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Determinants of Hospital Costs for Management of Chronic-Disease Patients in Southern Thailand

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Abstract:

Objective: Diagnosis-related groups (DRGs) are the main mechanism for assessing payments for medical treatment. This study aimed to analyze the determinants of costs for chronic-disease patient visits in a major public hospital.

Material and Methods: Hospital cost data available from the hospital database relating to claims made to the Thailand Health Security Office were obtained from a major tertiary hospital for all such patients admitted and discharged in 2016. Linear regression models were created to predict the cost based on several determinants including age and gender, primary diagnosis, number of diagnoses, length of stay, number of procedures, and discharge status.

Results: Only length of stay in hospital and number of procedures were significant predictors of the total hospital costs.

Conclusion: It thus appears that just a combination of these two factors might be a better measure of the true hospital visit costs for patients with chronic disease than DRGs.

Keywords: chronic disease, diagnosis-related groups, hospital costs, length of hospital stay, number of procedures

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Introduction

Health care costs in most countries are mainly determined by the diagnosis-related group (DRG) system, which was initiated in 1983.[1] DRG is a system of classifying patients into groups by standardized prospective payments to hospitals which generally cover all charges associated with an inpatient stay from the time of admission to discharge.[2] The assignment of a patient to a DRG depends on principal diagnosis, secondary diagnosis, surgical procedures performed, comorbidities and complications, patient age and sex and discharge status.[3] The purposes of using the DRG system are cost containment, improving the efficiency, transparency and fairness of funding and quality, and supporting the management of hospitals.[4] Hospitals in most developed countries have introduced DRG as a tool for assessing reimbursement over the past 30 years.[5]

Mathauer and Wittenbecher[6] recommended that the system should be employed to assess hospital costs in low- and middle-income countries with limited resources, even though the main factors for determining the hospital costs might not be the same as those in developed countries. Thus, DRG-based payments in such countries need to be assessed, which might help to improve the efficiency, equity and quality of health services. Globally, DRGs were originally used to calculate reimbursement for hospitals for acute inpatient care but are now also used to assess charges for chronic inpatient care.[6]

In Thailand, health care costs are increasing and one of the main factors influencing this increase is chronic disease, defined as a disease lasting three months or more and generally incapable of being prevented by vaccines or cured by medication.[7] Therefore, it is useful to investigate health care costs among patients suffering from chronic diseases in Thailand

The National Health Security Office (NHSO) of Thailand is the main health-care purchaser in the country and covers 76.0% of the population using the Universal Coverage Scheme which is tax-financed and transfers pooled funds to health providers.[8] The DRG system has been used by the NHSO for over a decade but several issues still exist and need to be solved. Also currently, many hospitals are facing the problem of incurring higher medical care costs than the reimbursement they receive from the NHSO, resulting in hospital financial crises. One possible reason for the widespread financial crises in Thai hospitals could be that the current DRGs might not reflect the real cost of medical care. Identifying the significant factors which influence hospital costs is useful for policy makers in allocating equitable and efficient reimbursement to health providers but no such study of costs has been done recently, thus the system does not have adequate information for informed analyses of the current situation. Therefore, this study aimed to analyze the determinants of costs for visits by patients with chronic diseases to a major public hospital.

Material and Methods

The costs of all hospital visits by patients with chronic diseases including admission and departure dates, age, gender, discharge status, principal and up to 12 secondary diagnoses, up to 12 treatment procedures, and the total visit costs were obtained from the Thailand NHSO. A total of 18,506 records of hospital visits in 2016 by patients with chronic diseases to Surat Thani regional hospital were included in this study. The minimum possible health care cost per visit for a patient related to a chronic disease is 800 Baht. Therefore, following the initial descriptive analysis of the entire sample, all patient visits incurring medical costs of less than 800 Baht or approximately 23 United States dollars (USD) (160 records) and cost more than 7 million (201,250 USD) with one day or less of hospital stay were excluded from further analysis, resulting in 18,342 qualifying records, which were analyzed in this study.

