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Evaluation of the inclusive payment system based on the diagnosis procedure combination with respect to cataract operations in Japan

------A comparison of lengths of hospital stay and medical payments among hospitals

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ABSTRACT

Following the recommendations of a report submitted by the Central Social Insurance Medical Council concerning the 2002 revision of the Medical Service Fee Schedule, a new inclusive payment system, which is based on the Diagnosis Procedure Combination (DPC) system, was introduced in 82 special functioning hospitals in Japan, effective beginning in April 2003. Since April 2004, the system has been gradually extended to general hospitals that satisfy certain prerequisites. In this paper, the new inclusive payment system is analyzed. Data pertaining to 1,225 patients, who were hospitalized for cataract diseases and underwent lens operations from July 2004 to September 2005, are used. The lengths of hospital stay and medical payments among hospitals are compared. Even after eliminating the influence of patient characteristics, there are large differences among hospitals in average lengths of hospital stay and DPC-based inclusive payments. The highest average inclusive payment is 3.5 times as high as the lowest payment. On the other hand, there are relatively small differences in non-inclusive payments based on the conventional fee-for-service system—the largest deviation from the average of all hospitals is approximately 10%. Thus, although payments based on the DPC account for only one-third of the total medical payments for this disease, the major differences in medical payments among hospitals are caused by differences in their DPC-based inclusive payments. The results of the study strongly suggest that revisions of the payment system in Japan are necessary for the efficient use of medical resources in the future.

Keywords: DPC; Inclusive Payment System; Cataract; Lens Operation; Length of Hospital Stay

1. INTRODUCTION

Lengthy hospitalization is one of the characteristics of the Japanese health care system. The average length of stay of a patient in 2005 was 10.2 days in Germany, 13.4 days in France, 7 days in the U.K., and 6.5 days in the U.S; however, in Japan it was nearly 20 days [1]. With the rapid increase in medical care expenses, decreasing the average length of stay in hospitals by reducing the number of instances of long-term hospitalization has become an important political issue in Japan.

Following the recommendations of a report submitted by the Central Social Insurance Medical Council concerning the 2002 revision of the Medical Service Fee Schedule, a new case-mix payment system [2] was introduced in 82 special functioning hospitals (i.e., university hospitals, the National Cancer Center, and the National Cardiovascular Center) in Japan, effective beginning in April 2003. Since April 2004, the system has been gradually extended to general hospitals that satisfy certain prerequisites. It was the largest and most important revision of the payment system since the Second World War. Under the new payment system, the medical payments are comprised of inclusive payments based on the Diagnosis Procedure Combination (DPC) system and non-inclusive payments based on the conventional fee-for-service system. In this paper, the new payment system is referred as the DPC-based inclusive payment system, since this is the more commonly used description [3].

The DPC system is unique to Japan. It allows the classification of diseases, operations, treatments, and patient conditions using a 14-digit code. The first 6 digits classify principal diseases on the basis of the International Classification of Diseases-10 (ICD-10)[1]. The remaining digits pertain to information on operations, treatments, and patient conditions such as the presence of a secondary disease. Initially, the DPC system classified patients into 1,860 categories[2]. Currently, the number of categories is 1,572. Inclusive payments based on the DPC system cover fees for the following six categories only: basic hospital stays, medical checkups, image diagnosis, medication, injections, treatments under 1,000 points[3], and medicines used during rehabilitation treatments and related activities. Fees for all other categories, such as fees for operations, are paid on the basis of the conventional fee-for-service system.

Unlike the Diagnosis-Related Group/Prospective Payment System (DRG/PPS) used in the U.S and other countries [4,5,6,7,8,9,10] the Japanese DPC-based payment system is a per diem prospective payment system. More specifically, three periods are established according to which per diem payment is applied, Period I, Period II, or Specific Hospitalization Period, which is determined for each DPC code. Period I is set as the 25th percentile of the length of hospital stay of the hospitals. Period II is set as the average length of hospital stay, that is, the 50th percentile (although this value is actually the median, it is called the "average length of hospital stay" in the DPC-based inclusive payment system). Finally, the Specific Hospitalization Period is given by the following equation: (average length of hospital stay) + 2 × (standard deviation).

The basic per diem payment is determined according to the length of hospital stay. For stays below Period I, the per diem payment to hospitals is 15% more than the average per diem payment of the patients whose stays were within the average length of hospital stay. For hospital stays between Periods I and II, the per diem payment is determined such that (per diem payment in the Period I – average per diem payments)× (number of days in Period I) equals (the average per diem payments – per diem payment between Periods I and II) × (number of days between Periods I and II). For stays between Period II and the Specific Hospitalization Period, the per diem payment is reduced by an additional 15%. Finally, for stays above the Specific Hospitalization Period, the per diem payment is determined through the conventional fee-for-service system. Note that the periods and per diem inclusive payments are affected by the conditions of a patient, such as the presence of a secondary disease. Furthermore, for each hospital, the actual payment amount is determined by multiplying the basic payment by the individual hospital coefficient, which is the sum of a basic coefficient and an adjustment coefficient. The adjustment coefficient is determined such that the hospital's revenue does not become less than that of the previous year. This is an incentive for hospitals to adhere to the new payment system. Since the system was introduced only recently, thorough evaluations of the system have yet to be performed. Empirical studies based on data pertaining to the length of hospital stay and medical payment amounts for a wide range of hospitals are necessary for an accurate evaluation of the system. Moreover, for a thorough analysis, a simple comparison among hospitals in terms of the average length of stay is not sufficient, and differences in the types of diseases for which the patients are hospitalized should also be considered. For each disease, individual patient characteristics and treatment types must also be taken into account.

