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A MEDICAL EXPENSE STUDY OF IMPLEMENTING DRG 124 IN A REGIONAL HOSPITAL

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***Abstract*: Diagnostic Related Group (DRG) codes are used to classify hospitalized patients into groups with predefined payments, and to control medical expenses. The National Health Insurance Administration, Ministry of Health and Welfare (NHI) has implemented 155 DRG code groups since 2010, and will complete implementation in five years. When a hospital implements this payment system, it needs to control costs. But it cannot just lower outcomes or increase staff workload because this affects service quality. In addition, it cannot discharge patients early because this incurs medical complaints or readmissions. Hospitals should study the major outcomes to refine it or to make suggestions to NHI.**

This paper investigates at the expensive tests included in DRG124: cardiac catheterization with complex diagnosis. We focus on patients in 2010 and 2011 whose medical expenses are higher, and track back through their medical records to analyze data alongside their medical histories. Methods developed in this study can also be applied to other DRGs to improve performance of hospitals.

This study finds that medical expenses relate to referral source of patients, inpatient days and related expenses, principle diagnosis, and test items. Patients with heart failure, emergency admission, and ICU stays are the most costly group. For patients and hospitals, it is important to screen for related syndromes and actively control progression. For NHI, we suggest dividing this code into two DRGs according to disease type: coronary artery syndrome (4111, 4140) or heart failure (42X.*), to clearly define reasonable expenses.

***Keywords*: Diagnostic Related Group, cardiac catheterization, medical expense, hospitalization days, coronary artery syndrome.**

I. INTRODUCTION

Our study looks at inpatients referred by hospital outpatient clinics or emergency transfers, who belong to DRG124: circulatory diseases, with cardiac catheterization and complex diagnosis. Acute myocardial infarctions are excluded. Subjects include hospital outpatient or emergency transfer patients. The difference between higher and lower cost groups for DRG124 patients are explored through variables including patient characteristics, inpatient days, total NHI medical expenses, and medical costs.

The result is a model of higher medical expense populations for clinical practice, which provides theoretical support alongside data for hospital management to adjust clinical pathways and prevent unnecessary interventions. This improves hospital performance, through a three way win of benefits to the hospital, the patient and health care. The research can also be generalized to other high cost DRG categories, or be compiled as plug-in modules for hospital information systems that will automatically analyze the data for the hospital management to better understand performance.

II. REVIEW

With the increasing and aging population, new medical technologies, and higher medical utilization, among other reasons, medical expenses are rising. In the 1960s, the United States health care cost 5.2% of gross domestic product (GDP), but had risen to 9.1% by the 1980s. The average consumer price index (CPI) rose only 7.8% over the same period. The federal government is concerned that the Hospital Insurance Trust Fund will face a financial crisis.

To control rising healthcare costs, make rational use of medical resources and reduce waste, states in the U.S. sought suitable payment methods to replace the original fee-for-service (FFS) payment system. Thus the prospective payment system, (PPS) was introduced. The prospective payment system pays a fixed amount according to the defined payment price. The advantage of such a system is that healthcare providers understand the medical expenses in advance by taking into account the cost and the price. If the costs exceed the price, the hospital will incur a loss; else the hospital will have a surplus. So, in addition to the necessary treatment of patients, hospitals are incentivized to reduce spend on those medical resources, which incur additional costs but are less effective. It also allows medical organizations to strengthen internal management, improve utilization of medical resources, and curb rising health care costs [10].

Research found that similar inpatients from different hospitals varied in their treatments and outcomes. Patients are classified according to hospital statistics that produce the diagnostic relationship groups (DRGs), which in turn indicate the price to pay for each DRG. After trials in New Jersey and several states in the 1970s, a prospective payment system was created as a benchmark. In 1983, the U.S. Congress passed the Social Security Act amendment, which sets at the elderly and the disabled insurance (Medicare), utilizes the second edition of DRG payment system to reimburse hospitals. There were 23 MDCs and 470 DRG. The 2001 edition is the eighteenth, and contains 26 MDCs and 500 DRGs[12].