In this study, the main outcome variable was the total cost in Baht per patient visit which included outpatient visit and admission. The determinants were gender, age group, length of hospital stay, International Classification of Diseases version 10 (ICD-10) diagnosis, discharge status, number of diagnoses or comorbidities and complications (nDiag) and number of procedures (nProc). Gender was classified as male or female. Age group was divided into ten groups with 10-year intervals: 0-9, 10-19, 20-29, 30-39, 40-49, 50-59, 60-69, 70-79, 80-89 and 90 and older. Length of hospital stay (LOS) was grouped into 12 groups: 0, 1, 2, 3, 4, 5, 6, 7-8, 9-11, 12-15, 16-24 and 25 or more days. The ICD-10 diagnoses were classified into 18 groups: tuberculosis, sepsis, human immunodeficiency virus (HIV), other infectious diseases, liver cancer, lung cancer, other digestive diseases, other cancers, endocrine diseases, muscle and nervous system diseases, ischemic heart disease, stroke, other cardiovascular diseases, respiratory diseases, digestive diseases, genitourinary diseases, ill-defined diseases, and other diseases. Discharge status was divided into six groups: approved, exited, escaped, other, death with autopsy and death with no autopsy. The number of diagnoses ranged from 1 to 13 and the number of procedures ranged from 0 to 12.

Data cleaning was performed in order to detect and correct coding errors, missing values, outliers and the duplication of records before the statistical analysis was performed. No coding errors and duplicated records were found. There were 4 outliers with medical cost more than 7 million Baht and these records were excluded from the study.

Descriptive statistical analysis was performed to summarize the characteristics of each variable. Medical costs were transformed using natural logarithms. Normal quantile plots were used to depict the distribution of both non-transformed and transformed costs. In order to eliminate the interaction effect of between gender and age group, these two variables were combined to form a new variable called gender-age group with 10 categories. Interactions between other variables were not found and some variables could not be tested due to their small sample size when the variables were combined. Multiple linear regression was used to investigate the relationships between cost and the various determinants. The coefficients and standard errors from the model were converted into cost in Baht and 95% confidence interval (CI) plots were created to illustrate the results from the multivariate analysis. Only significant factors were included in the final model and the results from this model were also illustrated using 95% CI plots. All the statistical analyses were conducted and graphical displays created using the R program, version 3.1.3.[9]

The authors determined that this clinical investigation required Institutional Review Board/Ethics Committee review and approval, and the resulting protocol/approval number was 61/2019.

Results

The summarized patient characteristics are shown in Table 1. More than half of the patients were males (55.6%). About 57.0 % of the patients were aged between 50 and 79 years. Half of the patients had LOS ranging from 1-3 days. Respiratory diseases were found to account for the highest percentage (12.7%) followed by ischemic heart disease (11.2%) and cancers other than liver or lung cancer (11.1%). While the largest group of patients (32.4%), had only one procedure, approximately 62.2% of the patients had from 2-5 multiple diagnoses.

The quantile-quantile (Q-Q) plot of costs for the entire initial sample of 18,506 patients in the left-hand plot of Figure 1 shows a very skewed distribution with four large outliers for visits costing more than 7 million Baht. However, after transformation based on log(1+cost/100), the distribution was found to be normal, apart from small groups at low and high extremes as shown in Figure 1, right-hand plot.