One of the major purposes of the DPC-based payment system is to reduce the long-term hospitalization cost by standardizing the medical payments so that the payments become the same amount for identical treatments, regardless of the hospital that provides them. This means that if the system works properly, the differences in the inclusive payment amounts become smaller than those of the non-inclusive payment amounts among different hospitals. In this study, this hypothesis is evaluated for cataract operations (DPC category code: 020110). Lengths of hospital stay and medical payments among hospitals are compared. The number of cataract patients in Japan has been increasing rapidly with the ageing of the population. According to a survey conducted by the Ministry of Health, Labour and Welfare, the number of cataract operations in June 2006 was 61,383 [11]. Thus, it is estimated that nearly 800,000 cataract operations are performed annually and nearly 2.5 billion yen are spent for cataract operations. The overall difficulty level of surgical and treatment procedures for cataracts is not high, owing to their standardization, and the outcomes are generally predictable. Moreover, most cataract operations are scheduled in advance, and the possibility of postoperative infections or complications is very low. Fedorowicz, Lawrence and Guttie [12] found no significant difference in outcome or risk of postoperative complications between day care and inpatient cataract surgeries. Thus cataract cases are considered to be the most suitable candidate for evaluating the various aspects of the DPC-based payment system. To accomplish this, data pertaining to 1,225 patients, who were hospitalized for cataracts or related diseases and underwent a lens operation on one eye, are used.

Table 1. Average medical payments by hospital (in points).

Hospital	Total Payment		Inclusive Payment		Non-inclusive Payment		Number of Patients
	Mean	S.D.*	Mean	S.D.	Mean	S.D.	
Hp1	25,058	3,996	10,482	2,596	14,576	2,431	60
Hp2	25,602	3,981	9,669	2,711	15,933	1,963	177
Hp3	28,492	3,309	12,808	2,789	15,684	1,313	94
Hp4	29,020	3,817	11,694	2,455	17,326	2,419	41
Hp5	25,799	1,206	11,529	1,173	14,270	109	8
Hp6	25,397	3,249	11,504	3,201	13,893	395	9
Hp7	22,617	699	7,702	88	14,914	680	111
Hp8	22,782	1,131	7,638	0	15,144	1,131	28
Hp9	21,171	5,753	4,837	1,510	16,334	4,591	78
Hp10	26,581	2,674	9,829	2,348	16,751	987	88
Hp11	24,163	7,483	8,768	6,025	15,395	1,983	25
Hp12	19,191	2,400	3,813	2,181	15,377	541	226
Hp13	29,892	2,285	15,467	1,847	14,425	783	41
Hp14	20,439	2,670	5,625	2,557	14,814	463	24
Hp15	29,073	3,408	13,311	2,833	15,762	1,497	67
Hp16	25,065	1,834	9,488	1,600	15,577	815	148
All	24,320	4,664	8,716	3,983	15,604	1,851	1,225

*: Standard Deviation.

2. DATA

2.1. Surveyed Hospitals

In this paper, data collected from 16 general hospitals (denoted as Hp1–Hp16) in Japan are used. The data were originally collected by the DPC Hospital Conference in Japan from July 2004 to September 2005 and include the following details for each patient: DPC code, dates of hospitalization and discharge from the hospital, date of birth, sex, placement after hospitalization, principal disease classification (ICD-10 code for the principal disease for which the patient was hospitalized), purpose of hospitalization, presence of secondary disease and the attending treatment if any, and medical payment amounts (including DPC-based, fee-for-service, and total payments). Since the same data officially submitted to the Ministry of Health, Labour and Welfare are used, the reliability of data is considered to be very high.

In our study, the data pertaining to patients classified under the DPC category code 020110 (ICD-10 code: H25.0-H26.9) are analyzed. These patients were hospitalized for cataract diseases and underwent lens operations. Furthermore, unlike in other countries, hospitals in Japan perform two-eye operations (where both eyes of the patient are operated on in a single period of hospitalization) in addition to one-eye operations (where only one eye of the patient is operated on in a single period of hospitalization). It is evident that the two-eye operation will require a patient to remain hospitalized for a longer period of time than that required following a one-eye operation. Therefore, we utilize data strictly pertaining to those patients who underwent cataract operations and insertion of prosthetic lens on one eye only (DPC codes: 0201103x01x000, 0201103x01x010, and 0201103x01x1x0)[4]. The number of patients included in our data set is 1,225.