The Taiwan NHI Administration initially published the first version of TW-DRGs with 499 items in 2002, the second version with 976 items in 2004, the third version with 976 items [17], the 3.1 version with 969 items, and the last in 2009 (version 3.2) TW-DRGs payment scheme contains 1017 items. They are divided into 26 Major Diagnosis Categories (MDC), including a PRE MDC. Implementation of TW-DRG includes 23 MDCs. MDC 19 and 20 for psychiatric care are not yet implemented, and will be formally introduced in five phases of TW-DRGs from January 2010. The first year of implementation will introduce 155 items. They will be fully implemented by 2014 [16].

DRG implementation can provide hospitals with comparative data on inpatients, to help standardize the medical services provided to those included in the average cost of a similar diagnosis. When staff at the hospital treats a patient successfully, the treatment of patients with similar diseases can be reviewed to identify excess medical costs as compared to peers. Although staff usually wants to be able to discharge patients with the best quality equipment, costs need to be taken into account. In related studies of some countries implemented DRGs, the annual number of cases increased, and the average length of stay decreased, and a significant decline was found in each indicator [5][19]. DRG apparently had measurable negative effects on stuffs and stuff-perceived patient outcomes not as distinct as often assumed [2], but lead to good monitoring of the effectiveness of hospitals and a better evaluation of the hospital sector as a whole [13].

Financial management responsibilities are moved to medical institutions from patients, which supports medical services in implementing changes. Literature from the U.S. found that the financial impact of DRG introduction was felt after just a few years [11]. Since, DRGs group similar cases together and pay the same amount for each, it is theoretically prone to negative effects such as the cost of migration--to refer lower profit patients to other hospitals [9][15], shifting tests to a clinic, which need to be done in the hospital [14], decreasing quality of care, stricter admissions policies, multiple readmissions, claiming the same patient twice, not using disease coding and editing results to the incorrect DRG, affecting payment fees. NHI has monitored DRGs and inappropriate discharges since the first year of implementing DRGs, its contents shown as [18]

Ma proposed in early TW-DRG launched to conduct a retrospective data analysis of DRG125 reported by a regional hospital between 2007 and 2009. Data from before the TW-DRG implementation was used to predict medical expenses after implementation [6]. But hospitals do not consider DRG costs, except prior to the implementation of DRG. Today the TW-DRG has been implemented for years; we can analyze data after the implementation of the patient's treatment information, to provide recommendations to hospitals to improve cost management.

This study finds heart failure which significantly influences the medical expense of patients under DRG-124, but heart failure should belong to DRG-127(heart failure and shock) if without catheterization. Catheterization of the right heart was first essayed by Forssman, Cournand and Ranges have recently developed improvement in certain details of this technique and have used right heart catheterization for determination of cardiac output by the direct Fick principle[7] but

catheters are not commonly placed during hospitalization[1][3]. Chomsky proposed that physicians with heart failure specialists resulting significantly lower length of stay and total hospital charge then cardiologists, and not significant with Catheterization [4], but Warren said cardiac catheterization is associated with low complication rates and mortality, and it should remain an important tool in the management of these patients [20]. Between the different studies, Demir suggested that to diagnostic with Aortopulmonary window by computed tomography, After 6 months, catheterisation could be utilised to perform vasoreactivity testing and to close the defect [8].

III. RESEARCH FRAMEWORK AND ASSUMPTIONS

This study investigated the factors related to patient medical expenses from outpatient clinics or referred as emergencies into the hospital under the TW-DRGs payment system. The aim was to identify more realistic medical expenses.
Firstly, we screen DRG124 monthly patient monthly files, medical expenses are classified according to the NHI reporting rules. The list of inpatient medical services classifies each medical order into 17 categories of medical expense. Then we analyze DRG124 patients' medical resource consumption at the clinic or emergency room. When there are differences to the hospital data, historical records of circulatory disease classified according to ICD-9-CM are used to identify the healthcare disease costs.

