Casemix Classification Payment for Sub-Acute and Non-Acute Inpatient Care, Thailand

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Background: *There is a need to develop other casemix classifications, apart from DRG, for sub-acute and non-acute inpatient care payment mechanism in Thailand.*
Objective: *To develop a casemix classification for sub-acute and non-acute inpatient service.*
Material and Method: *The study began with developing a classification system, analyzing cost, assigning payment weights, and ended with testing the validity of this new casemix system. Coefficient of variation, reduction in variance, linear regression, and split-half cross-validation were employed.*
Results: *The casemix for sub-acute and non-acute inpatient services contained 98 groups. Two percent of them had a coefficient of variation of the cost of higher than 1.5. The reduction in variance of cost after the classification was 32%. Two classification variables (physical function and the rehabilitation impairment categories) were key determinants of the cost (adjusted $R^2 = 0.749$, $p = .001$). Validity results of split-half cross-validation of sub-acute and non-acute inpatient service were high.*
Conclusion: *The present study indicated that the casemix for sub-acute and non-acute inpatient services closely predicted the hospital resource use and should be further developed for payment of the inpatients sub-acute and non-acute phase.*

Keywords: *Sub-acute and non-acute inpatient services, Rehabilitation, Casemix classification, Payment mechanism*

J Med Assoc Thai 2010; 93 (7): 849-59
Full text. e-Journal: *http://www.mat.or.th/journal*

Casemix is a tool to classify varieties of patient conditions into groups according to resources consumed as approximated by length of stay, episode cost, or cost of daily services[1]. Diagnosis related group (DRG) is the first casemix that has been used as payment tool in the US prospective payment system (PPS) for acute inpatient services since 1983[2,3]. Thailand has adopted DRG for inpatient care payment within a global budget of the universal coverage scheme since 2003[4]. Conceptually, the DRG classification has been developed based on acute health conditions, it is therefore inappropriate to use DRG for a payment system for sub-acute and non-acute health problems because of different clinical problems, mode of care and resource use[5]. Instead of being a short episode of care such as short stay for an operation or acute treatment[6], sub-acute and non-acute services are most often time-consuming for restoring functional status of the patients. Functional status is both very important for monitoring and for evaluating quality of sub-acute and non-acute care[7]. Thus, casemix of sub-acute and non-acute services has been developed and implemented in many countries[8-10].

The Thai DRG version 4 has only two out of 1,920 DRGs for rehabilitation services[11]. This ignores the value of rehabilitation services in restoring cognitive and physical function of patients who have suffered a stroke, spinal cord injury, traumatic brain injury, or amputation. Experience from other countries has shown that casemix payment can be designed to be a tool for management of hospitals enhancing equity and efficiency[12]. The aim of the present study was to develop and to examine the feasibility of classifying sub-acute and non-acute episodes of care in Thailand

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according to relative cost and to propose options to the casemix payment system.

Definition of sub-acute and non-acute patient (SNAP) care

Sub-acute and non-acute care in the present study is defined as "an episode of care provided for a person after an acute phase[13]". The sub-acute and non-acute services are directly involved with improving functional limitations. Sub-acute care is a program of treatment provided to patients recovering from acute illness who need additional support to recuperate before discharge from the hospital, such as rehabilitation, palliative care and psychogeriatric care. Non-acute care comprises a variety of services that help maintain functional status and quality of life, such as care for patients with cerebral palsy, dementia or deformities. However, the present study only focuses on rehabilitation service, because it shares a great majority of sub-acute and non-acute inpatient care for many kinds of acute episodes in Thailand.

Material and Method

Data sources

The present study was conducted in two general hospitals and a rehabilitation hospital. Available rehabilitation services include physiotherapy, occupational therapy and prostheses and orthoses. Each of the two general hospitals has 800 beds with a separate rehabilitation ward of 20 beds. Both of them have more than 1,500 outpatient visits per day and 60,000 inpatient admissions per year. The rehabilitation hospital is a 48-bed hospital with 217 outpatient visits a day and 200 inpatient admissions a year. All patients older than 17 years who stayed in hospitals for more than two days after acute care and were diagnosed with conditions needing intensive rehabilitation care (as listed in Table 1) were included. Patients who were referred to other hospitals or died during the study period were excluded. All eligible patients may be admitted to rehabilitation wards or general wards. Identification of acute and sub-acute phases is crucial, especially for patients admitted to general wards. The present study used experts in dealing with the criteria for decision making. All experts were medical, surgical, orthopedic, or rehabilitation doctors. Finally, a checklist form was designed for doctors to record when a patient changed to the sub-acute phase. Consequently, doctor decisions for referring patients to rehabilitation services for functional restoration according to such criteria were used for triggering sub-acute care.

