Cost Effectiveness and Resource Allocation

RESEARCH

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Assessing diagnosis-related groups based direct medical expenditures of chronic disease patients in general hospital of lower southern Thailand

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Abstract

Background Assessment of the cost-related burden of chronic diseases is important for making informed decisions. An effective and efficient methodology for examining medical expenditures is one of the most significant challenges for stakeholders. The objective of this study was to examine the role of the variables of diagnosis-related group (DRG) in determining the direct expense of chronic diseases in lower southern Thailand and suggest the determinants having high explainability.

Methods The records of 6,147 patients admitted to Satun Hospital from 2014 to 2018 and diagnosed with chronic conditions were analyzed in this study. Descriptive analysis was used to summarize the main characteristics. Correlation was used to analyze the strength of the relationship. A log-linear regression model was used to evaluate the adjusted mean cost using determinants of DRG.

Results The overall average medical expense for chronic disease was Thailand Baht (THB) 17,985. Chronic kidney and chronic obstructive pulmonary diseases were the most expensive chronic diseases with an average expense of about THB 20,000 and 25,000. All the determinants were significantly contributing to overall expense of chronic disease with a p-value < 0.001. However, the length of stay, number of diagnoses, and number of procedures had high explainability in the expense model.

Conclusions The expense assessment model plays a significant role in controlling and preventing the medical costs associated with chronic diseases. Healthcare administrators, stakeholders, and researchers need to make strategies by considering the results of this study to improve the DRGs-based hospital cost model.

Keywords Chronic disease, Medical expense, Diagnosis related groups, Thailand

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Introduction

Diagnosis-related groups (DRGs) are widely used in healthcare expense calculations around the world to control hospital costs and service quality [10]. Major determinants of DRGs are primary diagnosis, secondary diagnosis, number of procedures, discharge status, age, and gender [7]. These variables are used by the United States and Europe having different healthcare systems than low- and middle-income countries with fewer resources such as medical equipment, physicians, medicines, and less developed healthcare systems [3]. Healthcare costs in developing countries that use the DRG system should be evaluated to ensure equity and quality of healthcare services due to differences in healthcare facilities, resources, technology, and physician experience, unlike in developed countries where the DRG system has been thoroughly evaluated [15, 17].

In Thailand, DRGs were first used in 1993, with the initial expense calculation based on acute illnesses. Initially, the public hospitals that do not provide acute hospital care, opposed DRG system [11]. In 2002, the entire Thai population was covered by three governmental health insurance schemes: the Civil Servant Medical Benefit Scheme (CSMBS) for civil servants and their families, the Social Health Insurance Scheme (SHI) for private-sector employees, and Universal Coverage (UC) for the rest of the population (World Health Organization [23]). Since then, the medical cost of chronic disease patients in Thailand has rapidly increased and it causes massive waste due to excessive consumption [1]. As a result, managing hospital expenses through payment reforms has been one of the components of Thailand's healthcare system, where only the DRG system has been used to allocate expenditure on inpatient treatments (Patcharanarumol et al., [12]). However, DRG payment revisions have failed to improve the method's fairness, openness, and logic in the majority of countries [2, 21, 24].

Later, in Thailand, DRG systems were used for chronic illnesses, and are now used for all diseases from 2003 to onward [5]. Several studies have examined the factors that influence DRG payment [9, 10, 20]. Lehnert et al. [9] discovered, in a systematic review and meta-analysis, that multiple chronic illnesses are the most important determinant of total healthcare expenses for chronic patients. Additional factors used to determine the expense of the DRG system and affect healthcare costs includes facility variations, hospital size, healthcare administrator decisions, and the quality of health data [13, 14]; Watanabe et al., [22]; Suleiman et al., [8, 19]. Length of hospital stay (LOS) is also one of the determinants of the expense of chronic diseases in Thai DRGs. In a systematic review and meta-analysis, Meng et al. [10] discovered that the LOS is the most important predictor of hospital costs. Thongpeth et al. [20] found that the combined LOS and number of procedures are the most significant determinants of total hospital expenditures for chronic diseases, while the number of diagnoses is not a significant factor. They studied the hospital cost of the patients from Surat Thani Hospital, which is the Upper Sothern Thailand, and did not reflect the result for Lower Sothern Thailand. Moreover, a DRG-based model is needed based on fair determinants to examine the hospital cost of chronic diseases.

