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THE NEW DIAGNOSIS RELATED GROUP REIMBURSEMENT SYSTEM DECREASES MEDICAL COSTS AND CHANGES SOME PHYSICIAN TREATMENT BEHAVIOR

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Abstract

Findings regarding the effect of the diagnosis-related group (DRG) reimbursement system on medical costs and length-of-stay (LOS) have been inconclusive. This hospital-based study assessed the effect of a newly implemented DRG reimbursement system on medical costs, claims, LOS, and the behavior of physicians using transurethral resection of the prostate (TURP) to treat patients with benign prostatic hyperplasia. We retrospectively collected one regional hospital's claims data (reported medical costs, claims, and LOS) for the treatment of patients with TURP for three years prior to and four years after a DRG was implemented. One hundred eighty patients (63 before, 117 after) were included. Compared with pre-implementation calculations, the implementation of DRG significantly reduced medical costs (in cost points 37867.43 ± 5219.77 vs. 35588.78 ± 4763.34, $p< 0.01$) in both descriptive and regression analyses, in which it accounted for 4.7% of the variance. It shortened LOS in our descriptive analysis (4.22 ± 1.04 vs. 3.87 ± 1.04, $p < 0.05$). Laboratory fees and radiation fees were found to be the most reduced by DRG (by 909.15 and 184.37 cost points; both $p < 0.001$). Comparing costs and claims, we found the new DRG increased hospital revenues, though not significantly. Some physicians' prescribed radiation and laboratory fees changed in response to the new DRG. DRG significantly decreased medical costs and changed the treatment behavior of some physicians, suggesting physician treatment behavior may be targeted for further improvement in revenues.

Keywords: Diagnosis-related groups, Healthcare Costs, Length of stay, Physicians

Introduction

Diagnosis-related group (DRG) hospital payment systems, which reimburse healthcare providers a predetermined amount of money for set treatments of different diseases, aim to reduce medical costs and avoid unnecessary medical treatments. They transfer the responsibility of managing medical costs from insurance institutions to qualified physicians(Yoo et al., 2014).

In such a system, patients are grouped according to diagnosis, operation or treatment, age, comorbidities, and medical complications, and each category is assigned its own DRG reimbursement amount. DRG systems help predetermine medical costs, define hospital products, and facilitate medical resource management (Quentin et al., 2011). Mor33eover, they are thought to provide incentive for physicians to efficiently and appropriately manage their patients' medical expenses and length-of-stay (LOS) (Bystrov et al., 2015).

Previous studies have produced different conclusions regarding the effect of DRG on medical costs and LOS. One study of the effect of DRG on Medicare patients in over 5,400 hospitals reported a significant reduction in LOS the first year that DRG was implemented (Guterman and Dobson, 1986). Another study comparing quality of care of patients treated for community-acquired pneumonia in fee-for- service hospitals with hospitals using DRG in Switzerland reported those treated in DRG hospitals had significantly shorter (20%) LOSs (Schuetz et al., 2011). However, one study of the possible effect of DRG on costs and LOS for patients receiving hip replacements in 712 hospitals across ten European countries reported patient characteristics and treatment variables had a greater influence on differences in these variables than DRG (Geissler et al., 2012). A review of its effect on physician treatment behavior in a national health insurance system such as Taiwan's may limited if based only insurance claims alone because hospital claims data do not identify individual physicians. Thus, we do not know how DRG affect physician treatment behavior.

Benign prostatic hyperplasia (BPH) is a common disease for which patients are hospitalized (Tai et al., 2015). Transurethral resection of the prostate (TURP), a widely accepted means of treating BPH (Michalak et al., 2015; Nickel et al., 2010), is covered by Taiwan's National Health Insurance (NHI) program. In 2010, two new designations for the treatment received for TURP were added to Taiwan's DRG (Tw-DRGs) system: DRG 336 and DRG 337. These two diagnosis-related group designations, one for uncomplicated disease and the other complicated disease, are used to determine reimbursements for the treatment of TURP. Figure 1 shows the differences in how medical costs are reimbursed for the treatment of TURP before and after the new system was implemented. In the new system, at the lower end of the range, fee-for-service is used, at mid-range bundled payment is used, and at the higher end bundled payment also used until services and fees exceed a certain limit, at which point fee-for-service is used with reimbursement set at a less than favorable

rate. It is thought that this reimbursement system provides a strong incentive for physicians to control costs (Yan et al., 2011). Numerous studies have investigated the adequacy of DRG classification and its effect on overall medical cost to a health system (Geissler et al., 2012; Paat-Ahi et al., 2014; Street et al., 2012), but few have compared the differences in the medical costs expended by individual physicians (Van Rhee et al., 2002).