Data collection

The assisting staff (n = 60) of rehabilitation doctors, physiotherapist, occupational therapist and nurses in three hospitals were trained for two days. The key issues of training were data collection process, functional status measurement and cost data recording for SNAP casemix resource consuming. A SNAP manual was provided to each trainee and they were to practice the use of functional measurement with two patients not participating in the present study. Data collection was done prospectively in the two general hospitals and retrospectively in the rehabilitation hospital. Prospective data was collected from all patients older than 17 who were diagnosed at admission as having any condition listed in Table 1 between May 2008 and February 2009. In the retrospective study at the rehabilitation hospital, medical records of patients discharged between October 2006 and September 2009 were reviewed. Crucial information in the research such as rehabilitation activities and functional status were routinely recorded in the rehabilitation hospital, all data of patients who were admitted during the present study period were also prospectively collected.

Two groups of study data were obtained from multiple sources: (1) administrative data from which patient demographic characteristics, medical treatment including operation, discharge diagnoses, and costing data were obtained, and (2) additional data that was unique to the present study including case summary, nursing activity, rehabilitation services and functional status data. Administrative data was obtained from both computerized databases and paper documents. Unique forms were constructed for collecting case summary, nursing activities, rehabilitation services and functional status data. Two functional measurements were used. Firstly, the Barthel Index (BI), which is a physical function assessment instrument. It consists of 10 items in three groups: self-care, mobility and sphincter control. Total score ranges from 0 (dependent) to 20 (independent). Secondly, the Mini-Mental State Examination (MMSE) Thai 2002, which has been used for screening cognitive function in Thailand[14]. It contains 11 items in seven domains including orientation, registration, attention, calculation, memory, language, and visual construction. Total score ranges from 0 (lowest) to 30 (highest). The BI and the MMSE were completed by trained practitioners. For each patient BI and MMSE rating were performed at the beginning of the SNAP phase. Only the BI rating was performed at discharge from hospital.

Table 1. Rehabilitation impairment categories (RICs)

RIC groups and relevant conditions
1) Stroke (RIC 61)
Left body involvement
Right body involvement
Bilateral involvement
No paresis
Other stroke
2) Traumatic brain dysfunction (RIC 62)
Traumatic, unspecified
Open injury
Closed injury
3) Non-traumatic brain dysfunction (RIC 63)
Non-traumatic
Other brain
4) Traumatic spinal cord dysfunction (RIC 64)
Paraplegia, unspecified
Paraplegia, incomplete
Paraplegia, complete that cannot be classified into a
Quadriplegia, unspecified specific group
Quadriplegia incomplete C1-4
Quadriplegia incomplete C5-8
Quadriplegia complete C1-4
Quadriplegia complete C5-8
Other non-traumatic SCI Amputation
5) Non-traumatic spinal cord dysfunction (RIC 65)
Paraplegia, unspecified
Paraplegia, incomplete
Paraplegia, complete
Quadriplegia, unspecified
Quadriplegia incomplete C1-4
Quadriplegia incomplete C5-8
Quadriplegia complete C1-4
Quadriplegia complete C5-8
Other non-traumatic SCI
6) Neurological condition (RIC 66)
Multiple sclerosis
Parkinsonism
Polyneuropathy
Cerebral palsy
Other neurologic
Guillian-Barre
7) Lower extremity fracture (RIC 67)
Fracture of pubis
Fracture of neck of femur
Multiple fractures of femur & other fractures
8) Hip and knee replacement (RIC 68)
Status post hip replacement
Status post knee replacement
9) Other orthopaedic conditions (RIC 69)
Status post hip fracture
Status post femur (shaft) fracture
Status post pelvis fracture
Status post major multiple fracture
Other orthopaedic
10) Amputation (RIC 70)
Single upper extremity above the elbow
Single upper extremity below the elbow
Single lower extremity above the knee
Single lower extremity below the knee
Double lower extremity above the knee
Double lower extremity above/below the knee
Double lower extremity below the knee
Other amputation
11) Osteoarthitis (RIC 71)
Rheumatoid arthritis
Osteoarthritis, other arthritis
12) Cardiac disorders (RIC 72)
Cardiac
Includes cases in which the major disorder is poor activity tolerance secondary to cardiac insufficiency or general reconditioning due to a cardiac disorder
13 Pulmonary disorders (RIC 73)
Chronic obstructive pulmonary disease
Other pulmonary
14 Pain syndromes (RIC 74)
Neck pain
Back pain
Extremity pain
Other pain
15) Other major multiple trauma (MMT) (without brain) (RIC 75)
Spinal cord + multiple fracture/amputation
Other multiple trauma
Developmental disabilities
Debility, unspecified include only subjects who are debilitated for reasons other than cardiac (09) or pulmonary (10) conditions
16) Major multiple trauma (brain + spinal cord injury) (RIC 76)
Brain + spinal cord injury
Brain + multiple fracture/amputation
17) Miscellaneous (RIC 77)
Infections
Neoplasms
Nutrition with intubation/parenteral nutrition
Nutrition without intubation/parenteral nutrition
Circulatory disorders
Respiratory disorders-ventilator dependent
Respiratory disorders-non-ventilator dependent
Terminal care
Skin disorders
Medical/syrgical complications
Other medically complex conditions
18) Burns (RIC 78)
19) Deformities (RIC 79)
Spina Bifida
Other Congenital