Therefore, the objective of this study was to examine the role of the determinants of DRGs in determining the direct expense of chronic diseases in lower southern Thailand. It also examined the relationship between determinants of DRGs and direct expense of chronic diseases. Finally, suggesting the determinants have high explainability in determining the direct expense of chronic diseases in lower southern Thailand.

Methods

Data and data description

For analysis of the medical costs of patients hospitalized with chronic disease, data from 6,149 patients from year 2014 to 2018 were taken from the records of Satun Hospital, located in Mueang Satun District, Satun Province, Thailand. Satun Hospital is the largest government hospital in the Satun Province with more than 180 beds and is considered the health hub for the people of Satun Province. The variables consist of the patient's age, gender, primary diagnosis, secondary diagnosis, discharge status, number of procedures, LOS, and direct medical expenditure. We considered age, gender, primary diagnosis, secondary diagnosis, discharge status, number of procedures, LOS as independent variables because these are the determinants of DRG-based direct medical expenditure. Age was divided into nine groups: 0–19, 20–29, 30–39, 40–49, 50–59, 60–69, 70–79, and 80 and older. The gender consists of male and female. After that we combined gender and age group to evaluate their interactive effect. This study used the 10th International Classification of Diseases and Related Health Problems (ICD-10) for the primary diagnosis of chronic disease, which included cancer (CA, ICD-10: C00-C97), chronic obstructive pulmonary disease (COPD, ICD-10: J44), chronic kidney disease (CKD: ICD-10: N18), diabetes mellitus (DM, ICD-10: E10-E14) and hypertension (HT, ICD-10: I10). The number of diagnoses was divided into seven categories: 1, 2, 3, 4, 5, 6, and 7 or more diseases. The discharge status was classified into two categories: improved and other. The LOS was classified into seven categories: 1, 2, 3, 4, 5, 6, and 7 days or more. The number of procedures was divided into three categories: none, one procedure, and more than one procedure. In this study, the direct medical expenses include the total treatment expense during the inpatient service process, which

included medical service, medical equipment, nursing care, laboratory, x-ray, and medicine. The reason for selecting inpatient services is that we want to determine the cost during hospital stay based on the determinants of DRGs. After the removal of two records at zero cost mentioned, a total of 6,147 records were left for further investigation. Before conducting further statistical analysis, data exploration and cleaning were carried out.

Ethical approval

The Human Ethics Committee of Satun Hospital approved the ethical considerations of this study with the approval number: ST-620,059.

Table 1 Chronic patients' demographic and clinical characteristics

Variable	Categories	*n* (%)
Gender	Male	3289 (53.5%)
	Female	2858 (46.5%)
Age group (years)	≤ 19	112 (1.8%)
	20–29	111 (1.8%)
	30–39	320 (5.2%)
	40–49	782 (12.7%)
	50–59	1441 (23.4%)
	60–69	1447 (23.5%)
	70–79	1245 (20.3%)
	≥ 80	689 (11.2%)
Length of Hospital Stay (days)	1	1561 (25.4%)
	2	1099 (17.9%)
	3	760 (12.4%)
	4	668 (10.9%)
	5	464 (7.5%)
	6	307 (5%)
	≥ 7	1288 (21%)
Primary diagnosis	Diabetes mellitus	936 (15.2%)
	Chronic obstructive pulmonary disease	1773 (28.8%)
	Hypertension	344 (5.6%)
	Cancer	2186 (35.6%)
	Chronic kidney disease	909 (14.8%)
Number of diagnoses	1	752 (12.2%)
	2	1379 (22.4%)
	3	1460 (23.8%)
	4	915 (14.9%)
	5	566 (9.2%)
	6	347 (5.6%)
	≥ 7	728 (11.8%)
Number of procedures	0	2860 (46.5%)
	1	2266 (36.9%)
	≥ 2	1021 (16.6%)
Discharge status	Improved	5676 (92.3%)
	Not improved	471 (7.7%)

Statistical analysis

A descriptive analysis was performed. The frequency and percentage of patient visits were calculated for categorical variables.

A multiple-log-linear regression model was used to estimate medical costs. The results of the model were presented using 95% confidence interval plots with crude and adjusted means as the estimate of the expense for different determinants and identifying the potential determinants. All of the graphical and statistical illustrations were performed using the R programming language [16].

