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Original Article

Effects of diagnosis-related group payment on health-care provider behaviors: A consecutive three-period study

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Abstract

Background: This study aimed to evaluate the impact of diagnosis-related group (DRG) payments on health-care providers' behavior and the potential best course of action to make a profit under a DRG payment mechanism.
Methods: This is a natural experiment study with a tertiary hospital-based dataset. Under a consecutive three-period (3 years) or 12-period (12 seasons) design, length of stay, medical cost with detailed items, the percentage of general anesthesia (GA), and the percentage of receiving additional operations were compared. Furthermore, the differences between negative- and positive-profit groups were also examined.
Results: There was no difference in the length of stay and total medical cost after the launch of the DRG payment scheme. However, the percentage of additional operations increased significantly. In addition, there were reduced costs of radiological images and medication, a reduced percentage of GA, fewer patients undergoing additional operations, and a higher rate of complications or comorbidities in the "positive-profit group."
Conclusion: The introduction of DRG payment resulted in significantly reduced examination fee, slightly decreased medical costs without significant difference in several detailed items, a reduced number of GA cases without statistical significance, and more patients receiving additional operations. The possible solution to make a profit under the DRG payment scheme is to curtail the costs of radiological images and medication, lower GA percentage, perform fewer additional operations, and correct recording of complications or comorbidities.
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Keywords: diagnosis-related groups; National Health Insurance; Taiwan; tympanoplasty

1. Introduction

Taiwanese residents currently benefit from nationwide health-care coverage, which has been provided through the compulsory National Health Insurance (NHI) scheme since 1995. There are several advantages of this system, including easy accessibility without a referral system and low payments with a correspondingly high quality of health care.[1] In Taiwan, virtually all hospitals are under contract with the NHI, which provides reimbursement for nearly all medical fees. However, in response to burgeoning health-care expenditures, the Bureau of National Health Insurance (BNHI) was tasked to administer various policies, such as the global budget programs, case-payment system, and co-payment scheme.[2–4] Although the global budget program was introduced to restrain the soaring levels of health-care expenditures, the payment system remained primarily a fee-for-service. The hospitals were thus encouraged to provide as much medical care as they could to compete for reimbursement within the fee-for-service mechanism under the global budget program.[2] Consequently, the diagnosis-related group (DRG) payment system was introduced in Taiwan in 2010.

Conflicts of interest: The authors declare that there are no conflicts of interest related to the subject matter or materials discussed in this article.

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The DRG prospective payment system was developed in the United States and was initiated by the federal government within its Medicare program in 1983.[5,6] Since then, several additional countries adopted the DRG system as part of their health-care systems.[7] The Taiwanese version of the DRG payment system was developed by the BNHI based on the 18th version of DRG provided by the Centers for Medicare and Medicaid Services and was launched in 2010. DRGs are defined as a classification system that groups patients according to age, sex, principal diagnosis, type of treatment, surgery, discharge status, and the presence of complications or comorbidities. Under the prospective payment system, hospitals are paid a fixed fee for treating patients in a single DRG category, regardless of the actual cost.[8] By way of example, we analyzed the patients under one DRG classification of type I tympanoplasty because this surgery is generally considered a basic operation and is relatively common for each level of hospitals.[9]

Health insurance or payment policies may affect a health-care provider's behavior.[10] Previous studies have proposed that DRG payment has obvious influence on the medical service content, including the patients' length of hospital stay and the intensity of care.[11,12] Most existing studies were designed as a comparison between a pregroup and a postgroup with equal study periods.[13,14] However, there are few articles that have evaluated the effects of DRG payment during more than two consecutive periods. Therefore, the first goal of this study was to elucidate the effects of DRG payment on health-care providers' behaviors during a consecutive 3-year study period. Moreover, the DRG payment system shifts the financial responsibility from insurers to hospitals, and therefore, raises health-care providers' concerns regarding ongoing cost and profit. Accordingly, the second aim of this study was to discover an efficient method to enhance medical cost savings under the DRG payment system to optimize the profits of providers while also maintaining the functional work of hospitals.