This study analyzed medical costs, claims, and LOS of TURP cases (DRG 336 and DRG 337) at our hospital before and after the Tw-DRGs system was implemented in 2010. Our analysis also included differences in the care prescribed by the physicians at our hospital to identify their effect on patient medical costs and LOS before and after the implementation of the DRG system.

Materials & Methods

The Tw-DRG system was implemented in Taiwan in January 2010. This study retrospectively reviewed the claims records of patients who underwent TURP, including Surgical Procedure Codes 9406B (TURP 5-15 gms/ weight), 79411B (TURP 15-50 gms/ weight), and 79412B (TURP >50 gms/ weight), in one hospital between January 2007 and December 2013. We compared pre-DRG claims data (2007 to 2009) with post-DRG data (2010 to 2013). The protocol for this study was approved by the IRB of the hospital (IRB approval No: 20130925B). The requirement for informed consent was waived because data was devoid of any identifying information.

From the health insurance claims records, we were able to collect pre- and post-DRG data including DRG 336 and DRG 337 status, patient age, attending physician, LOS(days), medical cost (in points) and medical claims (in points). We calculated revenue defined in this study as the difference between medical costs (money actually spent expressed in points) and medical claims (money reimbursed also expressed in points).

Pre- and Post DRG characteristics of patients, physician case numbers, and details of care, LOS, and cost (in points) were summarized descriptively by year and expressed in percentages. A t test was conducted to evaluate the association between continuous pre- and post-DRG variables. ANOVA was used to analyze differences in patients, medical costs, medical claims, and LOS among physicians before and after DRG. Stepwise regression analysis was employed to identify the critical predictors of medical costs, medical claims, revenues, and LOS. Liner regression was used to analyze differences in medical costs, medical claims, and revenue between the two pre- and post-DRG implementation, DRG 336 and DRG 337, patient age, attending physician, and LOS. In a separate regression model for LOS, the independent variables were pre- and post-DRG, DRG 336 and DRG 337, patient age, and attending physician. The categorical variables were converted into dummy variables. P values below 0.05 were considered significant. All statistical operations were performed using SPSS Version 19 (IBM Co., Armonk, NY, USA).

Results

This study enrolled 180 patients (63 pre-DRG; 117 post-DRG) receiving TURP at our medical institute between January 2007 and December 2013. Patients were between 47- and 98-years-old (age: 69.00 ± 8.23 y). Table 1 (Note: All Tables and Figures are placed at the end of this article for formatting purposes) summarizes group characteristics.

Thirty-four patients (18.9%) received TURP including treatment for its complications (Tw-DRG Code 336) and 146 patients (81.1%) received TURP (Tw-DRG Code 337). The patients were treated by one of four physicians. Seventy-three patients (40.6%) were treated by Physician C, 51 (28.3%) by Physician D, 44 (24.4%) by Physician A, and 12 (6.7%) by Physician B. Overall medical costs, expressed in cost points (means ± standard deviation), were 36386.31 ± 5032.77, overall medical claims 48790.72 ± 1138.63, and revenue 12404.41 ± 4892.55. Overall length of stay (LOS) in days was 3.99 ± 1.05.

Table 2 compares differences in pre- and post-DRG medical costs, medical claims, and LOS by attending physician. In general, BPH patients treated after DRG was implemented used significantly fewer medical resources, had fewer medical claims, and had shorter lengths of stay than those treated before the implementation of DRG (pre- and post-DRG medical costs in cost points 37867.43 ± 5219.77 vs. 35588.78 ± 4763.34, $p < 0.01$; pre- and post-DRG medical claims in cost points 49513.67 ± 267.21 vs. 48401.44 ± 1235.21, $p < 0.001$; pre- and post-LOS in days 4.22 ± 1.04 vs. 3.87 ± 1.04, $p < 0.05$). There was no significant difference in patient age (pre-DRG 68.90 ± 8.09 vs. post-DRG 69.03 ± 8.34 vs., $p > 0.05$). We found no significant pre- and post-DRG physician differences in patient age, medical costs, or LOS. What was significantly different among the physicians before DRG (age and LOS) remained significant after implementation (age and LOS). Thus, we found that DRG reduced costs to some extent and LOS. It did not bring about any changes in physician behavior as a whole, which might account for it small effect on change.

