital was 1,300 million Baht in 2008. This consisted of 87% recurrent cost (37% labour and 50% non-labour) and 13% capital cost. Total cost of Udonthani Hospital was 1,660 million Baht, with 89% recurrent cost (35% labour and 54% non-labour) and 11% capital cost. Costs per bed day were 320 Baht for general wards in both hospitals, 480-590 Baht for private wards, 856-1,075 Baht for ICU. The cost of rehabilitation wards varied from 309 Baht per bed-day at Ratchaburi Hospital to 447 Baht per bed-day at Udonthani Hospital.

### Profile of cost for acute and sub-acute care

Table 1 presents cost per admission by service group. The average cost of acute phase was 23,089 Baht, of which 24.4% was instruments, 23.4% operations, 21.2% nursing activities, and 13.5% drug costs. The average cost of sub-acute phase was 14,877 Baht, of which 42.6% was nursing activities, 19.8% room and board, and 15.4% drug costs. On the other hand, rehabilitation cost in the sub-acute phase was only 2%.

### Patient characteristics

Table 2 shows that more than half of the patients

**TABLE 1.** Average hospital cost per admission according to phase of care by Service Group.

No	Service Groups	Allocation Approach	Average cost		Proportion of the hospital cost (%)	
			Acute phase	Baht (SD)	Acute phase	Sub-acute phase
1	Room	Cost/day	1,359 (1,819)	2,241 (3,366)	5.9	15.1
2	Board	Cost/day	426 (569)	705 (1,050)	1.8	4.7
3	Drug	RCC	3,128 (12,566)	2,284 (4,188)	13.5	15.4
4	Lab	RCC	662 (1,217)	448 (1,050)	2.9	3.0
5	X-ray	RCC	766 (1,443)	382 (1,012)	3.3	2.6
6	Special medical investigation	RCC	306 (1,202)	201 (929)	1.3	1.4
7	OR	RCC	5,406 (8,910)	701 (2,677)	23.4	4.7
8	Blood	RCC	108 (325)	24 (148)	0.5	0.2
9	Instrument	RCC	5,632 (22,304)	760 (5,106)	24.4	5.1
10	Medical equipment	RCC	255 (2,047)	165 (916)	1.1	1.1
11	Physical therapy	RVU	5 (92)	255 (941)	0.0	1.7
12	Occupational therapy	RVU	-	57 (289)	0.0	0.4
13	Speech therapy	RVU	-	-	0.0	0.0
14	Prosthesis and orthoses therapy	RVU	-	14 (516)	0.0	0.1
15	Doctor visit	Cost/day	145 (193)	303 (474)	0.6	2.0
16	Nursing activity	RVU	4,889 (9,367)	6,338 (11,107)	21.2	42.6
	Total cost		23,089 (37,948)	14,877 (19,873)	100.0	100.0

RCC= Ratio of cost to charge, RVU= Relative value unit

were male (62%). The most common condition was stroke (383 cases; 18.8%), followed by orthopaedic conditions (370 cases; 18.2%) and cardiac disorders (236 cases; 11.6%). The average age was 53.5 years. The average length of stay was 3.2 days in the acute phase and 8.6 days in the sub-acute phase.

#### Costs for acute and sub-acute inpatient services

Table 3 summarizes the average cost in each phase of care by Rehabilitation Impairment Category (RIC). In the acute phase, RIC 76 was the most costly (58,766 Baht), followed by RIC 63 (54,223 Baht), and RIC 77 (43,424 Baht). The highest cost at the sub-acute phase was RIC 78 (66,681 Baht), RIC 64 (38,343 Baht), followed by RIC 65 (20,698 Baht), and RIC 61 (19,332 Baht).

#### Cost vs. charges

Table 3 shows that the overall difference between cost and charge by RIC was statistically significant (paired t-test  $p < 0.001$ ). The results also showed that average cost per admission was significantly higher than average charge.

#### Determinants of sub-acute care cost

Table 4 presents the determinants of sub-acute care costs. Since the cost of the sub-acute phase was not normally distributed, a natural logarithmic transformation

was undertaken. The fitted model achieved an adjusted  $R^2$  of 0.688, and the probability of F-test = 0.000. The significant predicting variables were the Barthel score at admission, RIC, and LOS in sub-acute phase.

## DISCUSSION AND CONCLUSION

This study showed 3 remarkable findings. First, the micro-costing methodology in this study could estimate the cost of care of each individual patient and thus gave more accurate assessment of resource use. Cost components with a high impact on sub-acute care included nursing services, room and board, and drugs. It should be borne in mind that, if reimbursement rates are not correctly set on the basis of resource use, patients may be selected on the basis of financial considerations, not so much on the basis of diseases and servicing capacities.