2. Methods

2.1. Study population

This is a natural experiment study with a tertiary referral center-based dataset. We enrolled all the hospitalized patients who underwent a major surgical procedure as type I tympanoplasty in the Department of Otolaryngology, Taipei Veterans General Hospital from January 1, 2009, to December 31, 2011. We aimed to examine the impacts of DRG payment on health-care providers' behaviors, and first we divided these patients into three periods, according to the launching of the Taiwanese DRG payment system on January 1, 2010. Patients who were identified from January 1, 2009, to December 31, 2009, were defined as the "pre-DRG year 1," group; from January 1, 2010, to December 31, 2010, were defined as the "post-DRG year 1" group; and from January 1, 2011, to December 31, 2011, as the "post-DRG year 2" group. Second, each year was further separated into four seasons to reform a 12-period (12 seasons) model to observe the subtle changes of smaller periods.

Moreover, to discover the points that are helpful to gain positive profit after the introduction of the DRG payment system, we aggregated the patients from January 1, 2010, to December 31, 2011, and divided them into the "negative-profit group" and the "positive-profit group" (*negative profit* means that the reimbursement from DRG is less than the medical cost; by contrast, "positive profit" indicates more payment than the actual medical fees). The study was approved by the Institutional Review Board of Taipei Veterans General Hospital (No. 2013-03-003E).

2.2. Variables of interest

We incorporated the length of hospital stay, total medical cost with seven detailed items (doctor visit fee, ward fee, examination fee, radiological images fee, treatment fee, medication fee, and pharmacist service fee), the percentage of general anesthesia (GA), and the percentage of the patients who received additional operations other than type I tympanoplasty in the analysis of the changes in health-care providers' behaviors in response to DRG payment. The aforementioned variables along with the percentage of the presence of complications or comorbidities were used in the comparison between the "negative-profit group" and the "positive-profit group."

In this study, we used the original "points" to present all medical fees. One point in Taiwan DRG equals different prices in different levels of hospitals, depending on the complexity of the patient's care. The more complex the surgeries and medical cases seen at the facility, the higher the price of one point. Because our hospital was a tertiary referral center, one point equals 0.8 New Taiwan Dollar (TWD), which is equal to US$0.0269.

2.3. Statistical analysis

SPSS version 17.0 was used for data management and statistical analysis. Univariate analyses were performed using a Student t test (for continuous variables) or the Chi-square or Fisher exact tests (for categorical variables); one-way analysis of variance and the *post hoc* test were used for the comparison of continuous variables in three (or 12) groups representing the consecutive 3-year (or 12-season) period. Multivariate analyses were performed using logistic regression, and linear regression analyses were used to obtain the β weights. Variance inflation factor (VIF) was used as an indicator of multicollinearity and a value of 10 had been recommended as the maximum level of VIF. A two-tailed $p < 0.05$ was considered statistically significant.

3. Results

During the 3-year (consecutive) study period, there were a total of 767 patients with the main operation of type I tympanoplasty performed at our institution. The pre-DRG year 1, post-DRG year 1, and post-DRG year 2 groups included 272 patients, 255 patients, and 240 patients, respectively. Among the negative-profit group, there were 168 patients. As for the positive-profit group, a total of 299 patients were enrolled.

Table 1 shows the comparison between the three groups for the 3 consecutive years. First, the length of hospital stay had

Table 1
Comparison of the length of stay, medical cost, and decision making in the three-period study groups before and after DRG introduction.