IV. RESEARCH METHODS

This study investigated patients hospitalized under DRG124 circulatory disease code in 2010 and 2011. Patients selected were those with catheters and possible complex diagnosis, except for acute myocardial infarction. Their medical expenses from the outpatient or emergency sources should be different as the cost of hospitalizing patients transferred from the clinic or emergency sources is different. Patient medical records and NHI claims in 17 categories were tracked to analyze the impact of medical expense factors and possible solutions.

The research uses secondary patient data for those classified as DRG124 between January 1, 2010 and December 31, 2011. In each case we examine cost drivers to understand why the medical expenses were incurred. In this study, the main issue is the vast scale of the data, which requires medical professionals to decode and identify keywords. This requires significant manpower and time to complete. Information was provided by the hospitals as well as an explanation from medical professionals. The results also need to meet the needs of hospitals.

V. RESEARCH RESULTS

Even though the case study hospital has detailed patient histories, expensive DRGs in single regional hospital are not frequent (72 cases for two years). The preliminary results therefore need to be verified by NHI data in the future. Despite the NHI claim information containing the medical order list, there is no information on the disease. We must drill back the disease. For example, patients who have psychogenic pain without history of heart disease may mistakenly think it is due to stomach ulcers and gastrointestinal disorders, and seek treatment by Gastroenterology. These will appear at first to be non-cardiac DRG-related medical orders. This study therefore analyses NHI claims data to generate assumptions for future use and verification with larger datasets.

There are total of 72 cases of hospital patients in DRG124 in 2011 and 2012, of which, one case whose medical expenses are less than the lower limit and four cases of referral, these five cases are verification declaration. Another five cases are greater than the standard medical expenses, and two cases exceed the upper limit, such that the DRG124 did not cause a financial loss to the hospital overall. However, in order to control health spending, we still study the high-cost cases to understand them better and to identify cost control methods.

Since emergencies incur additional medical expenses, this study reduces it into net medical expenses for emergencies to exclude the emergency component. After analyzing the medical expenses and medical orders list belonging to DRG124 during the two years, we compare various aspects of the medical expenses. First, we use K-Means to sort data into high and low medical expenses, when k = 5 data are divided into groups according to statistics. There were 39 lower cost medical items (31,470 or less), 26 higher cost medical items (32,286 or above), and excess payments beyond the upper limit for 5 items combined into higher group. Since the last two items are outliers, we check the medical orders list and find that they are living on a respirator, so excluded them from the following analysis. We combine two groups of 31 items more than 32,286 as a higher expense group, then divided all data into two independent samples groups for analysis.

Descriptive statistics of 70 items are presented in TABLE I, the frequency distribution is shown in Fig. 1, and the cumulative distribution of the medical cost components is shown in Fig. 2. Among them, the number of days before cardiac catheterization, the number of acute inpatient bed days, examination fee, ward fees, inspection fees, radiation treatment fees, treatment and disposal fees and the average of daily drugs fees have the largest variations and are likely to need to control. But due to the daily billing system, most of them are related to the number of days in hospital, so this is a major influence. Chi-square test for nominal variables significantly associated with medical expenses before emergency additions are shown in TABLE II. Numerical variables arranged as correlation coefficients are shown in TABLE III. Age and medical expenses are slightly negatively correlated, which means that related disorders do not occur in the elderly.

TABLE I. DESCRIPTIVE STATISTICS

	Average	Std. Error	Min.	Max.
Age	65.46	12.88	26	90
Days before exam.*	1.21	1.92	0	10
Days of stay*	2.76	2.55	1	11
Diagnosis fees*	1476.24	1130.60	290	5703
Avg. diagnosis fees	607.00	259.22	290	2191
Bed fees.*	5123.17	5782.29	1046	30138
Exam. fees*	15089.69	3246.90	11090	27697
Radio diag. fees*	1593.30	1619.01	920	8242
Threatment fees*	579.64	833.72	0	4007
Avg. drug fees*	655.00	536.47	88	2939
Injection fees*	229.29	253.74	0	1125
Special material fees	6365.29	1988.16	4940	20380
Pharmacy service fees	266.64	188.28	76	912