Second, the costs of the sub-acute phase services were influenced by physical function which needed longer stays for restoring. Today, the main payment method for inpatient care in Thailand is based on diagnosis related group (DRG) including care for sub-acute and non-acute inpatients. The Thai DRG version 4 has only two out of 1,920 DRGs for rehabilitation services. This ignores the value of rehabilitation services in restoring cognitive and physical function of patients, especially those who have

**TABLE 2.** Characteristics of patients and length of stay by rehabilitation impairment category (RIC).

RIC	Description	N	% Male	Average age Years (SD)	Average length of stay(SD)	
					Acute phase	Sub-acute phase
61	Stroke	383	55.6	61.0(14.3)	3.7(7.4)	8.2(16.3)
62	Traumatic brain	108	80.6	39.2(14.5)	3.2(5.5)	6.0(6.4)
63	Non-traumatic brain	27	63.0	46.9(17.9)	6.5(7.2)	8.3(6.7)
64	Traumatic spinal cord	11	90.9	46.1(16.2)	5.7(5.5)	15.5(14.8)
65	Non-traumatic spinal cord	79	43.0	60.4(12.4)	2.4(3.5)	11.2(9.2)
66	Neurological condition	11	36.4	50.4(17.9)	2.2(3.2)	6.5(4.9)
67	Lower extremity fracture	125	53.6	59.6(22.9)	6.3(5.1)	6.7(5.8)
68	Hip and knee replacement	161	48.4	53.8(16.1)	4.3(6.1)	7.2(6.2)
69	Other orthopaedic conditions	370	68.4	45.4(17.4)	2.7(3.7)	5.7(6.9)
70	Amputation of limb	42	78.6	44.8(19.1)	3.7(4.7)	7.2(7.8)
71	Osteoarthritis	10	60.0	51.5(16.5)	2.5(2.0)	4.3(3.6)
72	Cardiac Disorders	236	59.7	65.3(12.4)	1.9(1.9)	4.1(1.7)
73	Pulmonary Disorders	76	77.6	65.1(14.0)	2.0(1.8)	4.1(2.0)
74	Pain Syndrome	135	48.9	48.8(14.4)	2.7(5.8)	9.9(7.3)
75	Other major multiple trauma (MMT)	58	89.7	38.4(16.7)	2.7(3.4)	4.9(7.4)
76	MMT with brain and spinal cord	33	78.8	41.5(17.1)	6.1(8.4)	9.7(8.8)
77	Miscellaneous	26	84.6	37.7(20.1)	2.5(3.2)	5.8(5.6)
78	Burns	137	66.4	52.1(12.9)	1.3(3.1)	28.8(32.0)
79	Deformity	5	40.0	43.8(7.1)	7.0(4.1)	3.3(1.7)
	All RICs	2,033	62.0	53.5(18.3)	3.2(5.2)	8.6(10.3)

**Remark:** RIC 77 are patients with infections, neoplasm, nutrition, circulatory disorders, respiratory disorders-ventilator dependent, respiratory disorders-non-ventilator dependent, terminal care, skin disorders, medical/surgical complications, and other medically complex conditions.

**TABLE 3.** Costs and charges for acute and sub-acute phases by rehabilitation impairment category (RIC).

RIC	Description	Acute phase			Sub-acute phase		
		Cost per phase (Baht)	Charge per phase (Baht)	Paired t-test	Cost per phase (Baht)	Charge per phase (Baht)	Paired t-test
61	Stroke	26,603(39,540)	7,837(18,934)	0.000**	19,332(21,654)	9,190(15,776)	0.000**
62	Traumatic brain	24,194(34,933)	14,825(34,667)	0.000**	14,599(19,643)	7,142(14,373)	0.000**
63	Non-traumatic brain	54,223(61,632)	29,248(75,713)	0.004**	22,121(28,025)	24,024(57,932)	0.824
64	Traumatic spinal cord	36,757(35,989)	27,617(29,533)	0.497	38,343(43,160)	13,997(19,622)	0.016*
65	Non-traumatic spinal cord	28,192(58,288)	6,454(32,249)	0.001**	20,698(30,536)	12,452(45,423)	0.045*
66	Neurological conditions	10,989(12,048)	6,972(5,255)	0.045*	14,280(16,334)	8,864(13,190)	0.162
67	Lower extremity fracture	34,297(24,599)	13,749(22,096)	0.000**	12,018(10,167)	7,344(20,241)	0.009**
68	Hip and knee replacement	37,618(51,534)	14,114(44,907)	0.000**	12,117(10,385)	6,267(12,902)	0.000**
69	Other orthopaedic conditions	16,196(20,202)	6,880(20,659)	0.000**	12,061(14,860)	8,253(20,051)	0.000**
70	Amputation of limb	30,472(60,508)	18,186(59,102)	0.003**	13,469(13,802)	12,057(23,721)	0.671
71	Osteoarthritis	14,873(15,529)	9,317(8,774)	0.162	10,322(11,743)	6,720(12,114)	0.009**
72	Cardiac Disorders	9,731(11,535)	6,071(21,121)	0.021*	8,428(6,537)	6,731(9,434)	0.000**
73	Pulmonary Disorders	6,690(4,023)	3,677(5,936)	0.000**	8,545(7,561)	6,431(10,074)	0.002**
74	Pain Syndrome	20,679(46,067)	8,659(45,924)	0.001**	14,465(12,306)	4,940(8,469)	0.000**
75	Other major multiple trauma (MMT)	23,423(38,569)	11,927(28,443)	0.011*	13,188(17,677)	14,575(37,817)	0.689
76	MMT with brain and spinal cord	58,766(153,230)	47,710(103,523)	0.617	23,074(24,871)	7,574(11,361)	0.000**
77	Miscellaneous	43,424(16,449)	4,793(10,912)	0.000**	13,864(12,894)	9,677(16,396)	0.000**
78	Burns	14,238(40,526)	5,869(17,368)	0.034*	66,681(71,808)	53,107(67,783)	0.286
79	Deformity	16,017(7,400)	4,624(4,178)	0.026	4,837(2,940)	422(402)	0.041*
	Average	23,089(37,948)	9,631(35,896)	0.000**	14,877(18,131)	9,002(21,785)	0.000**