Variables	Pre-DRG year 1 (n = 272)	Post-DRG year 1 (n = 255)	Post-DRG year 2 (n = 240)	p
Length of stay, d (mean ± SD)	4.76 ± 2.35	4.85 ± 2.19	4.52 ± 1.86	0.214
Total medical cost, point (mean ± SD)[a]	36,195.39 ± 16,188.93	36,506.89 ± 11,815.04	35,008.85 ± 10,007.56	0.407
Doctor visit fee (mean ± SD)	1857.66 ± 968	1875.71 ± 769.72	1738.75 ± 619.5	0.123
Ward fee (mean ± SD)	5786.4 ± 5108.56	5726.68 ± 2578.45	5336.73 ± 2190.53	0.319
Examination fee (mean ± SD)	2326.79 ± 1478.39	2329.42 ± 1506.96	2012.22 ± 1119.79	0.014*,**
Radiological images fee (mean ± SD)	512.57 ± 2075.53	421.59 ± 910.64	254.33 ± 427.05	0.098
Treatment fee (mean ± SD)	263.25 ± 837.51	236.67 ± 252.52	238.3 ± 264.48	0.818
Medication fee (mean ± SD)	2293.48 ± 3879.03	2106.38 ± 3775.04	1708.25 ± 2844.87	0.169
Pharmacist service fee (mean ± SD)	485.40 ± 194.21	489.82 ± 189.3	460.71 ± 153.02	0.157
Anesthesia type				0.350
GA, n (%)	124 (45.6)	103 (40.4)	96 (40)	
LA, n (%)	148 (54.4)	152 (59.6)	144 (60)	
Additional operations				0.009*
Yes, n (%)	37 (13.6)	42 (16.5)	57 (23.8)	
No, n (%)	235 (86.4)	213 (83.5)	183 (76.2)	

* Statistical significance, $p < 0.05$.
** *Post hoc* test showed $p = 0.032$ between the pre-DRG year 1 and post-DRG year 2 groups; $p = 0.033$ between the post-DRG year 1 and post-DRG year 2 groups.
DRG = diagnosis-related group; GA = general anesthesia; LA = local anesthesia; SD = standard deviation.
[a] 1 point in Taiwan DRG equals different prices in different levels of hospitals. For example, in our hospital, 1 point = 0.8 New Taiwan Dollar (or US$0.0269).

Table 2
Comparison of the length of stay, medical cost, and decision making in the 12-season study model (4 seasons before and 8 seasons after DRG introduction).

Variables	1st season of Pre-DRG year 1 (n = 65)	2nd season of Pre-DRG year 1 (n = 59)	3rd season of Pre-DRG year 1 (n = 68)	4th season of Pre-DRG year 1 (n = 80)	1st season of Post-DRG year 1 (n = 61)	2nd season of Post-DRG year 1 (n = 52)
Length of stay, d (mean ± SD)	4.46 ± 1.53	4.63 ± 2.2	4.71 ± 1.84	5.14 ± 3.21	4.41 ± 1.53	5.08 ± 2.5
Total medical cost, point[a] (mean ± SD)	33,728.6 ± 8016.15	36,948.15 ± 11,250.85	35,989.25 ± 12,209.44	37,819.73 ± 24,889.41	35,246.43 ± 10,196.53	37,628.33 ± 12,793.44
Doctor visit fee (mean ± SD)	1715.66 ± 498.13	1843.93 ± 737.85	1801.21 ± 618.12	2031.14 ± 1496.55	1737.21 ± 487.49	1954.42 ± 908.12
Ward fee (mean ± SD)	5264.62 ± 1807.43	5460.00 ± 2591.73	5552.94 ± 2167.76	6649.50 ± 8766.73	5203.61 ± 1807.33	5990.77 ± 2945.10
Examination fee (mean ± SD)	2018.63 ± 842.82	2289.81 ± 963.17	2139.94 ± 958.63	2763.25 ± 2271.46	2136.30 ± 808.61	2624.13 ± 1837.64
Radiological images fee (mean ± SD)	282.54 ± 494.5	327.46 ± 696.1	532.35 ± 1087.03	819.2 ± 3613.42	341.64 ± 692.84	570.1 ± 1245.57
Treatment fee (mean ± SD)	181.97 ± 113.9	230.39 ± 234.19	262.74 ± 273.14	353.95 ± 1509.14	214.11 ± 136.79	247.37 ± 300.96
Medication fee (mean ± SD)	2232.75 ± 1320.91	2817.63 ± 3193.36	2377.37 ± 6117.63	1884.95 ± 3254.6	1465.84 ± 848.32	1774.23 ± 2305.18
Pharmacist service fee (mean ± SD)	453.54 ± 115.61	489.46 ± 190.23	477.53 ± 148.44	514.98 ± 267.42	460.2 ± 121.72	504.31 ± 212.09
Anesthesia type						
GA, n (%)	24 (36.9)	29 (49.2)	34 (50.0)	37 (46.3)	24 (39.3)	21 (40.4)
LA, n (%)	41 (63.1)	30 (50.8)	34 (50.0)	43 (53.7)	37 (60.7)	31 (59.6)
Additional operations						
Yes, n (%)	7 (10.8)	11 (18.6)	9 (13.2)	10 (12.5)	12 (19.7)	10 (19.2)
No, n (%)	58 (89.2)	48 (81.4)	59 (86.8)	70 (87.5)	49 (80.3)	42 (80.8)