*: Variance is higher

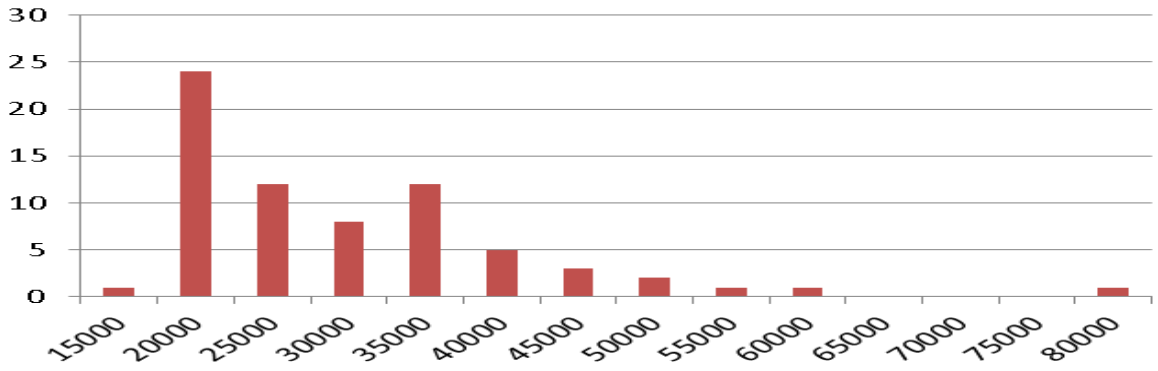

Fig. 1. Frequency distribution of net medical expenses.

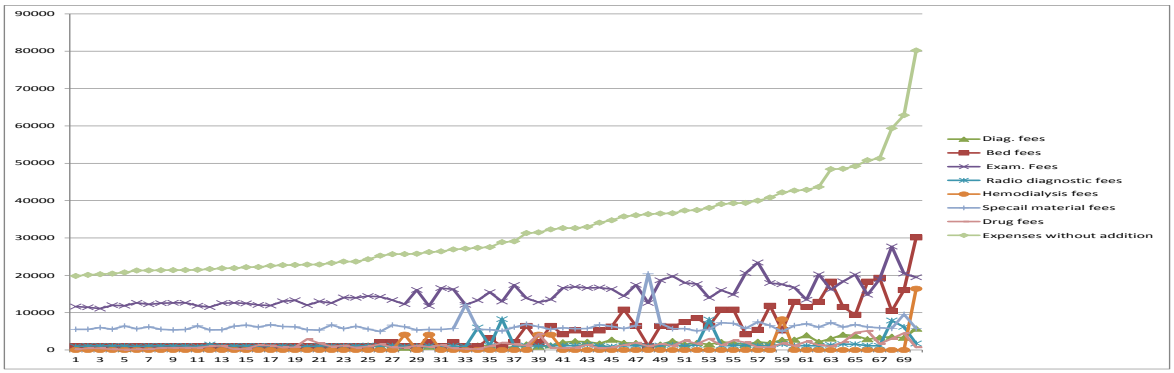

Fig 2. Trends of net medical expenses

TABLE II. CHI-SQUARE TEST OF SIGNINICANT NOMINAL VARIABLES GROUPED BY MEDICAL EXPENSES HIGH OR LOW

	Value	**df.**	**Sig. (two tails)**
Source of patients	35.502	2	0.000**
Stay ICU	26.903	1	0.000**
Diagnosed as 42X	8.886	1	0.003**

**:p<0.01

TABLE III. SIGNIFICANT PEARSON'S CORRELATION COEFFICIENT ORDERED BY PEARSON'S R

Expense	**Net medical expense**
Bed fees	.918**
Number of medical orders	.860**
Days of hospitalization	.790**
Days before exam.	.684**
Pharmacy service fees	.681**
Injection fees	.607**
Stay ICU	.591**
Threatment fees	.572**
Hemodialysis fees	.432**
Radio diagnosis fees	.309**
Age	-.314**