Results

Characteristics of the sample

Males accounted for 53.5% of the total 6,147 hospital visits, with a mean age of 60.8 with a standard deviation (SD) of 15.9 years. Approximately one-third of hospital patients were diagnosed with cancer. About 43% of patients had hospital stays of two days or less than two days. 73% of patients had a co-morbidity condition with four or fewer disorders. About 46.5% of patients had no procedures, whereas 36.9% had a single procedure. The majority of discharge status was discharged from the hospital (92.3%). The median medical expense was 7,438 Baht (minimum = 186 and maximum = 578,845 Baht) (Table 1).

Figure 1 presents the correlation matrix plot of the variables with the cost. It can be noted that the cost is positively and strongly related to LOS, number of diagnoses, and number of procedures. The results from multiple-log-linear regression for medical expense were presented by a 95% confidence interval plot with medical expense on the Y-axis and predictors on the X-axis, as shown in Fig. 2. The horizontal line is the average medical expense of THB 17,985. The R^2 from the model was 79.1%. All six determinants: gender-age group, principal diagnosis, LOS, discharge status, number of diagnoses, and number of procedures, had a significant relationship with medical cost. Males aged 20–49 and females aged 30–39 had significantly higher medical costs than the average, whereas males aged 0–19, 50–69, and females aged 60–79 had significantly lower medical costs than the average. CKD and COPD patients had significantly higher medical costs than other chronic diseases. Whereas CA and DM patients had significantly lower costs and HT had the least cost. Medical costs increased with the LOS, number of diagnoses, and number of medical procedures. Patients with a non-improving discharge status had significantly higher medical costs than the average.

The R^2 from the univariate analysis between each determinant and the outcome are shown in the plot. The R^2 from the univariate analysis showed a relationship between medical expense and LOS, number of diagnoses, and number of procedures of 67.1%, 37.3%, and 32.7%,

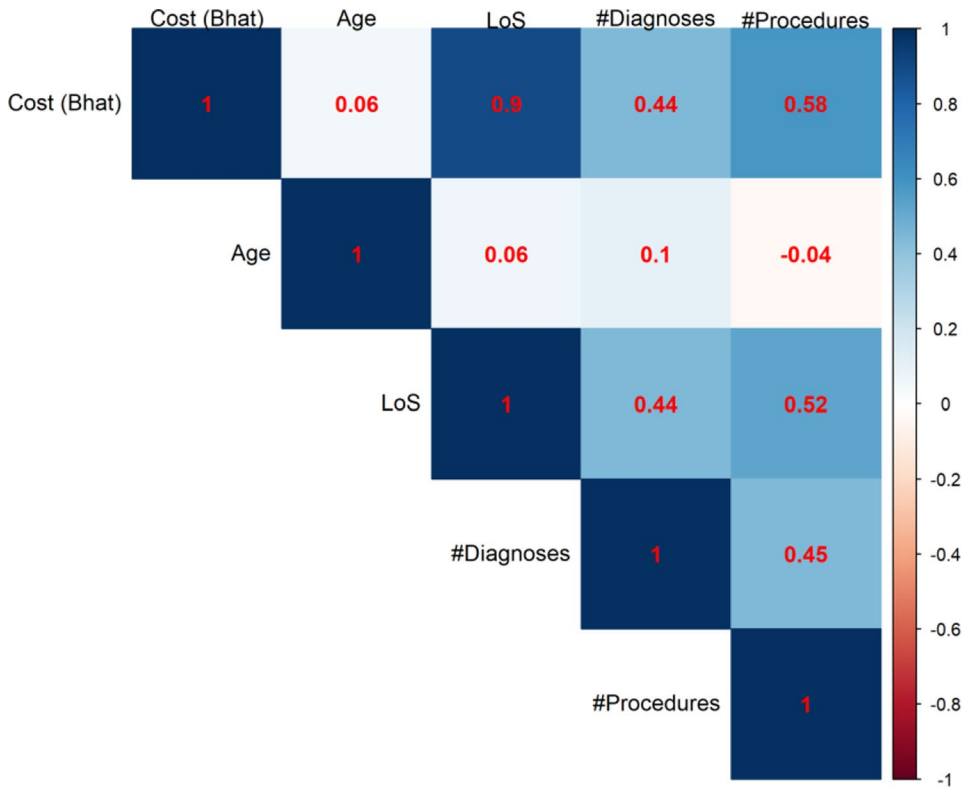

Fig. 1 Correlation Matrix Plot of Medical Expense (Thai Baht) with Other Determinants