2.2. Medical Payments

The average total payment per patient is 24,320 points (i.e., 243,200 yen). Of the total points, inclusive payments based on the DPC system (hereafter referred to simply as "inclusive payments") account for 8,716 points and non-inclusive payments based on the conventional fee-for-service system (hereafter referred to simply as "non-inclusive payments") account for the remainder, that is, 15,604 points (note that pre-adjustment values are used for the inclusive payments). Thus, the share of inclusive payments is 35.8%, or approximately one-third of the total payment.

Table 1 shows the medical payment amount per patient for Hp1–Hp16. Although in general the share of inclusive payments is approximately one-third of the total payment amount, its dispersion is rather large. For all patients, the standard deviation for non-inclusive payments is 1,851 points. On the other hand, the standard deviation for inclusive payments is 3,983 points, which is significantly higher than that in the case of non-inclusive payments. The coefficient of variation (= standard deviation/mean) of inclusive and non-inclusive payments is 45.7% and 11.7%, respectively. As is evident, the former is four times larger than the latter. Furthermore, the maximum and minimum average payments are, respectively, equivalent to 3,813 (Hp12) and 15,467 (Hp13) points for the inclusive payments and 13,893 (Hp6) and 16,751 (Hp10) points for the non-inclusive payments. Thus, the range is 11,254 points for the inclusive payments and 2,852 points for the non-inclusive payments. These facts suggest that variations in the inclusive payment amounts are the main cause of the differences in the medical payment amount per patient.

2.3. Medical Payments and Lengths of Hospital Stay

As expected, there exists a strong linear relationship between length of hospital stay (in number of days) and the inclusive payment amount. The correlation coefficient is particularly high at 0.9932 for the patients who were hospitalized for 10 days or less. This implies that for this period, almost all inclusive payment amounts are determined by the length of hospital stay (note that if the length of hospital stay is more than 10 days, the payment amounts in some cases are determined through the fee-for-service system). From the above, it is clear that a strong relationship exists between the length of hospital stay and the total amount of payment (with a correlation coefficient of 0.9101) and that the total payment amount increases as the length of hospital stay becomes longer. This, however, does not hold true for non-inclusive payments, which increase little as the length of hospital stay becomes longer (with a correlation coefficient of 0.1742).

The per diem inclusive payment is affected by various factors such as hospitalization period, the presence of a secondary disease, and the individual hospital coefficient. As a result, even if two patients undergo identical operations and treatments at two different hospitals, their payment amounts will differ. Since the length of hospital stay is an important factor in the inclusive payment amount determined for a patient, we analyze the length of hospital stay rather than the inclusive payment amount.

Table 2 shows the distribution of the average lengths of stay by hospital. Large differences can be seen among the hospitals. Hp12 has the shortest length of hospital stay, with an average of only 1.50 days, while the length of hospital stay was the longest in Hp 13, with an average of 7.22 days, which is 5.72 days longer than that of Hp12. Two hospitals, Hp7 and Hp8, have a standard deviation of zero, that is, all the patients at these hospitals were hospitalized for exactly three days during the survey period. This reflects the fact that the length of hospital stay at these hospitals is determined by the hospital's clinical paths. Finally, the skewness and kurtosis values are large for some of the hospitals. In other words, the distributions for these hospitals are different from the normal distribution: the large skewness and kurtosis values for certain hospitals imply that some patients remained in the hospital for a long period of time.

Table 2. Lengths of stay by hospital (in days).

Hospital	Mean	S/D.*	Skewness	Kurtosis**
Hp1	4.47	1.47	3.57	14.29
Hp2	4.09	1.40	1.20	3.78
Hp3	5.64	1.38	-0.47	4.68
Hp4	5.07	1.46	3.19	13.42
Hp5	5.00	0.53	0.00	3.50
Hp6	4.89	1.62	0.68	0.28
Hp7	3.00	0.00	-	-
Hp8	3.00	0.00	-	-
Hp9	1.88	0.58	0.01	-0.04
Hp10	4.20	1.42	3.41	18.21
Hp11	4.16	3.87	2.02	4.81
Hp12	1.50	0.85	1.16	-0.60
Hp13	7.22	1.13	1.62	3.55
Hp14	2.21	1.02	-0.19	-1.65
Hp15	5.99	1.64	1.20	4.21
Hp16	3.85	0.79	1.84	12.88
All	3.68	1.96	1.06	3.21

*: Standard Deviation.
**: The kurtosis value is set as 0 for the normal distribution.

3. MODELS

3.1. Length of Hospital Stay

The length of hospital stay is a discrete-type variable taking positive integers (1,2,3,…). Moreover, the skewness and kurtosis values for some of the hospitals are large. Therefore, the use of ordinary methods such as the least-squares method would not be suitable for analyzing the length of hospital stay (the results of the least -squares estimation are available from the authors upon request). Therefore, the length of hospital stay is analyzed by applying the model of Nawata *et al*. [13] to hospital profits.

First, let us consider the procedure that hospitals use to decide when to discharge patients, which determines the length of hospital stay. For cataract operations, the length of hospital stay is typically short. Therefore, we assume that the hospital can decide when to discharge the patient. However, the hospital must also consider its reputation, which can be affected by the length of hospital stay. A hospital's reputation has asset value because it can affect the hospital's revenue; for example, a highly reputed hospital would be the first choice for people when they become ill.