We wanted to investigate how the DRG influenced utilization of specific areas of treatment. To do that, we compared pre- and post-DRG differences in various medical expenses (laboratory, radiation, treatment, and special material fees, etc.) As can be seen in Table 3, the greatest difference was found in laboratory and radiation fees, both reduced post-DRG (4579.24 ± 1583.18 vs. 3670.09 ± 1113.17, difference 909.15, $p < 0.001$; 336.51±189.48 vs. 152.14 ± 177.43, difference: 184.37, $p < 0.001$), suggesting that the DRG system effectively controlled the medical costs in these two areas. When we considered the physicians as a group in relation to each other, we found the DRG system did not influence their differences in the way they controlled medical costs, including daily physician attending fees and ward fees as well as laboratory and radiation fees, though they lost some significance in difference among themselves after DRG. However, considering the behaviors of each physician specifically, we found Phy-

sician A and D had significantly lower radiation fees and Physician C had significantly lower treatment and drug fees in response to the new DRG, suggesting that there is room for targeting physician behavior to further reduce costs.

This study also sought to find out to what extent patient age, treatment period (pre- vs. post-DRG), diagnosis (DRG 336 vs. 337), physician, and LOS data most accounted for differences in stepwise regression analysis of medical costs, medical claims, and revenues. We also ran an LOS model studying influence of patient age, treatment period, diagnosis, and physician. As can be seen in Table 4, treatment period was most critical determinate of medical costs, accounting for 4.7% of the variance. Treatment period and diagnosis were critical determinants of medical claims, together accounting for 65% of the variance. Treatment period alone accounted for 27.3% of the variance in medical claims. LOS was found to be a significant determinant of revenues, accounting for 27.9% of the variance. The physician variable (A, D vs. C) was found to be a significant determinant of LOS, accounting for 27.8% of the variance in that model (Table 4). In summary, we found that treatment period had the largest influence on medical costs and physician difference in LOS had a large influence on the revenues.

Discussion

In 2010, Taiwan's National Health Insurance implemented DRG reimbursement system to encourage physicians to reduce the medical costs and LOS of their patients. At this time, NHI gradually established recommended treatment procedures specific for certain diseases, e.g., the use of TURP to treat BPH. This hospital-based study was performed to study the effect of the newly implemented DRG system on medical costs, claims, and LOS. In general, treatment of BPH patients after DRG was implemented saw significantly reduced medical costs and medical claims and shorter lengths of stay (Table 2). The greatest difference in medical costs was found to be largely due to reductions in laboratory and radiation fees (Table 3). Based on our stepwise logic regression, treatment period was most critical determinate of medical costs, accounting for 4.7% of the variance (Table 4).

While the new system did not bring about significant changes in how physicians differed as a whole from each other in treatment of their patients, it was found that it brought about some reduction in treatment costs of individual physicians, suggesting that physician behavior may be targeted for further reductions in medical costs in the reimbursement system as a whole.

In this study, medical costs were reduced significantly from 37867.43 ± 5219.77 to 35588.78 ± 4763.3 post-DRG ($p< 0.01$). While changes in LOS regardless of reimbursement system can explain differences physician attending fees and ward fees, it was DRG-induced changes in physician treatment behavior that led to reductions in radiation fees (pre-DRG 336.51±189.48 vs. post-DRG 152.14 ± 177.43, $p < 0.001$) and laboratory fees. The greatest difference was found in laboratory fees,

which were reduced significantly from 4579.24 ± 1583.18 pre-DRG to 3670.09 ± 1113.17 post-DRG (difference: 909.15, $p < 0.001$). However, these changes in fees may not be related to DRG system alone, as medical costs are also related to disease severity and complications and the procedures used to treat them (Van Rhee et al., 2002; Jones, 1985; Horn, 1983), though our designations included TURP with and without complications. There is also the possibility that physicians transferred inpatient costs (e.g., examinations fees) to outpatient costs (Kim et al., 2017) or the physicians shortened their LOS and transferred medical care costs to long-term care centers (Lin et al., 2006). In fact, it has been reported that the hospital costs of transfer patients are higher than those of non-transfer patients, suggesting that much of the treatment costs can be transferred to other care facilities after discharge (Muñoz et al., 1988).