Source: Adapted from IRF-PAI (Inpatient Rehabilitation Instrument-Patient Assessment Instrument) Training Manual revises 01/16/02. [On-line] http://www.cms.hhs.gov/InpatientRehabFacPPS/irfpai-manualint.pdf

Resource use

Cost in the present study was confined to provider costs. Unit costs of medical services were calculated employing the standard top-down costing method[15-17]. The methodology used to estimate the cost of individual patients was micro-costing method[18]. Administrative data total resources used in that fiscal year were allocated to various cost centers. Then three types of constants, based on charge categories, were calculated: cost in Baht per day for room and board, cost in Baht per unit of activity for nursing and rehabilitation services, and cost to charge ratio for other categories of charges, including medical devices and instruments, drugs and parenteral nutrition, medical supplies, blood transfusion services and blood components, laboratory services, radiologic services, special investigations, medical equipments and machine use, operations and anesthesia, dental services, acupuncture and other services. Patient-level cost data were determined by multiplying these constants to appropriate data from each patient. Services delivered to each patient were recorded in the medical records, hospital electronic databases and the records of nursing and rehabilitation activities. Cost at the rehabilitation hospital for the fiscal years 2006 to 2008 was adjusted for inflation to fiscal year 2009. Resource consumption of each patient was identified and split into acute and sub-acute phases of care.

Development of classification system for SNAP care

This classification was based on the concept of the Case Mix Group (CMG)[19]. The classification development consisted of RIC and comorbidity definition and casemix grouping algorithm construction. Since WHO ICD-10 has been used for diagnosis coding in Thailand, therefore, RIC conditions in Table 1 were mapped to ICD-10 code by researchers and then independently checked by a coding expert. Altogether, 2,295 ICD-10 codes were defined for the 19 RICs. Comorbidities were defined in the same way and composed of 16 groups of chronic conditions from 492 ICD-10 codes. Casemix grouping algorithm proceeded stepwise as shown in Fig. 1. First, patients were split into two groups on the basis of total physical score, 0 and others. Second, patients who had a physical score equal to 0 were sub-divided into 2 SNAP clusters: stroke and non-stroke. Patients with physical scores more than 0 were further split into 19 RICs according to principal diagnosis and into SNAP cluster by BI scores. Altogether, there were 49 SNAP clusters, each was further classified by cognitive function (according to MMSE with and without cognitive problems). Thirdly, only patients with stroke, and medically complex classification were further split using age (less than 60 years old and 60 and over). Fourthly, all groups were sub-divided into two SNAP groups by comorbidity (with and without comorbidity). After classification, patients in each RIC were randomly divided into two datasets: the first half for model building (subset 1) and the second half for validation (subset 2).

Assigning payment weights (relative weight)

Relative weight (RW) is the unit of resource use for each SNAP. The model-building sub-sample was used to develop RW. First, costs of patients were rechecked by the researcher, outliers (more than three times of standard deviation) were trimmed[20]. Then, average cost for all patients was calculated. Lastly, a SNAP was assigned to each patient using SNAP grouper and relative weight (RW) for each SNAP. The RW was calculated by dividing average cost of that group by the average cost of all patients. Higher RW reflected more cost of services provided to patients in that group.