Suppose that the revenue and cost of the hospital are given by

$$b_i = b(t, x_{1i}, u_{1i}) \text{ and } c_i = c(t, x_{2i}, u_{2i}), \quad \textbf{(1)}$$

where x_{1i} and x_{2i} are vectors of explanatory variables affecting the hospital's revenue and cost, respectively. The revenue includes not only direct monetary payments but also improvements in its asset value owing to high-quality medical services, and the cost also includes an opportunity cost arising from the loss of revenue that the hospital suffers because of the unavailability of beds for new patients.

Next, let

$$g(t, x_i, u_{1i}, u_{2i}) = \frac{\partial c_i}{\partial t} - \frac{\partial b_i}{\partial t} \quad \textbf{(2)}$$

where x_i is a vector of the explanatory variables contained in x_{1i}, and x_{2i} Moreover, $g(t)$ is assumed to be an increasing function of t. This is because if $g(t)$ is not an increasing function of t, it implies that the patient never leaves the hospital. While this may be applicable for patients with fatal diseases such as heart disease, brain disease, and cancer, cataract patients rarely have prolonged hospital stays. Therefore, for the cases included in our data set, we can reasonably assume that all the patients left the hospital at some point. We assume that

$$z_i(t) \equiv g(t, x_i, v_i) = \alpha_1 t^{\alpha_2} - (x_i'\beta + v_i) \quad \textbf{(3)}$$

where a_1, $a_2 \geqslant 0$ and $v_i = h(u_{1i}, u_{2i})$.

Since the model is the same if we put $z_i(t) = \alpha_1^* \{(t^{\alpha_2} - 1)/\alpha_2\} - (x_i'\beta^* + v_i)$, it is considered as the Box-Cox transformation [14] of t, which is widely used in various fields. Here, v_i is an error term that follows the standard normal distribution. We have made the term $(x_i'\beta + v_i)$ negative so that the length of hospital stay increases as the value of $x_i'\beta$ becomes larger. Further, to remove the influence of a small number of patients who remained in the hospital over a long period of time, we limit the maximum number of days that patients could stay at the hospital to T. For patients staying more than T days, we just use the information such that they stay in the hospital more than T days.

The length of hospital stay is a discrete variable taking positive integers. Therefore, the condition for the i-th patient to leave the hospital on the t_i-th day is given by

$$\begin{aligned} &z_i(t_i) \geq 0, \text{if } t_i = 1 \\ &z_i(t_i - 1) < 0, z_i(t_i) \geq 0, \text{if } t_i > 1 \end{aligned} \quad \textbf{(4)}$$

Note that if the error term follows a normal distribution, the probability of a patient leaving the hospital becomes positive for any positive t. To maintain consistency in the model, we treat $z_i(t_i) \geqslant 0$ if $t_i=1$. Thus, the probability of the i-th patient leaving the hospital on the t_i-th day ($t_i \leqslant \boldsymbol{T}$) is given by

$$P_i = \begin{cases} P[\alpha_1 (t_i)^{\alpha_2} - x_i'\beta \geq v_i], t_i = 1 \\ P[\alpha_1 (t_i - 1)^{\alpha_2} - x_i'\beta < v_i \leq \alpha_1 t_i^{\alpha_2} - x_i'\beta], 1 < t_i \leq T \end{cases} \quad \textbf{(5)}$$

Let Φ be a distribution function of the standard normal distribution. Then,

$$P_i = \begin{cases} \Phi(\alpha_1 t_i^{\alpha_2} - x_i'\beta), t_i = 1 \\ \Phi(\alpha_1 t_i^{\alpha_2} - x_i'\beta) - \Phi[\alpha_1 (t_i - 1)^{\alpha_2} - x_i'\beta], 1 < t_i \leq T \end{cases} \quad \textbf{(6)}$$

The probability of the i-th patient staying in the hospital for a period longer than T_0+T is given by

$$P[\alpha_1 T^{\alpha_2} - (x_i'\beta + v_i) < 0] = 1 - \Phi(\alpha_1 T^{\alpha_2} - x_i'\beta) \quad \textbf{(7)}$$

From **Eq.5–7**, we obtain the following likelihood function:

$$\begin{aligned} L(\alpha_1, \alpha_2, \beta) = &\prod_{t_i = 1} \left[\Phi(\alpha_1 t_i^{\alpha_2} - x_i'\beta) \right] \\ &\times \prod_{1 < t_i \leq T} \left[\Phi(\alpha_1 t_i^{\alpha_2} - x_i'\beta) - \Phi\{\alpha_1 (t_i - 1)^{\alpha_2} - x_i'\beta\} \right] \\ &\times \prod_{t_i > T} \left[1 - \Phi(\alpha_1 T_i^{\alpha_2} - x_i'\beta) \right] \end{aligned} \quad \textbf{(8)}$$

We obtain the maximum likelihood estimator (MLE), $\hat{\alpha}_1, \hat{\alpha}_2$, and $\hat{\beta}$ by maximizing the likelihood function. A program that was specifically developed for this study is employed to estimate the model.