This study analyzed the factors affecting LOS. Analyzed descriptively, the implementation of DRG significantly reduced LOS (pre-DRG 4.22 ± 1.04 vs. post-DRG 3.87 ± 1.04, $p < 0.05$). However, stepwise regression did not find the two to be significantly correlated, a finding inconsistent with a Korean study of its affect on LOS in appendectomy patients (Kim et al., 2015) and inconsistent with a Taiwanese study investigating the same relationship in cases receiving coronary artery surgeries (Cheng et al., 2012). The difference between our study and theirs may be related to the fact that our long-term study examined the period three years prior to and subsequent to the implementation of a DRG system while their short-term studies explored the effects of the DRG system just prior to and just after the implementation of a DRG system.

While our stepwise regression did not find a significant correlations between reimbursement system and LOS, it did reveal β coefficients of 1.137 and 1.066 (standardized $\beta = 0.490$ and 0.438) for Physician D and A, respectively, compared to Physician C, explaining 27.8% of the total variance in LOS. While differences in LOS are often related to various factors including medical techniques, examination time, and care quality at different care facilities (Lu et al., 2015), the present study was performed in one hospital which controlled examination time and care quality, eliminating the influence of differences in general approaches to care at different hospitals.

Consequently, the differences in LOS among the physicians may be attributed to individual differences in their treatment behavior, as has been found in a previous study (Geissler et al., 2012) showing that treatment variables exerted a greater effect on LOS than did DRG implementation. Therefore, hospitals might benefit from establishing a method that their physicians and hospital managers can use to analyze the costs of treating DRG patients and use to better control costs. Such an analysis can help clarify how medical departments and physicians can best manage each DRG category to and help hospitals ensure that their patients receive cost-effective treatment while efficiently utilizing medical resources (Paat-Ahi et al., 2014; Bartkowski, 2012). In this way, hospitals might gain better control of revenues if they focused on greater uniformity in

physician treatment behavior. One previous DRG study (Feyrer et al., 2005) recommended that hospitals implement clinical pathways, which are time-orientated treatment regimens, to standardize LOS and medical resources used by physicians. Established by interdisciplinary medical teams focusing on the treatment of certain diseases, these regimens can help reduce unnecessary examinations and reduce medical costs (Feyrer et al., 2005), though care should be taken to avoid the possibility of certain physician-related negative responses to DRG, including modifying codes for greater profit, targeting patients with less severe disease, or increasing patient readmission rates (Fourie et al., 2014). While one study reported improvements physician job satisfaction of physicians and patient care in Switzerland a year after DRG was implemented, follow up studies on patients health status over the long term may be needed (Fässler et al., 2015).

DRG systems are used by Taiwan's National Health Insurance Administration (NHIA) to transfer the responsibility of reducing medical costs to the hospitals and physicians. This study found medical costs were slightly but significantly reduced ($p < 0.01$) post-DRG (Figure 2), indicating that physicians can effectively manage medical costs to some extent. Medical claims were also slightly reduced ($p< 0.001$). Revenue of the hospitals also slightly increased from 11646.24 ± 5278.40 pre-DRG to 12812.66 ± 4643.88 post-DRG, suggesting that the DRG was mutually beneficial to both the NHI and hospitals. Although the increase in revenue was statistically nonsignificant, the effect of DRG on medical costs merits ongoing observation. The model used in this study can be applied to analyze various DRG expense categories.

This study has several limitations. One limitation is that, although our investigation of TURP patients from the same regional hospital enabled us to focus on physician differences, our results may not be extrapolated to larger populations in other regions or to different level hospitals (e.g., medical centers). Another limitation is that BPH can be treated using other advanced surgical methods such as laser surgery (Michalak, 2015). We did not include the treatment in our study because only TURP is covered by the Tw-DRGs system. Therefore, medical costs regarding laser surgery were not discussed. Still this study is performed to assess the effect of DRG on one treatment, not on the effect of kinds of treatments used.