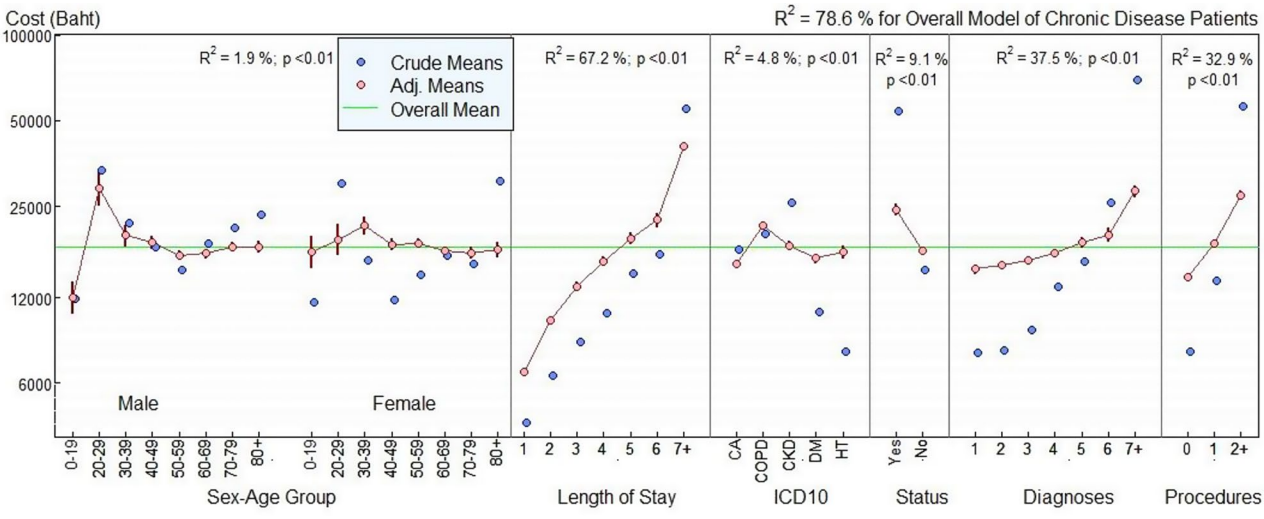

Fig. 2 Mean and 95% Confidence Intervals Plot for Medical Expenses for Determinants Used in DRG System

respectively. Other predictors were also significantly related to medical costs, but their R^2 were all less than 10%. Confounding effects are indicated by the differences between the crude and adjusted medical costs for each determinant. As a result, the effects of LOS, the number of diagnoses, and procedures were investigated further.

The number of diagnoses and procedures were combined and given the name "diagnosis-procedure" in order to determine the effect of each group of this variable on medical costs. Figure 3 depicts a 95% confidence interval plot of the medical expense model results using LOS and a diagnosis-procedure as predictors. The R^2 for the model with only LOS as a predictor was 67.2%, while the R^2 for the model with only diagnosis-procedure as a predictor was 48.7%. The results showed that a rise in LOS had a markedly rising trend in medical costs. The higher number of diagnoses with no procedure group had a slightly increasing trend in medical costs. The increasing