Table 1 Demographic and clinical characteristics of study patients

Demographic and clinical characteristics	Visits	%
Gender		
Male	10,201	55.6
Female	8,141	44.4
Age group (years)		
0 to 9	1,421	7.7
10 to 19	346	1.9
20 to 29	476	2.6
30 to 39	1,055	5.8
40 to 49	2,241	12.2
50 to 59	3,534	19.3
60 to 69	3,494	19.0
70 to 79	3,440	18.8
80 to 89	1,998	10.9
90+	336	1.8
Length of hospital stay (days)		
0	833	4.5
1	3,260	17.8
2	3,758	20.5
3	2,131	11.6
4	1,578	8.6
5	1,140	6.2
6	765	4.2
7-8	1,266	6.9
9-11	1,158	6.3
12-15	791	4.3
16-24	890	4.9
25+	772	4.2
ICD-10 group		
Tuberculosis	202	1.1
Sepsis	179	1.0
HIV	271	1.5
Other infection	284	1.5
Liver cancer	374	2.0
Lung cancer	298	1.6
Other digestive diseases	1,282	7.0
Other cancers	2,030	11.1
Endocrine diseases	702	3.8
Muscle and nervous system diseases	266	1.5
Ischemic heart disease	2,046	11.2
Stroke	1,289	7.0
Other cardiovascular diseases	1,152	6.3
Respiratory diseases	2,332	12.7
Digestive diseases	1,338	7.3
Genitourinary diseases	1,417	7.7
Ill-defined diseases	460	2.5
Other	2,420	13.2
Discharge status		
Approved	160	0.9
Exited	16,168	88.1
Escaped	561	3.1
Other	8	0.0
Autopsy	114	0.6
No autopsy	1,331	7.3
Number of diagnoses		
1	1,138	6.2
2	2,836	15.5
3	3,069	16.7
4	3,168	17.3
5	2,328	12.7
6	1,590	8.7
7	1,209	6.6
8	854	4.7
9	627	3.4
10	422	2.3
11	312	1.7
12	220	1.2
13	569	3.1
Number of procedures		
0	2,891	15.8
1	5,934	32.4
2	3,756	20.5
3	1,936	10.6
4	1,160	6.3
5	668	3.6
6	764	4.2
7	424	2.3
8	230	1.3
9	165	0.9
10	125	0.7
11	49	0.3
12	240	1.3

ICD-10=International Classification of Diseases version 10, HIV=Human Immunodeficiency Virus

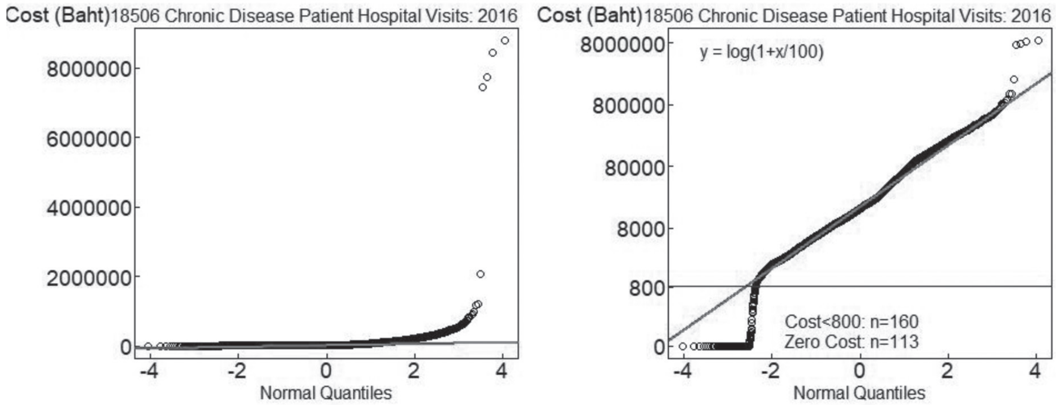

Figure 1 Normal quantile-quantile plots of cost (left) and transformed cost (right)