In conclusion, the implementation of DGR system significantly reduced medical costs especially laboratory and radiation fees. Some physicians change treatment behavior in response to the new system while others did not, suggesting that physician behavior may be targeted for further reductions in medical costs in the reimbursement system as a whole.

References

Bartkowski, R., (2012) Length of hospital stay due to DRG reimbursement. Ther Umsch, 69, 15-21.

Bystrov, V., Staszewska-Bystrova, A., Rutkowski, D., Hermanowski, T.(2015) Effects of DRG-based

hospital payment in Poland on treatment of patients with stroke. Health Policy, 119, 1119-1125.

Cheng, S.H., Chen, C.C., Tsai, S.L. (2012) The impacts of DRG-based payments on health care provider behaviors under a universal coverage system: a population-based study. Health Policy, 107, 202-208.

Fässler, M., Wild, V., Clarinval, C., Tschopp, A., Faehnrich, J.A., Biller-Andorno, N. (2015) Impact of the DRG-based reimbursement system on patient care and professional practice: perspectives of Swiss hospital physicians. Swiss Med Wkly, 145, w14080.

Feyrer, R., Rösch, J., Weyand, M., Kunzmann, U. (2005) Cost unit accounting based on a clinical pathway: a practical tool for DRG implementation. Thorac Cardio vasc Surg, 53, 261-266.

Fourie, C., Biller-Andorno, N., Wild, V. (2014) Systematically Evaluating the Impact of Diagnosis-Related Groups (DRGs) on Health Care Delivery: AMatrix of Ethical Implications. Health Policy, 115, 157–164.

Geissler, A., Scheller-Kreinsen, D., Quentin, W., EuroDRG group.(2012) Do diagnosis-related groups appropriately explain variations in costs and length of stay of hip replacement? A comparative assessment of DRG systems across 10 European countries. Health Econ, 21 (Suppl 2), 103-115.

Guterman, S. & Dobson, A. (1986) Impact of the Medicare prospective payment system for hospitals. Health Care Financing Review, 7, 97-114.

Horn, S.D. (1983) Measuring severity of illness: comparisons across institutions. Am J Public Health, 73, 25-31.

Jones, K.R. (1985) Predicting hospital charge and stay variation. The role of patient teaching status, controlling for diagnosis-related group, demographic characteristics, and severity of illness. Med Care, 23, 220-235.

Kim, H., Jung, I.M., Yun, K.W., Heo, S.C., Ahn, Y.J., Hwang, K.T., et al (2015) Earlyoutcome of the Korean Diagnosis-Related Groups payment system for appendectomy. Ann Surg Treat Res, 88, 126-132.

Kim, S.J., Han, K.T., Kim, W., Kim, S.J., Park, E.C. (2017) Early Impact on Outpatients of Mandatory Adoption of the Diagnosis-Related group-Based Reimbursement Syst em in Korea on Use of Outpatient Care: Differences in Medical Utilization and Presurgery Examination. Health Serv Res, doi: 10.1111/1475-6773.12749.

Lin, H.C., Kao, S., Tang, C.H., Yang, M.C., Lee, H.S. (2006) Factors contributing to patient dumping in Taiwan. Health Policy, 77, 103-112.

Lu, M., Sajobi, T., Lucyk, K., Lorenzetti, D., Quan, H. (2015) Sys-

tematic review of risk adjustment models of hospital length of stay (LOS). Med Care, 53, 355-365.

Michalak, J., Tzou, D., Funk, J. (2015) HoLEP: the gold standard for the surgical management of BPH in the 21stCentury. Am J Clin Exp Urol, 3, 36-42.

Muñoz, E., Soldano, R., Gross, H., Chalfin, D., Mulloy, K., Wise, L. (1988) Diagnosis related groups and the transfer of general surgical patients between hospitals. Arch Surg, 123, 68-71.

Nickel, J.C., Méndez-Probst, C.E., Whelan, T.F., Paterson, R.F., Razvi, H. (2010) Guidelines for the management of benign prostatic hyperplasia. Can Urol Assoc J, 4, 310-316.