Testing capability of the classification system

Several statistics were used for assessing SNAP classification. Coefficient of variation (CV), a measure of homogeneity of cases within each group, was calculated by dividing standard deviation with arithmetic mean. Low CV (1.5 and lower) indicates narrow variation within each group. Reduction in variance (RIV) is a technique widely used to assess the performance of a grouping method by comparing variances of cost before and after grouping. The higher RIV reflects better performance of grouping. Stepwise multiple regression analysis was also employed to analyze the relationship between the cost of sub-acute care (dependent variable) and several potential explanatory variables (independent variables such as RIC, functional score at admission to the sub-acute phase, patient age, and length of stay in the sub-acute phase). Since the cost of the sub-acute phase and length of stay were not normally distributed, a natural logarithmic transformation was undertaken. For assumption tests and model diagnosis, a scatter plot of residuals against predicted values and all independent variables was tested to indicate homoscedasticity (no funnel shape). Cross-validation was used to test the validity of casemix in a separate set of data.

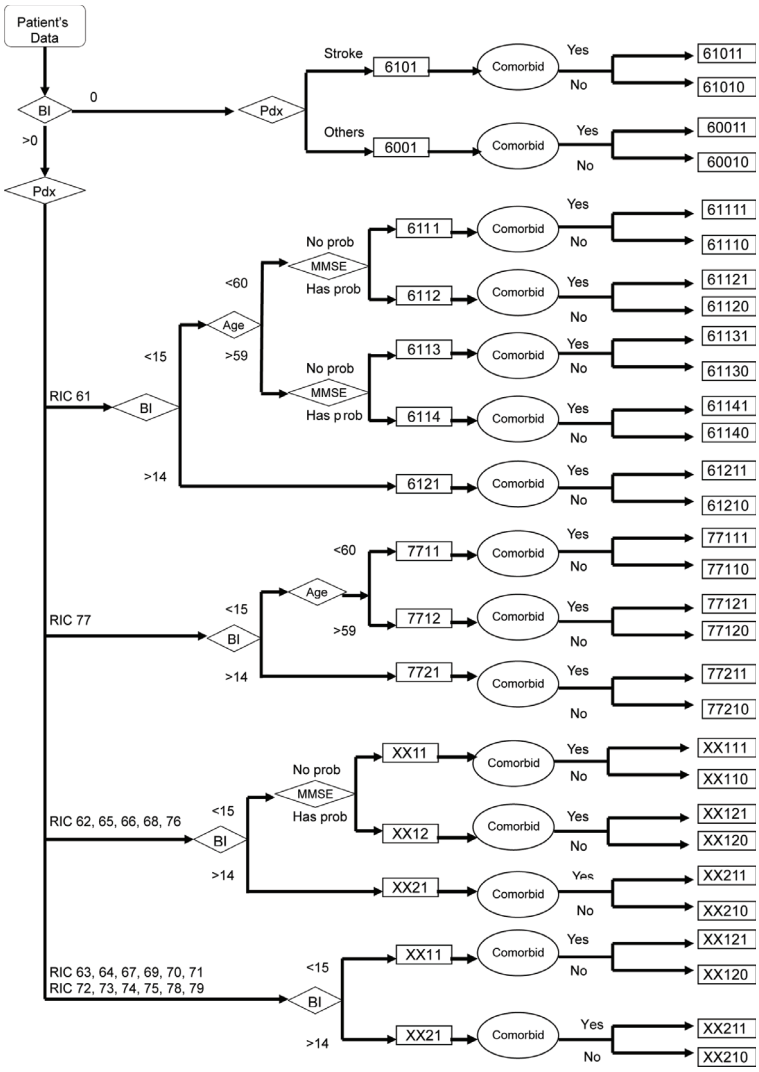

Fig. 1 SNAP classification

Student t-test and F-test were used to test the coefficients of independent variables in multiple regression equation and coefficient of determination (R^2) respectively. A p-value of less than 0.05 was considered statistical significance.