* *Post hoc* test showed $p = 0.027$ between the 4th season of pre-DRG year 1 and the 2nd season of post-DRG year 2; $p = 0.012$ between the 4th season of pre-DRG year 1 and the 3rd season of post-DRG year 2.
** Statistical significance, $p < 0.05$.
DRG = diagnosis-related group; GA = general anesthesia; LA = local anesthesia SD = standard deviation.
[a] 1 point in Taiwan DRG equals different prices in different levels of hospitals. For example, in our hospital, 1 point = 0.8 New Taiwan Dollar (or US$0.0269).

no significant changes after the launching of the DRG payment system (4.76 days ± 2.35 days, 4.85 days ± 2.19 days, and 4.52 days ± 1.86 days in the pre-DRG year 1, post-DRG year 1, and post-DRG year 2 groups, respectively; $p = 0.214$). The total medical cost also showed no significant decrease after DRG introduction (36,195.39 points ± 16,188.93 points; 36,506.89 points ± 11,815.04 points; and 35,008.85 points ± 10,007.56 points in the pre-DRG year 1, post-DRG year 1, and post-DRG year 2 groups, respectively; $p = 0.407$). In terms of the seven detailed items of medical cost, only the examination fee was significantly reduced not only between the pre-DRG year 1 and post-DRG year 2 groups but also between the post-DRG year 1 and post-DRG year 2 groups (2326.79 points ± 1478.39 points, 2329.42 points ± 1506.96 points, and 2012.22 points ± 1119.79 points in the pre-DRG year 1, post-DRG year 1, and post-DRG year 2 groups, respectively; $p = 0.014$; *post hoc* test showed $p = 0.032$ between the pre-DRG year 1 group and the post-DRG year 2 group; $p = 0.033$ between the post-DRG year 1 group and the post-DRG year 2 group). However, we also found a slightly decreasing trend without a significant difference with regard to ward fee (5786.4 points ± 5108.56 points, 5726.68 points ± 2578.45 points and 5336.73 points ± 2190.53 points in the pre-DRG year 1, post-DRG year 1, and post-DRG year 2 groups, respectively; $p = 0.319$), radiological images fee (512.57 points ± 2075.53 points, 421.59 points ± 910.64 points, and 254.33 points ± 427.05 points in the pre-DRG year 1, post-DRG year 1, and post-DRG year 2 groups, respectively; $p = 0.098$), and medication fee (2293.48 points ± 3879.03 points, 2106.38 points ± 3775.04 points, and 1708.25 points ± 2844.87 points in the pre-DRG year 1, post-DRG year 1, and post-DRG year 2 groups, respectively; $p = 0.169$). Similarly, the patients who received GA became lesser in an insignificant way (45.6%, 40.4%, and 40.0% in the pre-DRG year 1, post-DRG year 1, and post-DRG year 2 groups, respectively; $p = 0.350$). Nevertheless, additional operations other than type I tympanoplasty occurred significantly more frequently and were more common (13.6%, 16.5%, and 23.8% in the pre-DRG year 1, post-DRG year 1, and post-DRG year 2 groups, respectively; $p = 0.009$). There was no significant difference concerning doctor visit fee (1857.66 points ± 968 points, 1875.71

Table 2 (continued).