3.2. Non-Inclusive Payments

Let y_i be the non-inclusive payment. Since y_i can be treated as a continuous variable, it is analyzed using the regression model given by

$$y_i = x_i'\gamma + \varepsilon_i \quad \textbf{(9)}$$

As in the previous model, x_i is a vector of explanatory variables affecting the effectiveness of treatment and ε_I is the error term with mean 0 and variance σ_ε^2, respectively.

4. ESTIMATION RESULTS

4.1. Length of Hospital Stay

In this paper, we employ variables that represent 1) the characteristics of patients, 2) the principal disease classification based on ICD-10, and 3) influence of hospitals as explanatory variables. The variables that represented the characteristics of the patient are sex, age, usage of an ambulance, hospital's own outpatient or not, place of hospital stay post-hospitalization, and information about the secondary disease and treatment. The Female dummy (= 1 if the patient was female and 0 if the patient was male) is used to indicate the sex of the patient. The numbers of male and female patients are 518 and 707, respectively. Since the length of hospital stay tends to increase with patient age and the number of young patients under 30 is small, the Below 30 dummy (= 1 if the patient was below 30 years and 0 if otherwise), the Age 30 dummy (= 1 if the patient was between 30 and 40 years of age and 0 if otherwise), and the Age 40 dummy (= 1 if the patient was over 40 years old and 0 if otherwise) are used. The numbers of patents by age in the Age 40 group is further subdivided into 546 in their seventies, 289 in their eighties, and 253 in their sixties. The total number of patients in the Below 30 and Age 30 groups is 13. For the other patient characteristics, the Ambulance dummy (= 1 if the patient used an ambulance and 0 if otherwise), the Own Outpatient dummy (= 1 if the patient is an outpatient of the hospital where they underwent surgery and 0 if otherwise), and the Home dummy (= 1 if the patient returned home post- hospitalization and 0 if otherwise) are used. Since the outpatient care is exempt from the prospective payment, hospitals may choose to shift necessary medical checkups, medication, injections, and treatments to outpatient settings, as happened in the U.S. when prospective payment was introduced into the Medicare program system [15]. This may affect the length of hospital stay. The Own Outpatient dummy evaluates this effect.

For secondary diseases and treatments, we use the Secondary Disease dummy (= 1 if the patient had a secondary disease and 0 if otherwise) and the Secondary Treatment dummy (= 1 if the patient underwent secondary treatment and 0 if otherwise). Although all hospitalizations were planned in advance, five patients used ambulances. A total of 985 patients went directly to the hospital where they were treated, while 240 were referred there by other hospitals. Post-hospitalization, 1,088 patients returned home, whereas 137 went to another hospital or facility. Of the total, 766 patients did not have any secondary diseases and treatments, 499 patients had secondary diseases but did not undergo any secondary treatments, and 10 patients had secondary diseases for which they underwent treatment.

For principal disease classifications, dummy variables based on the H25.0 **(**Senile incipient cataract**)** category are used. For classification, 173 patients had diseases classified under H25.0, 555 had diseases under H25.9 (Senile cataract, unspecified**),** and 382 had diseases under H26.9 (Cataract, unspecified). The number of patients with diseases under other categories is relatively small: 90, 6, and 19 patients with diseases classified under H25.1 (Senile nuclear cataract), H25.2 (Senile cataract, morgagnian type), and H25.8 (Other senile cataract), respectively. Since the average length of hospital stay is the shortest for Hp12, dummy variables based on Hp12 are used to represent the influence of hospitals.

$x_i'\beta$ of **Eq.3**, becomes

$$\begin{aligned} x_i'\beta &= \beta_0 + \beta_1(\text{Female dummy}) + \beta_2(\text{Below30 dummy}) \\ &+\beta_3(\text{Age30 dummy}) + \beta_4(\text{Age40 dummy}) \times (\text{Age-40}) \\ &+\beta_5(\text{Ambulance dummy}) + \beta_6(\text{Own Outpatient dummy}) \\ &+\beta_7(\text{Home dummy}) + \beta_8(\text{SecondaryDisease dummy}) \\ &+\beta_9(\text{SecondaryTreatment dummy}) \\ &+\sum_j \beta_j(j\text{-th Principal Disease dummy}) \\ &+\sum_k \beta_k(k\text{-th Hospital dummy}) \end{aligned} \qquad \textbf{(10)}$$

We select $T = 10$. Note that a total of 7 patients—less than 1% of all patients—stayed at the hospital for more than 10 days.

Table 3 presents the estimates for α and β. The estimate for α_2 is significantly smaller than 1.0, which implies that certain patients remained at the hospital for a long period of time. The estimate for the Female dummy is positive and significant at the 5% level. Moreover, the estimates for the Below 30 dummy, Age 30 dummy, and Age 40 dummy are positive and significant at the 5% level, negative and significant at the 1% level, and positive and significant at the 1% level, respectively. This implies that sex and age affect the length of hospital stay. The estimates for the Ambulance and Own Outpatient dummies are negative but not significant at the 5% level. We could not find an evidence that the length of stay depends on whether the patient is an outpatient of the hospital. The estimate for the Secondary Disease dummy is positive and significant at the 1% level and exerts a strong influence on the length of hospital stay. The estimates for the Secondary Treatment and Home dummies are negative but not significant at the 5% level. None of the estimates for the Principal Disease dummies are significant at the 5% level. In other words, differences in the principal disease that patients suffer from do not significantly affect the length of hospital stay. This may support the suitability of the DPC groups with respect to cataract patients.