Results

The data on the 2,479 inpatients were prospectively collected from two regional hospitals. Retrospective data on 586 inpatients from the national medical rehabilitation center was collected. Three thousand sixty five inpatients with RIC diagnoses at admission were studied. According to inclusion and exclusion criteria, 227 patients were excluded because they stayed in hospital less than three days, 14 died during the present study period, 72 were referred to other hospitals, and 139 had a discharge diagnosis different from the RIC. The final number of subjects for analysis was 2,613 patients (85% of 3,065). Table 2 shows that more than half of the patients were male (61.6%). The most common condition was stroke (787 cases; 30%), followed by orthopaedic conditions (387 cases; 14.8%) and cardiac disorders (247 cases; 9.4%). Average age was 53.8 years old. They stayed in hospital from three to 113 days; an average LOS was 14.6 days in sub-acute phase.

Two thousand six hundred thirteen patients were grouped into the new classification by RIC,

Table 2. Characteristics of sub-acute and non-acute casemix

RIC	Description	n	% male	Mean age years	LOS (days)		Variables for classifying*	Number of SNAP groups
					Acute phase	Sub-acute phase		
61	Stroke	787	60.6	57.7	5.4	30.5	P,A,C,CC	12
62	Traumatic brain dysfunction	113	80.5	39.4	4.1	6.0	P,C,CC	6
63	Non-traumatic brain dysfunction	32	59.4	48.0	6.7	9.6	P,CC	4
64	Traumatic spinal cord dysfunction	11	90.9	46.1	6.3	15.5	P,C,CC	6
65	Non-traumatic spinal cord dysfunction	99	43.4	57.0	3.6	12.4	P,CC	6
66	Neurological condition	21	42.9	48.9	3.0	42.7	P,CC	6
67	Lower extremity fracture	133	52.6	60.1	6.6	7.0	P,CC	4
68	Hip and knee replacement	206	46.1	55.7	5.2	10.9	P,C,CC	6
69	Other orthopaedic conditions	387	66.9	45.9	3.0	5.9	P,CC	4
70	Amputation of limb	45	77.8	45.8	4.2	8.1	P,CC	4
71	Osteoarthitis	10	60.0	51.5	2.8	4.3	P,CC	4
72	Cardiac disorders	247	61.1	65.4	2.6	2.8	P,CC	4
73	Pulmonary disorders	82	76.8	64.9	2.3	2.9	P,CC	4
74	Pain syndrome	160	48.1	50.0	4.8	9.9	P,CC	4
75	Other major multiple trauma (MMT)	62	88.7	38.1	3.3	4.9	P,CC	4
76	MMT with brain and spinal cord	36	77.8	41.9	7.1	9.7	P,C,CC	6
77	Miscellaneous	147	65.3	52.2	3.5	6.1	P,A,CC	6
78	Burns	28	85.7	38.5	3.4	28.8	P,CC	4
79	Deformity	7	42.9	45.1	6.2	3.3	P,CC	4
	Total	2,613	61.6	53.8	4.2	14.6		98

* P = physical score, A = patient age, C = cognitive score, CC = comorbidity

functional status at admission to sub-acute phase and age. Table 3 presents 47 SNAP clusters with three clusters that had CV on cost higher than 1.5. Further breakdown into SNAPs achieved better homogeneity (only 2% of 98 SNAPs had CV higher than 1.5). Average of all sub-acute and non-acute inpatient costs was 12,593 Baht. The result showed, that the RW of SNAP 66110 (neurological condition with low BI score) was the highest (4.1748), followed by SNAP 61110 (stroke with low BI score, age < 60, low cognitive) (3.2510) and SNAP 78110 (burns, low BI score) (3.1818).

Table 4 presents statistics for heterogeneity between groups. RIV of cost after classification by impairment categories, functional status, age and comorbidity was as high as 32%. Also, RIV of cost which was split by impairment categories, functional status, and age in step 2 (30.3%) was not significantly different from the RIV of cost in step 3 (32.1%).

Table 5 presents determinants of sub-acute and non-acute care cost. The fitted model achieves an adjusted R-square of 0.749 and the probability of F-test = 0.000. Two main classification variables (physical function at admission, the RIC) were key determinants of the cost.

Cross-validation was tested by applying the estimate obtained in the model building sample to the validation sample and calculating R-square values for the validation data. The relationship between predicted and estimated costs in subset 1 was analyzed by multiple regressions. The subset 1 regression equations were validated by applying its equation for predicting costs in subset 2. The differences of R-squares of subset 1 and subset 2 were compared. The validation of casemix was the shrinkage value (R-square difference), less than 0.05 or better. The results showed that the equation in subset 1 (Original R-square = 0.7530) was strongly correlated to estimated cost in subset 2 (R-square from cross-validate = 0.7263). The shrinkage value was 0.0267.