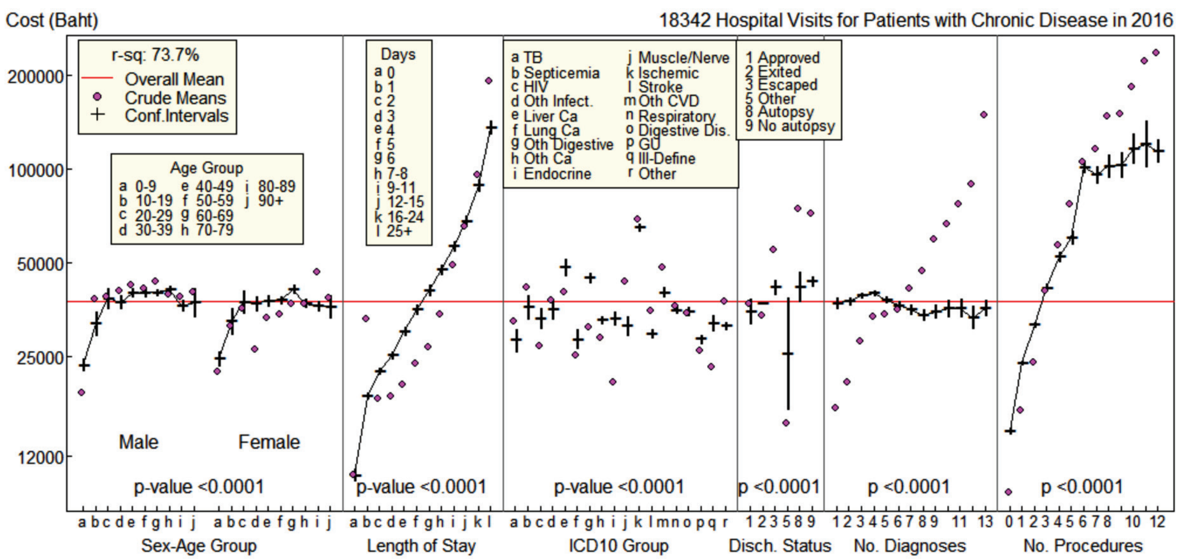

Figure 2 95% confidence interval plot of medical costs and determinants from a multiple linear regression model

As indicated above, abnormally low costs below 800 baht and abnormally high costs higher than 7 million were excluded from further analysis and a log-linear model was then created. Gender-age group, LOS, ICD-10 group, discharge status, number of diagnoses (nDiag) and number of procedures (nProc) were included in the model as determinants. Figure 2 shows the results from the multiple linear regression model.

A model was constructed to predict the natural log of the medical cost of each variable. The CI plots showed predictive accuracy of 73.7%, and the best predictors were nProc and LOS. Diagnosis (ICD-10 group) and nDiag predicted poorly when nProc and LOS were included. Crude means (circle dots) for nDiag suggested that it was a good predictor of cost. However, this correlation disappeared when LOS and nProc were included in the model. Therefore, it was found to be a confounding variable. Simple linear models were then constructed for each determinant and the r-squared values showed that nProc had the highest predictive value, of 54.1%, followed by LOS with 43.0% and nDiag with 17.6%. Since nProc and LOS had the highest r-squared values they were the only variables included in the final model even though significant p-values were found for all the other variables. nProc was classified into six groups: 0, 1, 2, 3, 4-5 and 6-12 procedures and was combined with LOS to produce a new variable named nProc-LOS with 72 groups. A simple linear regression was created with log of cost as the outcome variable and nProc-LOS as the determinant. A 95 % CI plot was created to show the relationship between cost and nProc-LOS as shown in Figure 3, which shows the CIs for hospital visit costs for 72 combinations of LOS and nProc.

Even though only two of the factors from the six-factor model were included in the final model, the r-squared only decreased by 0.015. The results therefore showed that medical costs increased when the LOS increased for all combinations of nProc and LOS except for those patients who experienced between 6 and 12 procedures during their hospitalization.

Discussion

This study explored the factors associated with hospitalization costs among chronic-disease patients using hospital administrative data. A log-linear model to estimate costs based on gender-age, diagnosis, nDiag, discharge status, LOS and nProc fit the data well with a predictive accuracy of 73.7% and all of these predictors were significantly associated with the cost, with the highest predictive value for nProc (54.1%) and LOS (43.0%) found in simple linear regressions. A reduced model with just one predictor – a factor combining nProc and LOS - produced a predictive accuracy of 72.2% with only a reduction in r-squared of 0.015. The results from the final model therefore showed that medical costs increased when the LOS and nProc increased except for those patients who experienced more than 6-12 procedures.