Paat-Ahi, G., Aaviksoo, A., Świderek, M. (2014) Cholecystectomy and Diagnosis-Related Groups (DRGs): patient classification and hospital reimbursement in 11 European countries. Int J Health Policy Manag, 3, 383–391.

Quentin, W., Geissler, A., Scheller-Kreinsen, D., Busse, R. (2011) Understanding DRGs and DRG-based hospital payment in Europe. In: Busse R, Geissler A, Quentin W, Wiley M (eds.) Diagnosis-Related Groups in Europe: Moving towards transparency, efficiency and quality in hospitals. Buckingham: Open University Press and WHO Regional Office for Europe.

Schuetz, P., Albrich, W.C., Suter, I., Hug, B.L., Christ-Crain, M., Holler, T., et al (2011). Quality of care delivered by fee-for-service and DRG hospitals in Switzerland in patients with community-acquired pneumonia. Swiss Med Wkly, 141:w13228.

Street, A., Kobel, C., Renaud, T., Thuilliez, J. EuroDRG group (2012) How well do diagnosis-related groups explain variations in costs or length of stay among patients and across hospitals? Methods for analysing routine patient data. Health Econ, 21(Suppl 2): 6–18.

Tai, S., Xu, L., Zhang, L., Fan, S., Liang, C. (2015) Preoperative risk factors of postoperative delirium after transurethral prostatectomy for benign prostatic hyperplasia. Int J Clin Exp Med, 8, 4569-4574.

Van Rhee, J., Ritchie, J., Eward, A.M. (2002) Resource use by physician assistant services versus teaching services. JAAPA, 15, 33-38, 40, 42.

Yan, Y.H., Chen, Y., Kung, C.M., Peng, L.J. (2011) Continuous quality improvement of nursing care: case study of a clinical pathway revision for cardiac catheterization. J Nurs Res, 19, 181-189.

Yoo, R.N., Chung, C.W., Kim, J.W. (2014) Evaluating the efficacy of the current diagnosis-related group reimbursement system for laparoscopic appendectomy at a single institute in Korea. Annals of Surgical Treatment and Research, 87, 148-155.

Table 1: Characteristics of cases with treatment of TURP in our study (n=180)

Variable	Pre-DRG			Post-DRG				total
	2007	2008	2009	2010	2011	2012	2013	
Number of patients	22	24	17	40	33	23	21	180
Tw-DRGs code number [a]								
336	5	4	0	9	6	4	6	34
	22.7%	16.7%	0.0%	22.5%	18.2%	17.4%	28.6%	18.9%
337	17	20	17	31	27	19	15	146
	77.3%	83.3%	100.0%	77.5%	81.8%	82.6%	71.4%	81.1%
Cases of physician								
Physician A	10	9	4	8	3	6	4	44
	45.5%	37.5%	23.5%	20.0%	9.1%	26.1%	19.0%	24.4%
Physician B	4	3	2	1	1	1	0	12
	18.2%	12.5%	11.8%	2.5%	3.0%	4.3%	0.0%	6.7%
Physician C	0	5	8	17	22	12	9	73
	0.0%	20.8%	47.1%	42.5%	66.7%	52.2%	42.9%	40.6%
Physician D	8	7	3	14	7	4	8	51
	36.4%	29.2%	17.6%	35.0%	21.2%	17.4%	38.1%	28.3%
Medical costs	38153.05 ±5713.43	38825.67 ±5290.99	36145.00± 4224.94	35183.15± 4077.55	37154.52 ±6030.88	34246.39 ±3976.83	35371.19 ±4134.00	36386.31 ±5032.77
Medical claims	49359.00 ±0.00	49359.00 ±0.00	49932.18± 147.704	49067.03± 1171.02	48256.55 ±1043.81	47618.22 ±1048.86	48219.14 ±1249.39	48790.72 ±1138.63
Revenue	11205.95 ±5713.43	10533.33 ±5290.99	13787.18± 4228.74	13883.88± 4266.93	11102.03 ±5576.48	13371.83 ±3772.71	12847.95 ±4084.27	12404.41 ±4892.55
LOS	4.23 ±0.97	4.50 ±1.14	3.82 ±0.88	3.78 ±1.21	3.82 ±0.98	3.87 ±0.87	4.14 ±0.96	3.99 ±1.05

a Tw-DRG 336: transurethral prostatectomy with complication
Tw-DRG 337: transurethral prostatectomy without complication