3rd season of Post-DRG year 1 ($n = 66$)	4th season of Post-DRG year 1 ($n = 76$)	1st season of Post-DRG year 2 ($n = 41$)	2nd season of Post-DRG year 2 ($n = 49$)	3rd season of Post-DRG year 2 ($n = 76$)	4th season of Post-DRG year 2 ($n = 74$)	*p*
5.20 ± 2.66	4.75 ± 1.91	4.78 ± 1.51	4.24 ± 1.56	4.42 ± 2.25	4.66 ± 1.76	0.234
37,738.62 ± 13,065.7	35,681.63 ± 11,231.64	33,609.15 ± 7302.47	35,683.86 ± 10,674.27	33,297.78 ± 9931.08	37,094.73 ± 10,656.46	0.427
2010.03 ± 971.08	1816.37 ± 631.66	1809.85 ± 484.07	1663.37 ± 541.58	1728.07 ± 785.00	1760.23 ± 543.03	0.156
6132.42 ± 3133.76	5613.46 ± 2250.54	5640.98 ± 1780.05	5008.98 ± 1842.76	5223.61 ± 2657.30	5501.35 ± 2078.77	0.333
2533.59 ± 1596.27	2105.49 ± 1576.40	1907.71 ± 823.95	1878.80 ± 1069.18	1936.28 ± 1281.46	2236.47 ± 1104.31	0.001***
570.62 ± 1121.31	254.74 ± 459.93	216.59 ± 106.2	214.69 ± 79.03	247.89 ± 437.98	308.11 ± 620.38	0.204
272.5 ± 305.37	216.34 ± 237.77	211.54 ± 167.77	277.73 ± 409.29	201.76 ± 199.62	264.54 ± 242.84	0.890
2913.88 ± 5879.35	2146.5 ± 3623.61	1133.27 ± 580.87	1621.51 ± 1541.33	1992.68 ± 4160.65	1792.15 ± 2585.11	0.265
522.67 ± 231.48	475.16 ± 174.5	474.34 ± 114.53	458.82 ± 149.02	452.74 ± 189.94	462.59 ± 132.75	0.289
						0.527
23 (34.8)	35 (46.1)	16 (39)	20 (40.8)	25 (32.9)	35 (47.3)	
43 (65.2)	41 (53.9)	25 (61)	29 (59.2)	51 (67.1)	39 (52.7)	
						0.001*
9 (13.6)	11 (14.5)	6 (14.6)	19 (38.8)	9 (11.8)	23 (31.1)	
57 (86.4)	65 (85.5)	35 (85.4)	30 (61.2)	67 (88.2)	51 (68.9)	

points ± 769.72 points, and 1738.75 points ± 619.5 points in the pre-DRG year 1, post-DRG year 1, and post-DRG year 2 groups, respectively; $p = 0.123$), treatment fee (263.25 points ± 837.51 points, 236.67 points ± 252.52 points, and 238.3 points ± 264.48 points in the pre-DRG year 1, post-DRG year 1, and post-DRG year 2 groups, respectively; $p = 0.818$), and pharmacist service fee (485.40 points ± 194.21 points, 489.82 points ± 189.3 points, and 460.71 points ± 153.02 points in the pre-DRG year 1, post-DRG year 1, and post-DRG year 2 groups, respectively; $p = 0.157$).

Table 2 shows a more detailed comparison between these groups broken down by the 12 consecutive seasons. The results in the 12-season model mostly resembled those in the 3-year model. Of all these variables, only the "examination fee" and "additional operations other than type I tympanoplasty" reached statistical significance. The examination fee significantly reduced not only between the 4th season of pre-DRG year 1 group and the 2nd season of post-DRG year 2 group but also between the 4th season of pre-DRG year 1 group and the 3rd season of post-DRG year 2 group [2763.25 points ± 2271.46 points, 1878.80 points ± 1069.18 points, and 1936.28 points ± 1281.46 points in the 4th season of pre-DRG year 1 group, the 2nd season of post-DRG year 2 group, and the 3rd season of post-DRG year 2 group, respectively ($p = 0.001$); *post hoc* test showed $p = 0.027$ between the 4th season of pre-DRG year 1 group and the 2nd season of post-DRG year 2 group; $p = 0.012$ between the 4th season of pre-DRG year 1 group and the 3rd season of post-DRG year 2 group]. Additional operations other than type I tympanoplasty were significantly more and more common in the 12 consecutive seasons ($p = 0.001$).