\* P-value <.05 \*\* P-value <.01 (Paired t-test statistic)

suffered stroke, spinal cord injury, traumatic brain injury or amputation. This result suggested that a sub-acute patient case mix system may be a better tool for payment in sub-acute care. In addition, functional status measurement is important in applying appropriate resource allocation according to the needs of patients in different disease groups.

Third, the results of this study indicate that most of the charges quoted were lower than costs. The costing approach in this study supported evidence-based cost accounting to identify the costs related to treatment strategies. The results could be useful for payers such as the National Health Security Office and the Comptroller

**TABLE 4.** Explanatory determinants of natural log of sub-acute care costs.

	Unstandardized coefficients			Sig	95% CI for B	
	B	SE	t		Lower bound	Upper bound
(Constant)	7.725	0.029	263.011	0.000	7.668	7.783
Ln (salos)	0.795	0.014	58.117	0.000	0.768	0.822
big1	0.523	0.043	12.286	0.000	0.440	0.607
big2	0.188	0.025	7.568	0.000	0.139	0.237
RIC77	0.600	0.101	5.936	0.000	0.402	0.798
RIC72	0.266	0.038	6.986	0.000	0.191	0.340
RIC73	0.283	0.061	4.653	0.000	0.164	0.403
RIC61	0.161	0.034	4.702	0.000	0.094	0.228
RIC78	0.151	0.047	3.239	0.001	0.060	0.243
RIC62	0.156	0.052	3.016	0.003	0.054	0.257
RIC75	0.156	0.069	2.251	0.024	0.020	0.292

Adjusted R<sup>2</sup> = 0.688, probability of F-test=.000

SE = Standard error

Salos = length of stay in sub-acute phase

big 1 = Barthel index score 0-2

big 2 = Barthel index score 3-14,

See details of RIC in Table 2, RIC 79 used as reference group

General's Department in improving payment so that it is more reasonable.

Despite the strengths of this prospective, patient-level cost study, there were several limitations. First, most of the patient treatments were focused on acute problems. This may not be a good sampling of the sub-acute service since they had too short LOS and lower cost for the sub-acute phase. This was different from a previous study in a rehabilitation hospital in Thailand which showed that the average LOS for rehabilitation was 27±18 (2-74) days.<sup>11</sup> Second, no cost methodology is totally perfect. The cost methodology in this study was similar to that of the Australian National Sub-Acute and Non-Acute Patient Classification (AN-SNAP).<sup>12</sup> Approaches for capturing cost in heterogeneous service cost centre cover the RCC, RVU, intensity weight, and activity based costing (ABC). For RCC in a cost centre with detailed bill data, it provides a reasonable compromise between accuracy and ease of implementation in estimating patient level costs.<sup>13</sup> The RCC was also adopted in examining the average cost per DRG.<sup>14</sup> Though RCC was simple to apply, the low resemblance of charge to the cost data was another drawback. The RVU provided a better cost driver approach as it took account of both time and resources consumed for calculating cost per activity.<sup>15</sup> Even for the ABC which is considered to be the gold standard methodology, the application is lengthy, complicated, time consuming, and needs detailed information which might not be available or accurately registered.<sup>16,17</sup>

This study could conclude that cost analysis is important for setting the appropriate price of services and reimbursement rates. These findings generate cost data on individual patients which can help policy makers in considering a reimbursement system according to the phase of services provided: acute and sub-acute phases which consumed different medical resources. The micro-costing approach is very useful in terms of the accurate cost of each service. Although, this cost methodology was complex, standard costing method was necessary. The results can also provide illustrative ideas to both practitioners and managers of hospitals in cost calculation methodology. In a case mix classification development, cost data at patient level is important in calculating the cost relative weight between classes.<sup>18,19</sup> Physical function

and RIC which affect sub-acute costs could help further development of this sub-acute case mix classification and reimbursement policy. Hospital information systems should be developed to routinely record activities and cost data for all patients. As the costing system becomes more detailed and accurate, hospitals will be able to make better pricing decisions and can become more efficient in cost and services management. In the Thai health care system, a suitable and practical costing method for similar types of hospitals, similar efficiency of hospitals, and similar contexts for standard costs should be implemented.

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