All values for the Hospital dummies are positive, with a maximum value of 5.290. This implies that the length

Table 3. Estimation results for length of hospital stay.

Variable	Estimate	Standard Error	t-value
Constant	2.1310	0.6044	3.5256**
Female dummy	0.1588	0.0695	2.2843*
Below 30 dummy	1.4054	0.6979	2.0137*
Age 30 dummy	-1.3652	0.2580	-5.2920**
Age 40 dummy × (Age – 40)	0.0174	0.0037	4.7029**
Ambulance dummy	-0.1051	0.7809	-0.1346
Own Outpatient dummy	-0.0808	0.0914	-0.8842
Secondary Disease dummy	0.3001	0.0769	3.9009**
Secondary Treatment dummy	0.1581	0.4822	0.3279
Home dummy	-0.1173	0.1528	-0.7678
Principal Disease Dummies			
H25.1	0.0286	0.6069	0.0471
H25.2	0.4881	0.6197	0.7875
H25.8	-0.0316	0.5090	-0.0621
H25.9	-0.1577	0.4230	-0.3728
H26.9	-0.0565	0.4167	-0.1356
Hospital Dummies			
Hp1	3.2520	0.4535	7.1709**
Hp2	2.9639	0.1484	19.9733**
Hp3	4.3442	0.1727	25.1563**
Hp4	3.8194	0.2109	18.1121**
Hp5	3.7617	1.3073	2.8775**
Hp6	3.6674	0.3619	10.1326**
Hp7	2.0452	0.4871	4.1983**
Hp8	2.0845	1.2731	1.6373**
Hp9	0.9070	0.1843	4.9222**
Hp10	3.1095	0.4354	7.1414**
Hp11	2.5642	0.1213	21.1454**
Hp13	5.2897	0.4018	13.1664**
Hp14	1.0896	0.4695	2.3208*
Hp15	4.3771	0.4742	9.2311**
Hp16	2.7421	0.1645	16.6733**
α_1	2.9848	0.4021	7.4237**
α_2	0.5245	0.0394	13.3112**
LogL		-1743.192	

*: Significant at the 5% level. **: Significant at the 1% level.

of hospital stay is the shortest for Hp12 even if the influence of factors such as patient characteristics is eliminated. Thus, despite the exclusion of the effects of patient characteristics and treatment types, large differences remain among hospitals.

4.2. Non-Inclusive Payments

The non-inclusive payment variable z_i is estimated by the least-squares method. x_i is chosen such that $x_i'\gamma$ of **Eq.9** becomes

$$\begin{aligned} x_i'\gamma &= \gamma_0 + \gamma_1(\text{Female dummy}) + \gamma_2(\text{Below 30 dummy}) \\ &+\gamma_3(\text{Age30 dummy}) + \gamma_4(\text{Age50 dummy}) \\ &+\gamma_5(\text{Age60 dummy}) + \gamma_6(\text{Age70 dummy}) \\ &+\gamma_7(\text{Age80 dummy}) + \gamma_8(\text{Ambulance dummy}) \\ &+\gamma_9(\text{OwnOutpatient dummy}) + \gamma_{10}(\text{SecondaryDisease dummy}) \\ &+\gamma_{11}(\text{SecondaryTreatment dummy}) + \gamma_{12}(\text{Home dummy}) \\ &+\sum_j \gamma_j(j-\text{th Principal Disease dummy}) \\ &+\sum_k \gamma_k(k-\text{th Hospital dummy}) \end{aligned} \quad \textbf{(11)}$$

Since there is no clear trend with respect to patient age, the dummy variables based on the age 40's (the Age 80 dummy includes all patients over 80 years old) are used. However, with the exception of the variables for age, the definitions of all the variables are the same as those in the previous section.

The estimation results are presented in **Table 4**. The Female dummy is positive but not significant at the 5% level. While the estimate for the Age 30 dummy is negative and significant at the 5% level, the other estimates are not significant. The estimates for the Ambulance, Own Hospital Outpatient, and Secondary Disease dummies are positive but not significant at the 5% level. Again, we could not find an evidence that the hospitals' medical treatments depend on whether the patient is an outpatient of the hospital. The estimate for the Secondary Treatment dummy is positive and significant at the 1% level. In fact, the value of this variable is estimated at 5,999 points, which implies that there is a large increase in the non-inclusive payment amount when secondary treatment is carried out. The estimate of the Home dummy is negative but not significant at the 5% level. With respect to the principal disease classifications, the estimate for the H25.8 dummy is negative and significant at the 5% level, but none of the other estimates is significant at this level. The maximum value for the Hospital dummies is 1,535, while the minimum value is –1,708; thus, the difference between the maximum and minimum values is 3,243. This implies that although there exist significant differences among the hospitals, they are not very large as compared to the estimates for the other variables such as those for secondary treatment.