Discussion

The present study is the first development of a casemix classification for sub-acute and non-acute inpatient care in Thailand. The results showed that the new SNAP casemix is sound scientific. Several factors

Table 3. Average length of stay and relative weight of SNAP clusters

SNAP cluster	Description	Average LOS	RW	CV on cost
6001	Non-stroke conditions, BI score = 0	14.1	1.1041	1.0
6101	Stroke, BI score = 0	18.9	1.4367	1.4
6111	Stroke, low BI score, age < 60, low cognitive	43.8	3.2510	1.0
6112	Stroke, low BI score, age < 60, high cognitive	7.9	0.4866	1.0
6113	Stroke, low BI score, age > 59, low cognitive	33.0	2.4066	1.2
6114	Stroke, low BI score, age > 59, high cognitive	5.3	0.3231	0.6
6121	Stroke, high BI score	33.2	2.1967	1.0
6211	Traumatic brain, low BI score, low cognitive	5.3	0.2635	0.8
6212	Traumatic brain, low BI score, high cognitive	5.2	0.4757	1.0
6221	Traumatic brain, high BI score	4.4	0.2388	0.8
6311	Non-traumatic brain, low BI score	9.8	0.6489	1.4
6321	Non-traumatic brain, high BI score	9.2	1.1350	1.8
6411	Traumatic spinal cord, low BI score	20.0	1.4103	1.1
6511	Non-traumatic spinal cord, low BI score, low cognitive	11.9	0.7830	1.5
6512	Non-traumatic spinal cord, low BI score, high cognitive	12.3	0.7084	1.0
6521	Non-traumatic spinal cord, high BI score	12.8	0.6328	1.1
6611	Neurological condition, low BI score	55.2	4.1748	1.3
6621	Neurological condition, high BI score	22.1	1.5528	1.4
6711	Lower extremity fracture, low BI score	7.4	0.3606	1.0
6721	Lower extremity fracture, high BI score	5.3	0.3126	1.0
6811	Hip and knee replacement, low BI score, low cognitive	13.6	0.7360	1.9
6812	Hip and knee replacement, low BI score, high cognitive	6.9	0.2816	0.6
6821	Hip and knee replacement, high BI score	9.8	0.5421	1.4
6911	Other orthopaedic conditions, low BI score	6.8	0.3874	1.2
6921	Other orthopaedic conditions, high BI score	4.8	0.2848	1.6
7011	Amputation of limb, low BI score	9.3	0.7148	1.1
7021	Amputation of limb, high BI score	7.9	0.4471	1.5
7111	Osteoarthitis, low BI score, low cognitive	3.2	0.2070	0.8
7121	Osteoarthitis, high BI score	5.4	0.3463	1.2
7211	Cardiac disorders, low BI score	3.4	0.3116	0.7
7221	Cardiac disorders, high BI score	2.2	0.1479	0.6
7311	Pulmonary disorders, low BI score	3.1	0.2806	0.9
7321	Pulmonary disorders, high BI score	2.4	0.1636	0.6
7411	Pain syndrome, low BI score	7.6	0.3888	1.2
7421	Pain syndrome, high BI score	10.5	0.4562	0.8
7511	Other major multiple trauma (MMT), low BI score	4.6	0.3494	1.1
7521	Other major multiple trauma (MMT), high BI score	3.2	0.2546	1.2
7611	MMT with brain and spinal cord, low BI score, low cognitive	8.3	0.3816	0.7
7612	MMT with brain and spinal cord, low BI score, high cognitive	7.0	0.7045	0.7
7621	Major multiple trauma with brain and spinal cord, high BI score	3.5	0.1988	0.5
7711	Miscellaneous, low BI score, age < 60	5.7	0.3220	0.7
7712	Miscellaneous, low BI score, age > 59	6.6	0.5034	0.8
7721	Miscellaneous, high BI score	5.7	0.3283	0.9
7811	Burns, low BI score	41.3	3.1818	1.1
7821	Burns, high BI score	19.6	1.1795	0.7
7911	Deformity, low BI score	3.0	0.1334	1.0
7921	Deformity, high BI score	3.5	0.1259	0.4
	Total	14.6	1.0000	

Note: This table shows 47 SNAP clusters. Further breakdown of 98 SNAPs demonstrated that only two SNAPs had CV higher than 1.5

strengthen the value of the results such as prospective data collection, standard costing method of patient level-data, the assisting staff training, and reliable, valid, and simple functional measurement used. However, many points need discussion.