All factors exerted statistically significant effects on the profit issue in univariate analyses (Table 3). Shortened length of stay (4.02 days ± 1.41 days in the positive-profit group vs. 5.86 days ± 2.2 days in the negative-profit group; $p < 0.001$), reduced costs of each of the seven detailed items, lowered percentage of GA (16.7% in the positive-profit group vs. 81% in the negative-profit group; $p < 0.001$), and fewer patients receiving additional operations (1.7% in the positive-profit group vs. 48.2% in the negative-profit group; $p < 0.001$) made the profit positive. However, the rate of complications or comorbidities was higher in the positive-profit group (11.7% and 4.8% in the positive-profit group and negative-profit group, respectively; $p = 0.013$). In multivariate analyses, profit was gained significantly by reducing the radiological images fee ($p < 0.001$), reducing the medication fee ($p < 0.001$), lowered percentage of GA ($p < 0.001$), fewer patients receiving additional operations ($p < 0.001$), and higher rates of complications or comorbidities ($p = 0.002$).

Table 4 shows the importance of each variable in gaining the profit under the DRG payment system. Model 1 showed significant β weights in length of stay ($\beta = -12116.5$; $p = 0.003$), anesthesia type of GA ($\beta = -7510.56$; $p < 0.001$), additional operations ($\beta = -9437.82$; $p < 0.001$), and complications or comorbidities ($\beta = 2733.547$; $p < 0.001$). Nevertheless, Model 2 was reformed by excluding "length of stay," "doctor visit fee," "ward fee," and "pharmacist service fee," because the VIF value of these variables exceeded 10. There were only three evident β weights in Model 2, including anesthesia type of GA ($\beta = -8588.99$; $p < 0.001$), additional operations ($\beta = -8758.05$; $p < 0.001$), and complications or comorbidities ($\beta = 2430.22$; $p < 0.001$).

4. Discussion

Since the implementation of DRG payment in the United States, hospitals face a marginal profit and tend to reduce the health-care resource.[15] These changes in the behaviors of health-care providers would be reflected by the medical service content. Hence, we examined the changes in the medical service content in three aspects, namely, the length of hospital stay, medical cost and the physician's decision making about the percentage of GA, and the percentage of patients who received additional operations other than type I tympanoplasty. For the sake of achieving a thorough understanding of resource utilization, we incorporated seven detailed items of medical cost into the analysis.

Previous studies, based on the experiences of various countries, have demonstrated that the DRG payment system results in a significant reduction in the length of hospital stay.[16–18] However, we found no significant changes in the length of hospital stay after the introduction of this system in our consecutive three-period study design. This means that health-care providers have maintained the standard course of hospitalization and have not given in to the temptation of reducing medical expenditure by discharging the patients early. A number of adverse events may be subsequently avoided.

Health-care intensity is evaluated mainly by the number of orders for medical services.[12,19] Considering the different charge in each different order, we used total medical cost and its detailed content to represent health-care intensity. Existing reports regarding the impact of DRG payment on health-care intensity were inconclusive. Some articles indicated that health-care intensity was reduced under the DRG payment system,[12,20] whereas other studies proposed no significant difference in health-care intensity.[12] In our study, the total medical cost had no significant decrease in the 3-year study period. However, with regard to each specific detailed item, we found a slightly decreasing trend without a significant difference on ward fee, radiological images fee, and medication fee. A possible explanation is that the DRG payment system did exert an influence in an insignificant way on health-care providers' behaviors, inclusive of reducing the medical cost by releasing more low-cost wards to save ward fee, arranging expensive temporal bone computed tomography at outpatient service before hospitalization to reduce radiological images fee, and prescribing high-priced advanced antibiotics in a separate hospitalization prior to the present hospitalization for surgery to avoid costly medication fee. It is particularly noteworthy that the fixed reimbursement of DRG payment is decreasing every year in

Table 3
Comparison between the positive- and negative-profit groups after implementation of DRG using univariate and multivariate analyses.