Table 4. Estimation results for non-inclusive payments.

Variable	Estimate	Standard Error	t-value
Constant	15,340	509	30.1517*
Female dummy	106	94	1.1206
Below 30 dummy	232	805	0.2876
Age 30 dummy	-1,004	508	-1.9776*
Age 50 dummy	-218	459	-0.4750
Age 60 dummy	-229	421	-0.5441
Age 70 dummy	-378	406	-0.9309
Age 80 dummy	-198	417	-0.4749
Ambulance dummy	1,785	2,611	0.6837
Own Outpatient dummy	94	99	0.9479
Secondary Disease dummy	246	128	1.9319
Secondary Treatment dummy	5,999	478	12.5625**
Home dummy	-98	119	-0.8266
Principal Disease Dummies			
H25.1	401	263	1.5252
H25.2	572	441	1.2977
H25.8	783	372	2.1037*
H25.9	172	245	0.7030
H26.9	42	219	0.1924
Hospital Dummies			
Hp1	-684	393	-1.7388
Hp2	554	169	3.2817**
Hp3	232	167	1.3927
Hp4	847	224	3.7858**
Hp5	-1,429	232	-6.1556**
Hp6	-1,708	201	-8.4847**
Hp7	-421	123	-3.4213**
Hp8	-43	340	-0.1276
Hp9	839	520	1.6113
Hp10	1,535	261	5.8827**
Hp11	-507	410	-1.2371
Hp13	-1,237	217	-5.6959**
Hp14	-433	259	-1.6730
Hp15	-28	246	-0.1138
Hp16	-29	131	-0.2222
R2		0.231551	

*: Significant at the 5% level. **: Significant at the 1% level.

5. COMPARISON OF LENGTHS OF HOSPITAL STAY AND MEDICAL PAYMENTS AMONG HOSPITALS

In this section, we compare lengths of hospital stay and non-inclusive payments, taking into consideration patient characteristics and principal disease classifications for each hospital. Let us consider a 70-year-old male patient whose DPC code is 0201103x01x000 (cataract operations and insertion of prosthetic lens, no secondary disease or treatment) and who does not use an ambulance, is an outpatient and returns home after his hospital stay, and has a principal disease classified under the ICD-10 code H25.0. **Table 5** presents the patient's estimated average length of hospital stay, inclusive payment amount, non-inclusive payment amount, and total payment amount at each of the surveyed hospitals. The average length of hospital stay is estimated as 3.99 days for all the hospitals, with a standard deviation of 1.49 days. The shortest length of hospital stay is estimated as 1.41 days in Hp12. On the other hand, the longest average length of hospital stay is estimated as 6.97 days in Hp13,

Table 5. Lengths of hospital stay and medical payments after eliminating the influence of patient characteristics by hospital*

Hospital	Length of Stay(days)	Payments (in points)		
		Inclusive	Non-inclusive	Total
Hp1	4.18	9,808	14,278	24,086
Hp2	3.93	9,332	15,516	24,848
Hp3	5.65	12,523	15,194	27,717
Hp4	4.95	11,243	15,809	27,052
Hp5	4.88	11,123	13,533	24,656
Hp6	4.78	10,949	13,254	24,203
Hp7	2.99	7,374	14,541	21,915
Hp8	2.98	7,339	14,919	22,258
Hp9	2.01	5,085	15,800	20,886
Hp10	4.07	9,587	16,497	26,084
Hp11	3.54	8,525	14,455	22,980
HP12	1.41	3,590	14,962	18,552
Hp13	6.97	14,772	13,725	28,497
Hp14	2.12	5,365	14,529	19,894
Hp15	5.74	12,673	14,934	27,607
Hp16	3.66	8,765	14,933	23,698
All				
Mean	3.99	9,253	14,805	24,058
Standard Deviation	1.49	3,013	869	2,905

*: Considering a 70-year-old male patient whose DPC code is 0201103x01x000 (cataract operations and insertion of prosthetic lens, no secondary disease or treatment) and who does not use an ambulance, is an outpatient and returns home, and has a principal disease classified under the ICD-10 code H25.0.

which is approximately 5 times that of Hp12. The average inclusive payment for all the hospitals is 9,253 points, with a standard deviation of 3,013 points. The lowest and highest inclusive payments are 3,590 points (Hp12) and 14,772 points (Hp13), respectively, thus exhibiting a range of 11,183 points.

The average non-inclusive payment for all the hospitals is 14,805 points, and the standard deviation is 869 points. The lowest and highest payments are 13,254 points (Hp6) and 16,497 points (Hp10), respectively, thus exhibiting a range of 3,243 points. The coefficient of variation among the hospitals is 5.9%, and the range among the hospitals is 21.9% of the overall average. Thus, the variation is much smaller than that among the hospitals' inclusive payment amounts.