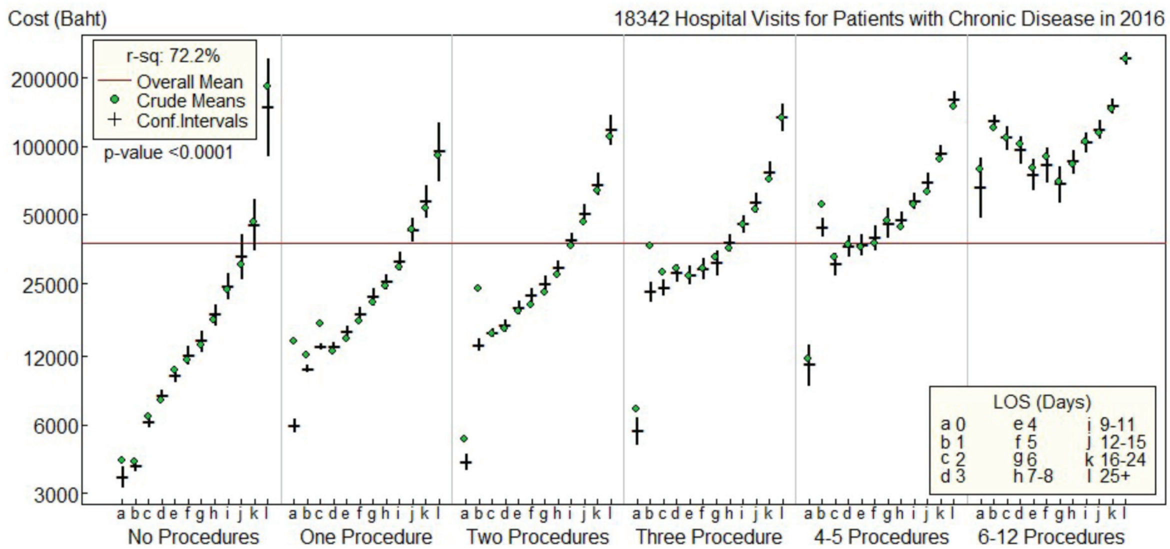

Figure 3 95% confidence interval plot of the relationship between medical cost and nProc-LOS

In this study, the patient demographic factors (gender and age), diagnosis history (principal diagnosis, and complications and comorbidities) were significantly associated with medical care costs and this result is consistent with a previous study of factors affecting health-care costs and hospitalizations among diabetic patients in Thai public hospitals conducted by Chaikledkaew et al.[10] Similar results were also reported by Slabaugh et al.[11] which found that clinical and demographic characteristics were the strong predictors of health-care cost among type 2 diabetes patients in the United States. However, the results from the present study show that the difference in the r-squared value in a model including these variables and one from which these determinants were excluded was only 0.015. Thus, it is not recommended that consideration should be given to all determinants with significant p-values, but that the overall effect on the r-squared value should be the main factor taken into consideration in determining the predictors of health-care costs since when dealing with large samples significant results can be found even where the r-squared value is quite low.

The final results showed that the determinants of medical costs among chronic-disease patients with the highest levels of significance were nProc and LOS. Thus, in assessing medical costs in Thailand, nProc and LOS should be the main factors employed in calculating the actual costs for patients. DRG-payment assessments which rely on coding systems based on diagnoses and procedures may therefore not represent accurate means of assessing patient costs when those patients are suffering from chronic diseases. In many countries where poorly developed hospital cost-accounting systems produce only low quality data, DRG systems based on those used in the United State are applied, even though they may not reflect their own practice patterns.[4] In Thailand, Pongpirul et al.[12] suggested that high quality DRG codes should not be presumed especially in resource-limited hospitals.

Conclusion

The results of this study suggest that DRG cost-assessment systems, in which costs are assessed based on the patient's diagnosis, discharge status and gender and age might not be the best means of assessing medical costs for patients with chronic illnesses in Thailand, and that the period spent in hospital and the number of procedures carried out during that time are more accurate indicators of the true medical cost.

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Conflict of interest

This study has no conflicts of interest.

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