**: p<0.01

Using the K-S z test (used as it is not normally distributed) and chi-square test to analyze the data in TABLE IV, the preliminary findings are that medical expenses are associated with the following factors: whether the patient comes from outpatient or emergency (emergency medical expenses after removing additions are still higher than for outpatient referrals), inpatient days (including medical expenses related to the number of days of hospitalization - such as examination fees, ward fees, drugs, etc., but the difference in average drugs fees is not significant), the number of days before cardiac catheterization, whether the patient stays in ICU, the primary diagnosis (medical expenses for heart diseases such as ischemic heart disease: ICD9-4254, 4280 are higher than medical expenses for coronary artery disease such as coronary atherosclerosis (ICD-9 4111, 41401) and inspection fees. Use the cases whether medical expense is high as independent variables of logistic regression. For the logistic regression, we excluded variables directly impacted by the number of days of hospitalization, and sorted according to the parameters listed in TABLE V. Two variables, 'stay in ICU', and 'days before relevant examination' are significant, and can be used to predict overall costs.

TABLE IV. Z TEST OF SIGNIFICANT SCALE VARIABLES GROUPED BY MEDICAL EXPENSES HIGH OR LOW

	Max. difference			**Z test**	**Sig. (two tails)**
	Abs.	**+**	**-**		
Age	.356	.071	-.356	1.482	.025*
Days before exam.	.634	.634	.000	2.633	.000**
Days of hospitalization	.730	.730	.000	3.035	.000**
Diagnose fees	.916	.916	.000	3.809	.000**
Avg. diagnose fees	.401	.285	-.401	1.667	.008**
Bed fees.	.942	.942	.000	3.915	.000**
Exam. fees	.717	.717	.000	2.980	.000**
Radio diag. fees	.653	.653	-.026	2.712	.000**
Threatment fees	.626	.626	.000	2.602	.000**
Injection fees	.685	.685	.000	2.846	.000**

Special material fees	.333	.333	-.013	1.382	.044*
Pharmacy service fees	.724	.724	.000	3.008	.000**

*: $p < 0.05$
**: $p<0.001$

TABLE V. LOGISTIC REGRESSION TO MEDICAL EXPENSE GROUPS ORDERED BY B

	B	**S.E,**	**Wald**	**Sig.**
ICU	9.980	4.558	4.794	.029*
Days before exam.	4.952	2.300	4.638	.031*
Diagnosed 42X	3.037	2.179	1.943	.163
Patients' source	−1.491	1.595	.873	.350

*: $p < 0.05$

We found that high medical expense groups have the following characteristics: primary diagnosis or first secondary diagnosis of congestive and other heart failure (ICD-9 428.*), emergency or referral to the ICU, longer hospitalization before relevant examination (they may need to stabilize vital signs), and all heart-related checks other than the cardiac catheterization. Since cardiac catheterization is not necessary for the diagnosis of heart failure, the data show that after receiving a patient the hospital makes all checks to determine the patient's condition. Due to higher cost of stay, ICU is the main factor that affects total medical expense, staying in ICU alone provides up to 95% of the sensitivity and specificity as high as 75% to determine whether cases belong to higher cost group. If ICU stay and heart disease diagnosis are combined, then the sensitivity is up to 100% and the specificity is still 67%.

VI. CONCLUSIONS

The analysis shows that factors including e`mergency status, heart failure, ICU stay, and other tests done will increase medical expenses. For the patients who have coronary artery disease, cardiac catheterization can be done immediately and they can be discharged without other checks. Since this is a long-term trend in the evolution of the hypertension, coronary artery disease can be detected by early screening related factors, and some areas offer continuity of care for patients outside the hospital to control the disease. Patients can be admitted without doing all tests for diagnosing all possible diseases.

Because the cost of heart disease such as ischemic heart disease and the cost of coronary artery disease such as coronary atherosclerosis are significantly different, NHI should consider classifying this as two distinct DRG categories, which will more clearly show proper medical expenses.

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