Table 2: Comparison of patient age, medical costs, medical claims and LOS between pre- and post-DRG

		Total n(63/117)	Physician A n (23/21)	Physician B n (9/3)	Physician C n (13/60)	Physician D n (18/33)	Pre-DRG p value	Post-DRG p value
patient age	Pre-DRG	68.90 ± 8.09	66.48 ± 5.88	70.33 ±7.09	74.23 ± 8.32	67.44 ± 9.39	a A<C	a A<C
	Post-DRG	69.03 ± 8.34	64.19 ± 5.60	70.67 ±8.14	70.05 ± 9.02	70.12 ± 7.73		
Medical costs	Pre-DRG	37867.43± 5219.77 b	38531.61± 4992.35	37061.67 ±5771.89	36233.62 ± 5212.33	38601.61 ± 5357.80		
	Post-DRG	35588.78± 4763.34	36437.19± 4252.42	37753.33 ±4066.21	34866.82 ± 5436.56	36164.76 ± 3631.62		
Medical	Pre-DRG	49513.67± 267.21 c	49464.91± 236.02 c	49494.33 ±268.54 c	49686.92 ± 315.99 c	49460.50 ± 233.54 c		
Claims	Post-DRG	48401.44± 1235.21	48309.67± 1288.59	47768.33 ±677.51	48378.48 ± 1242.41	48559.12 ± 1244.45		
revenue	Pre-DRG	11646.24± 5278.40	10933.30± 5076.60	12432.67 ±5808.29	13453.31 ± 5322.00	10858.89 ± 5312.52		
	Post-DRG	12812.66± 4643.88	11872.48± 3957.09	10015.00 ±3393.86	13511.67 ± 5180.54	12394.36 ± 3971.89		
LOS	Pre-DRG	4.22 ± 1.04 a	4.48 ± 0.67	3.56 ±1.01	3.46 ± 0.97	4.78 ± 1.06	c C<A,D	c C<A,D
	Post-DRG	3.87 ± 1.04	4.48 ± 0.68	3.33 ±0.58	3.38 ± 0.92	4.42 ± 1.00	B<D	

a $p<0.05$, b $p<0.01$, c $p<0.001$

Table 3: Comparison of pre- and post-DRG medical expenses.