First was performance of classification. The results showed that the validity of the classification was high according to heterogeneity statistical results. However, the RIV on cost of 32% was lower than the RIV of the CMG currently used in the US[21] and the Australian National sub-acute and non-acute patient (AN-SNAP)[22].

Second, the results on resource consumption and relative weight of younger patients were more expensive than older patients, such as stroke group (Table 3). Besides, RW of patients without cognitive problems were higher than patients that had cognitive problems who need time to recover. Furthermore, multiple regressions also supported that only physical function and RIC were key determinants of the cost (Table 5). From these results, age and cognitive problem may not be able to predict resource consumption for SNAP.

Third, the present study was developed from a population of acute hospitals with rehabilitation wards for adults (18 years old and above). The average age of subjects in the present study was lower (53.8 years, Table 2). On the other hand, CMG was developed on the basis of elderly patients (the US Medicare requires recipients to be 65 and above). These differences may be a significant consideration regarding appropriate casemix systems in further study.

Fourth, because the purpose of the present study was to develop casemix as a tool to pay for SNAP services, the validation of data is very significant. There were three significant data that reflect resource consumption: diagnosis, functional status, and actual cost data. Although the present study used principal diagnoses of acute phase, those diagnoses were concluded at discharge. In practice, some diagnoses had etiology that cannot be used for principal diagnosis. Therefore, the present study applied secondary diagnosis in some RICs, such as stroke. Moreover, to assure that these diagnoses as coded in ICD-10 reflected the impairment category, ICD-10 codes were drawn code-by code from clinical and rehabilitation

Table 4. Reduction in variance (RIV) on cost of SNAP

	Number of group	RIV on cost
Step 1	20	25.5%
Step 2	49	30.3%
Step 3	98	32.1%

Step 1: split by impairment categories
Step 2: split by impairment categories, functional status, and age
Step 3: split by impairment categories, functional status, age, and comorbidity

Table 5. Explanatory determinants of sub-acute care cost using multiple regression analysis

	Unstandardized coefficients		t	Sig	95% CI for B	
	B	SE			Lower bound	Upper bound
(Constant)	7.779	0.032	243.056	0.000	7.717	7.842
ln(salos)	0.897	0.012	72.234	0.000	0.873	0.922
RIC19	0.403	0.131	3.069	0.002	0.145	0.660
BIG1	0.294	0.047	6.320	0.000	0.203	0.385
RIC13	0.282	0.079	3.582	0.000	0.128	0.437
RIC02	0.240	0.067	3.577	0.000	0.108	0.371
RIC01	0.212	0.036	5.903	0.000	0.141	0.282
RIC12	0.163	0.048	3.366	0.001	0.068	0.258
BIG2	0.141	0.031	4.626	0.000	0.082	0.201
RIC14	-0.146	0.058	-2.529	0.011	-0.258	-0.033

Adjusted R^2 = 0.749, probability of F-test = .000, SE = Standard error, salos = length of stay in sub-acute phase, RIC = rehabilitation impairment category, see details in Table 1, BIG = Barthel index group, BIG1 = Barthel index from 0-2, Big2 = Barthel index from 3-14, BIG3 = Barthel index more than 14

experts. For functional status, nurses in each ward were trained to evaluate and complete the code. They were also often monitored during all study periods. However, a problem on the validity and reliability of functional score may occur. If this casemix is implemented, both clinical data and functional data should be carefully monitored. For cost data the present study used micro-costing at patient level. It was generally believed to be the gold standard for studying cost of health service[23]. The micro-costing approach presented a method of cost assessment that includes accurate cost calculation according to resources consumed per individual patient differentiated by individual medical service received. This methodology is recommended for the development of casemix relative weight[24]. However, the micro-costing methodology is complicated, time consuming, needs detailed information and might not be practical for a whole hospital. For classification methodology, the predictors variables (diagnosis, functional status, patient age) were statistically significant as with other studies[10,25]. The present study did not use Classification and Regression Trees (CART) to provide statistics for classification, instead, after expert opinion, multiple regressions and split-half cross-validation statistics were used to confirm the validity.

Lastly, casemix for payment mechanism is based on financial risk sharing between payer and providers. The results from the US and Australian studies found that funding model according to individual patient requirements is better[26,27]. This ensures the use of this sub-acute and non-acute casemix payment is considered to promote equity and efficiency among payer, provider, and patient.