Variables	Positive profit ($n = 299$)	Negative profit ($n = 168$)	Univariate analyses (p)	Multivariate analyses (p)
Length of stay, d (mean ± SD)	4.02 ± 1.41	5.86 ± 2.2	<0.001*	>0.99
Medical cost, point				
Doctor visit fee (mean ± SD)	1584.64 ± 469.24	2193.13 ± 789.15	<0.001*	0.238
Ward fee (mean ± SD)	4739.73 ± 1664.45	6918.32 ± 2593.14	<0.001*	>0.99
Examination fee (mean ± SD)	1950.75 ± 757.94	2410.69 ± 1629.2	0.001*	0.073
Radiological images fee (mean ± SD)	234.57 ± 375.98	524.82 ± 1072.29	0.001*	<0.001*
Treatment fee (mean ± SD)	183.12 ± 189.01	324.07 ± 294.5	<0.001*	0.774
Medication fee (mean ± SD)	1075.44 ± 637.77	3103.42 ± 4174.33	<0.001*	<0.001*
Pharmacist service fee (mean ± SD)	418.81 ± 104.06	574.01 ± 203.41	<0.001*	0.163
Anesthesia type			<0.001*	<0.001*
GA, *n* (%)	50 (16.7)	136 (81)		
LA, *n* (%)	249 (83.3)	32 (19)		
Additional operations			<0.001*	<0.001*
Yes, *n* (%)	5 (1.7)	81 (48.2)		
No, *n* (%)	294 (98.3)	87 (51.8)		
CC			0.013*	0.002*
Yes, *n* (%)	35 (11.7)	8 (4.8)		
No, *n* (%)	264 (88.3)	160 (95.2)		

* Statistical significance $p < 0.05$.
CC = complications or comorbidities; DRG = diagnosis-related group; GA = general anesthesia; LA = local anesthesia; SD = standard deviation.

accordance with the yearly reducing trend of several detailed items of medical cost, whether significant or not. This yearly subtle adjustment of payment by the BNHI seems to be helpful in containing costs.

Of the seven detailed items of medical cost, there was no statistical significance concerning the doctor visit fee, treatment fee, and pharmacist service fee. The dissimilarity between pharmacist service fee and medication fee is that the pharmacist service fee depicts only the number of orders of medication. However, the medication fee, which comprises not only the number of orders but also the sum of diverse charges for various orders, may give a more complete picture of the physician's behavior. Our study result may be explained with no obvious changes in the numbers of doctor visits, which are proportional to the length of stay, and no difference in the number of orders of medication in contrast to a slightly insignificant decrease of medication fee after DRG payment was made. The physicians also provide satisfactory treatments and postoperative care, such as suitable wound-dressing types, to the patients who received type I tympanoplasty.

Nevertheless, only the examination fee saw a significant decrease between the 4th season of pre-DRG year 1 group and the 2nd season of post-DRG year 2 group and between the 4th season of pre-DRG year 1 group and the 3rd season of post-

Table 4
Importance of the length of stay, seven detailed items of medical cost, and each decision making in gaining the profit under the DRG payment system.