		Total n(63/117)	Physician A n (23/21)	Physician B n (9/3)	Physician C n (13/60)	Physician D n (18/33)	Pre-DRG p value	Post-DRG p value
Physician examination	Pre-DRG	1478.06 ±316.45	1519.04 ± 191.81	1245.33 ± 287.62	1339.62 ±359.89	1642.06 ± 336.43	b B,C<D	c C<A,D
	Post-DRG	1480.13 ±344.62	1655.67 ± 237.70	1256.67 ± 167.43	1343.65 ±336.29	1636.88 ± 315.87		
Ward	Pre-DRG	4313.78 ±1045.31	4561.39 ± 674.41	3591.11 ± 1036.06	3598.62 ±950.22	4875.22 ± 1081.49	c B,C<A,D	c C<A,D
	Post-DRG	4049.90 ±1086.15	4682.10 ± 710.90	3486.67 ± 603.91	3538.97 ±964.69	4627.76 ± 1046.99		
Laboratory	Pre-DRG	4579.24 ±1583.18 c	5339.57 ± 1945.99	4056.89 ± 762.09	3683.08 ±1034.30	4516.11 ± 1291.19	a C<A	c B,C< A C<D
	Post-DRG	3670.09 ±1113.17	4654.57 ± 471.89	3014.33 ± 568.01	3154.45 ±997.24	4040.73 ± 1087.40		
Radiation	Pre-DRG	336.51 ±189.48 c	356.52 ± 170.10 b	400.00 ± 141.42	123.08 ±130.10	433.33 ± 157.18 a	c C<A.B,D	c C<A,D A<D
	Post-DRG	152.14 ±177.43	171.43 ± 192.73	200.00 ± 200.00	53.33 ±89.19	315.15 ± 166.06		
Treatment	Pre-DRG	1154.79 ±583.53 a	1030.70 ± 388.52	902.56 ± 397.52	1665.62 ±868.20 b	1070.56 ± 422.52	b A.B,D <C	-
	Post-DRG	979.57 ±543.15	995.43 ± 344.49	840.00 ± 390.51	1071.38 ±622.01	815.24 ± 476.18		
Operation	Pre-DRG	20670.38 ±3660.16	20293.17 ± 4139.80	22010.56± 3308.32	19795.46 ±2444.70	21114.17 ± 3920.94	-	-
	Post-DRG	19906.36 ±2949.28	18870.05 ± 3099.76	23040.00± 2450.66	20142.55 ±3001.82	19851.52 ± 2608.37		
Blood	Pre-DRG	327.46 ±542.97	190.00 ± 300.95	300.00 ± 427.20	753.08 ±914.67	209.44 ± 319.86	a A,D<C	-
	Post-DRG	446.32 ±1259.53	209.05 ± 345.22	456.67 ± 617.77	667.50 ±1704.98	194.24 ± 313.83		
Anesthesia	Pre-DRG	2656.43 ±567.16	2550.00 ± 0.00	2866.67 ± 950.00	2821.15 ±977.66	2568.33 ± 77.78	-	-
	Post-DRG	2871.92 ±1005.79	2687.14 ± 557.51	3500.00 ± 1645.45	2979.50 ±1234.66	2736.82 ± 627.01		
Special material	Pre-DRG	267.71 ±134.87 b	284.09 ± 151.38 a	204.44 ± 72.94	269.85 ±100.24	276.89 ± 156.57	-	-
	Post-DRG	204.96 ±120.62	202.76 ± 87.80	178.33 ± 79.74	206.15 ±140.61	206.61 ± 104.88		
Drug	Pre-DRG	1805.49 ±777.41	2102.96 ± 744.47	1253.89 ± 431.72	1933.54 ±675.62 a	1608.72 ± 861.77	a B<A	-
	Post-DRG	1573.37 ±1073.75	2010.57 ± 1589.25	1562.67 ± 111.01	1479.53 ±612.99	1466.73 ± 1324.21		

a p<0.05, b p<0.01, c p<0.001

Table 4: Stepwise regression analysis for the dependent variables of the medical costs, medical claims revenue and LOS (n = 180)

Independent variable	β	standard error	Standardized β	R2	R2 change	t	p
Medical costs model							
Constant	40146.079	1322.444				30.36	<0.001
Post-DRG(vs. Pre-DRG)	-2278.651	769.957	-0.217	0.047	0.047	-2.96	0.004
Medical Claims model							
Constant	49240.351	87.326				563.87	<0.001
DRG 336(vs. DRG 337)	1913.208	129.477	0.660	0.377	0.377	14.78	<0.001
Post-DRG(vs. Pre-DRG)	-1247.720	106.254	-0.524	0.650	0.273	-11.74	<0.001
Revenue							
Constant	22237.279	1225.960					
Length of stay	-2461.636	296.903	-0.528	0.279	0.279	-8.29	<0.001
LOS model							
Constant	3.412	0.097				35.09	<0.001
Physician D (vs. Physician C)	1.137	0.159	0.490	0.111	0.111	7.16	<0.001
Physician A(vs. Physician C)	1.066	0.166	0.438	0.278	0.167	6.40	<0.001

Figure 1. Comparison for reimbursement system for TURP before and after DRG in Taiwan

	Pre-DRG	Post-DRG
No change	Reimbursement fees set for various services	Reimbursement fees set for various services
Changes	Basic services to be rendered the patient set by BNHI. Three-level reimbursement system: Costs below a certain level: fee-for-service. Middle range of costs: bundled payment, if at least 65% of the services were rendered. Costs above a certain level: fee-for-service until the hospital exceeds a specified ratio of cases, at which point hospitals receive bundled payment for remaining cases. Fees set regardless of the presence or absence of complications	Services rendered decided by physicians. Three-level reimbursement system: Costs below a certain level: fee-for-service. Middle range of costs: bundled payment. Costs above a certain level: bundled payment until services and fees exceed a certain limit. Thereafter, fee-for-service reimbursed at lower rate. Fees set based on presence (DRG 336) or absence (DRG 337) of complications.

BNHI = Bureau of National Health Insurance

Figure 2. Pre-DRG vs. post-DRG medical costs, medical claims, revenues, and LOS.