As a final point, some limitations should be mentioned. The criteria for sub-acute phase of care selection were uncertain, which may have caused selection bias. Some data such as functional outcome and rehabilitation activity were prospectively collected at patient-level along with the caregivers' high workloads and lack of time. There could be susceptible to over- or underreporting. In addition, caution should be taken in generalizing the results of the present study to the entire country since the data were drawn from only three hospitals with only 3,000 cases.

Conclusion

The new casemix for sub-acute and non-acute patient (SNAP) contained 98 groups. The performance of this classification was satisfactory as 98% of all SNAPs groups showed the CV on cost were less than 1.5 and RIV on cost was 32%. The value of prediction by regression analysis revealed that classification variables (physical function at admission, rehabilitation impairment categories (RIC) and LOS) were the key determinants of cost (adjusted $R^2 = 0.749$, $p = .001$). Validity results of split-half cross-validation of SNAP were high. The present study indicated that SNAP closely predicted hospital resource use and should be further developed for sub-acute and non-acute phase in hospital payment.

Acknowledgements

The present study was financially supported by grants from the National Health Security Office (NHSO), the Health Intervention and Technology Assessment Program (HITAP) and the Health Promotion for People with Disabilities Program. The authors wish to thank facilitators, nurses, computer programmers, research assistants, and all patients who participated in the present study.

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การจัดกลุ่มโรคร่วมในกลุ่มอาการกึ่งเฉียบพลัน และไม่เฉียบพลันเพื่อกำหนดค่ารักษาพยาบาลของประเทศไทย

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ภูมิหลัง: *ระบบหลักประกันสุขภาพของประเทศไทยจำเป็นต้องพัฒนาระบบ กลุ่มโรคร่วมอื่นนอกจากกลุ่มวินิจฉัยโรคร่วมเพื่อจ่ายเงินให้แก่โรงพยาบาลที่ดูแลผู้ป่วยกลุ่มที่ไม่ใช่อาการระยะเฉียบพลัน*

วัตถุประสงค์: *เพื่อพัฒนากลุ่มโรคร่วมผู้ป่วยในระยะกึ่งเฉียบพลันและไม่เฉียบพลัน*

วัสดุและวิธีการ: *เป็นการศึกษาเชิงปริมาณใน 2 โรงพยาบาลศูนย์ และโรงพยาบาลฟื้นฟูสมรรถภาพ วิธีการศึกษา คือ 1) จัดกลุ่มโรคร่วมผู้ป่วยในระยะกึ่งเฉียบพลันและไม่เฉียบพลัน 2) วิเคราะห์ต้นทุนและหาค่าน้ำหนักสัมพัทธ์ 3) ตรวจสอบความสามารถของกลุ่มโรคร่วมในการทำนายการใช้ทรัพยากร สถิติที่ใช้ ได้แก่ coefficient of variation (CV), reduction in variance (RIV), linear regression และ split-half cross-validation*

ผลการศึกษา: *การพัฒนากลุ่มโรคร่วมผู้ป่วยในระยะกึ่งเฉียบพลันและไม่เฉียบพลัน (sub-acute and non-acute inpatient, SNAP) ได้กลุ่มโรค 98 กลุ่ม ร้อยละ 2 ของกลุ่มโรค 98 กลุ่มมีค่า CV ของต้นทุนสูงกว่า 1.5 เมื่อจัดกลุ่มผู้ป่วยตามกลุ่มโรคร่วมนี้สามารถลดความแปรปรวน (RIV) ของต้นทุนได้ถึงร้อยละ 32 ตัวแปรทำนายต้นทุนได้แก่ ระดับความสามารถ กลุ่มรหัสโรคเวชศาสตร์ฟื้นฟูและวันนอนในโรงพยาบาล กลุ่มโรคร่วม SNAP มีความตรงสูงในการทำนายต้นทุน*

สรุป: *กลุ่มโรคร่วมผู้ป่วยในระยะกึ่งเฉียบพลัน และไม่เฉียบพลันสามารถทำนายการใช้ทรัพยากรได้ใกล้เคียงกับต้นทุนจริง มีความเป็นไปได้ที่จะพัฒนาเพื่อเป็นเครื่องมือจ่ายเงินสำหรับกองทุนประกันสุขภาพระดับประเทศ*