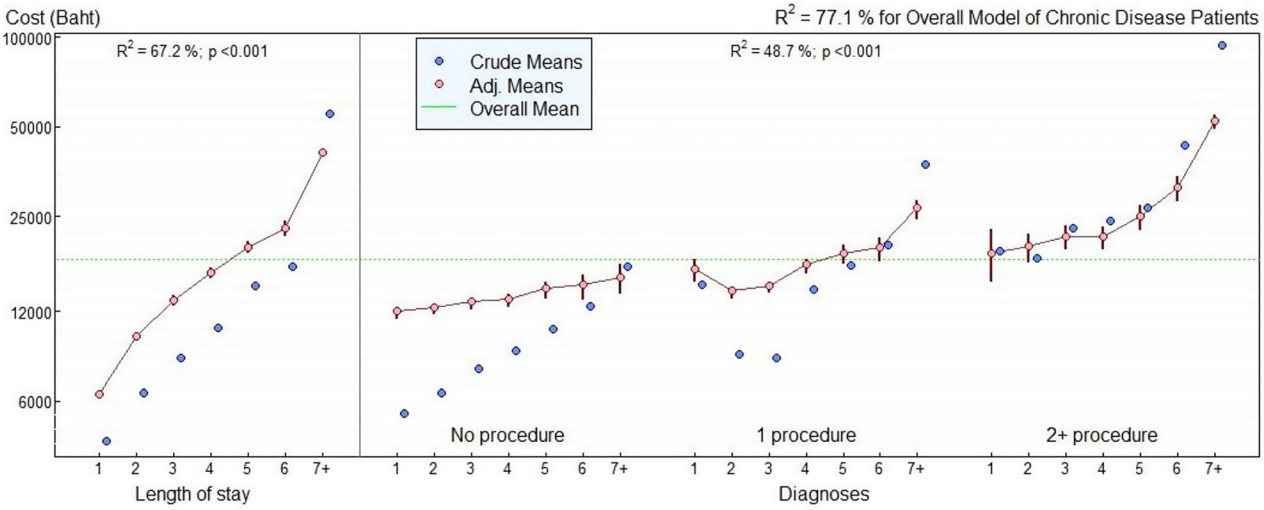

Fig. 3 Mean and the 95% Confidence Intervals of Medical Expense with Length of Stay and Diagnoses-Procedure as Determinants

number of diagnoses had a dramatic increase in medical costs among one procedure group and two or more procedure groups.

Discussion

This study assessed DRG-based direct medical expenditures of chronic disease patients using six DRG determinats: sex-age, principal diagnosis, LOS, discharge status, number of diagnoses, and number of procedures. The R^2 from the log-linear model with all determinants was 78.6%, while the model with three determinants, including LOS and the number of diagnoses and procedures, had an R^2 of 77.1%. The results from final model showed that the explainability of medical costs increased with LOS and the number of diagnoses and procedures. Moreover, the medical cost increased gradually with the increasing number of diagnosis with no medical procedure but as the medical procedure increased the medical cost increased dramatically. The same relation of dramatically increase can be observed with LOS.

In this study, the difference in R^2 value between a model that included all determinants (R^2=78.6%) and a model that included LOS and the number of diagnoses and procedures (R^2=77.1%) was only 0.015. Which strongly recommends, instead all the variables were highly significant, the effect size was considerably low except LOS and number of diagnoses and procedures. Our findings support the conclusion of Thongpeth et al. [20] that all factors with significant p-values should not be considered. The overall effect on the R^2 value should be the most important thing to consider when determining healthcare costs. Moreover, in determining medical costs for DRG, one should take into account the effect size rather than the p-value, as several studies suggested that in addition to using p-values to assess the significance of a study, the results should also be evaluated clinically [6, 18].

LOS and the number of procedures were found to be highly significantly associated with medical care costs for chronic disease patients in this study, which is consistent with the findings of a previous study conducted by Thongpeth et al. [20]. However, in Thongpeth et al. [20]'s study, the number of diagnoses was a weak predictor of medical cost, whereas in our study, this variable is a strong predictor of medical cost. This could be due to differences in medical care policies, resources, data quality, and hospital size. Diagnoses and procedures are the most important classification variables in DRG system [15]. Improper diagnosis or procedure code selection can occur after a patient's visit to the hospital, resulting in inappropriate payment. Chatterjee et al. [4] suggested that variations in hospital settings may be one of the major factors affecting medical care costs in each hospital. Other studies confirm that the accuracy of medical records may influence how DRGs analyze the costs of medical care [13]; Pongpirsul et al., 2011b; Suleiman et al., [19]. As a result, the main reason for the disparity in results is the difference between a hospital setting and the quality of medical records.

The study did not consider data on physician DRGs coding experience, which may vary by institution, resource constraints, varying hospital sizes, and the payment system. Moreover, including more hospitals and considering other variables is also the limitation of this study.

Conclusion

DRGs remain the only available payment method for healthcare expenditures under the fairness system. Using suggested necessary determinants of DRGs for health

care costs does not affect the true cost for chronic diseases. Thus, a robust model is needed based on suggested determinants of DRGs to calculate the hospital expense for chronic diseases more efficiently. Also, the model can be used to examine the unnecessary LOS, number of diagnoses, and number of procedures performed on chronic patients to reduce medical expenses and improve the accuracy of health system. Stakeholders and local government health officials need to make sure to improve the DRGs-based hospital cost model for chronic disease patients and make strategies by considering the results of this study.

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Author contributions
A.K, A.L, P.H, and W.T designed this study. A.K, A.L, and H.K analsysis the data. A.K and W.T with the help of A.L and H.K wrote the initial draft. A.L and H.K finalize the draft. All the authors reviewed and approved the final draft.

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Data availability
Data and related materials will be available from the authors upon a reasonable request.

Declarations

Ethical approval
The Human Ethics Committee of Satun Hospital approved the ethical considerations of this study with the approval number: ST-620059.

Competing interests
The authors declare no competing interests.

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