Variables	Model 1 [a]			Model 2 [b]		
	β	Standard error	p	β	Standard error	p
(Constant)	14,843.74	535.094	<0.001 *	11,806.29	374.73	<0.001 *
Length of stay, d	−12,116.5	4115.959	0.003 *			
Medical cost, point						
Doctor visit fee	−2.806	0.923	0.002 *			
Ward fee	9.151	3.54	0.010 *			
Examination fee	−0.331	0.134	0.014 *	−0.75	0.16	<0.001 *
Radiological images fee	−0.943	0.191	<0.001 *	−0.92	0.23	<0.001 *
Treatment fee	0.018	0.661	0.978	−1.60	0.78	0.040 *
Medication fee	−0.545	0.067	<0.001 *	−0.92	0.07	<0.001 *
Pharmacist service fee	12.406	3.373	<0.001 *			
Anesthesia type: GA	−7510.56	304.079	<0.001 *	−8588.99	355.53	<0.001 *
Additional operations	−9437.82	370.348	<0.001 *	−8758.05	446.63	<0.001 *
CC	2733.547	462.489	<0.001 *	2430.22	559.55	<0.001 *

* Statistical significance, $p < 0.05$.
CC = complications or comorbidities; DRG = diagnosis-related group; GA = general anesthesia.
[a] Model 1: Adjusted $R^2 = 0.8849$.
[b] Model 2: Adjusted $R^2 = 0.8272$ (Model 2 is produced by excluding "length of stay," "doctor visit fee," "ward fee," and "pharmacist service fee," because the variance inflation factor (VIF) value of these variables are over 10 and the VIF indicates multicollinearity).

DRG year 2 group in terms of the seven detailed items of medical cost. This represents an apparent decline of expensive examinations during the 2nd year after the launch of DRG payment. Tables 1 and 2 indicate that examination fee accounts for a considerable portion of total medical cost and the examination fee could be managed by the physicians themselves. As a result, it is more efficient for health-care providers to reduce total medical cost by cutting down its substantial portion as examination fee.

Type I tympanoplasty has been generally considered a basic operation for chronic otitis media patients.[9] This procedure could be performed either under GA or under local anesthesia (LA) and the expense under GA is undoubtedly higher than that under LA due to an additional anesthesia fee. However, a study declared that tympanoplasty performed under GA, as opposed to LA, had significantly better results.[21] Our study result shows that GA was used lesser but without significant difference in the 3 consecutive years (45.6%, 40.4%, and 40.0%; $p = 0.350$). This may imply that under the financial stress of DRG payment, physicians tend to choose LA in an insignificant way.

Unexpectedly, additional operations other than type I tympanoplasty were significantly more common in the consecutive 3-year model (13.6%, 16.5%, and 23.8%; $p = 0.009$) and even in the 12-season model ($p = 0.001$). This may be due to the rapid development of patient-centered care in Taiwan and a misunderstanding of less disapproval and application rates in DRG payment cases.

The DRG payment system, which is designed for cost containment and improving hospital efficiency,[19] offers health-care providers not only an opportunity but also an obligation to become acquainted with cost and profit. There are few studies talking over the profit issue under the DRG system. Therefore, this study is characteristic of comparing the two groups, negative profit or positive profit, to seek for the possible solution to gain the profit under the DRG payment system.

We found that reduced costs of radiological images and medication, lower percentage of GA, and less patients receiving additional operations made the profit positive. However, the rate of complications or comorbidities was unexpectedly higher in the positive-profit group (11.7%) than that in the "negative-profit group" (4.8%). This may reflect a higher set payment for those patients with complications or comorbidities under the DRG payment scheme and also reminds us of the importance of correct recording about the patients' illness as comorbidities and about hospital course to check if complications occur.

There are several limitations to our study. First, the major limitation is the relatively small or limited study populations. A nationwide or population-based dataset should be established. Second, this study did not include clinical characteristics and lacked propensity score matching and difference-in-differences design. Third, the study group of this article is based only on type I tympanoplasty patients, which may limit the generalizability of the findings to the other surgeries. Thus, a multidisciplinary study with a nationwide or population-based dataset deserves to be developed.

During the consecutive 3-year study period, the implementation of DRG payment caused significantly reduced examination fee, slightly decreased medical costs in mostly detailed items but without significant difference, less GA cases without statistical significance, and more patients receiving additional operations. The possible solution to make a profit under DRG payment is to curtail the costs of radiological images and medication, to lower GA cases, to perform less additional operations, and correct recording of complications or comorbidities.

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