The average total payment is 24,058 points for all the hospitals. The share of inclusive payments in the total payments is 38.5%. Although the share of inclusive payments is small, both the standard deviation and range for inclusive payments are 3.5 times larger than those for non-inclusive payments. We thus conclude that the differences in the total medical payment amounts among hospitals are largely due to the differences in the inclusive payment amounts, which are determined by the length of hospital stay.

6. EVALUATION OF THE NEW PAYMENT SYSTEM

As mentioned before, one of the major purposes of the DPC-based payment system is to reduce the long-term hospitalization cost by standardizing the medical payments. However, this study found that for cataract patients, the differences in the non-inclusive payment amounts—which are conventional fee-for-service reimbursements—are relatively small, whereas those in the inclusive payment amounts are quite large among sixteen different hospitals. This result shows that the DPC system, in fact, works in reverse of its intended purpose to standardize the medical payments. The relatively small difference in non-inclusive payment amounts among the hospitals can be explained as follows: 1) since for the patients in our data set, other operations—such as ones for glaucoma and vitreous—are performed in addition to the cataract operations, the diseases are classified into other DPC categories and thus the homogeneity of the patients is high (for example, operations for glaucoma and vitreous are classified under the DPC code 020340); and 2) the operation and treatment procedures for cataracts are standardized, and therefore, the difficulty levels for cataract operations are not high.

The correlation coefficient between non-inclusive payments per diem and total payments is –0.872. To reduce the total medical payment for this disease, it may be effective to shorten the length of hospital stay and spend medical resources intensively within a short period of time. However, since the current system is a per diem prospective payment system, hospitals may not have a strong incentive to reduce the length of hospital stay. For example, since the probability of postoperative infections or complications is very small in the case of cataract operations, few medical resources for medical treatment and examination are necessary after the operation. In other words, the direct cost to hospitals is a decreasing function of time. Moreover, even if the payment per diem is reduced, empty beds may be worse for hospital managers so long as the marginal revenue exceeds the marginal cost. Further, for cataract operations, the length of hospital stay is generally a few days, which is not a very long period of time. Since the patient does not change hospitals unless the benefit of reducing the length of hospital stay exceeds the cost of finding a new hospital, the hospital can usually make the final decision with respect to the patient's length of hospital stay. Indeed, the hospital may even choose to keep the patient in the hospital until a new patient is admitted to fill the bed. If so, the new payment system may not offer hospitals a sufficiently strong incentive to reduce their patients' length of hospital stay.

To make the new payment system work effectively in the case of cataract operations, it may be necessary to reduce the per diem payment by a large amount for long-term hospitalizations and encourage hospitals to spend medical resources intensively within a short period of time. Furthermore, the introduction of the DRG/PPS may merit serious reconsideration in Japan. In the DRG/PPS, a hospital is paid a fixed fee on the basis of the classification of the DRG, regardless of the length of hospital stay. Although ten hospitals in Japan had adopted the DRG/PPS on a trial basis in 1998, the medical society expressed strong disapproval with the DRG/PPS. Moreover, since the Japanese medical system has been following the fee-for-service payment system for over half a century, it would have been extremely difficult to adopt the DRG/PPS system nationwide without any modifications. Therefore, the DPC inclusive payment system was introduced. Thus, although the current system essentially employs the same method nationwide to classify diseases, it is necessary to revise the system, taking into consideration the characteristics of diseases and hospital specialties to facilitate the effective use of medical resources. Furthermore, individual hospitals must improve their medical systems by introducing clinical paths, efficiently managing hospitalization schedules [16], and adopting proper medical technologies [17] to reduce the length of hospital stay.

7. CONCLUSIONS

In this paper, the Japanese DPC-based inclusive payment system, which was introduced in 2003, was evaluated. We utilized data pertaining to 1,225 patients who were hospitalized for cataract diseases and underwent lens operations from July 2004 to September 2005. The lengths of hospital stay and medical payments among hospitals were compared. The variables found to affect the length of hospital stay were those pertaining to the patients' sex and age and the presence of secondary diseases. We found large differences in the length of hospital stay among hospitals, even after eliminating the influence of patient characteristics and principal disease classifications. The highest average inclusive payment for the hospitals was 3.5 times as high as the lowest payment.

Next, non-inclusive payments were analyzed. The variables affecting the non-inclusive payment were the Age 30 dummy, Secondary Disease dummy, and H25.8 dummy. The differences among hospitals in terms of non-inclusive payments based on the conventional fee-for-service system were relatively small. The largest deviation from the average of all hospitals was approximately 10%. Thus, we can conclude that the major differences among hospitals with respect to medical payments are caused by differences in their DPC-based inclusive payments, which account for only one-third of the total medical payments for cataract patients. The results of the study strongly suggest that in future revisions of the payment system, the characteristics of diseases must be considered when determining the efficient use of medical resources.

In the present study, only cataract operations were analyzed. To evaluate the DPC-based inclusive payment system more precisely, it is necessary to analyze other important cases such as cancer, cardiac infarction and stroke, and compare the results of the cataract operations with the other cases. These are subjects to be analyzed in future studies.

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Notes

1. The ICD-10 comprises a wide range of categories—from general categories to very specific ones—and uses codes consisting of one alphabet and three-digit numbers.

2. The initial classification was done based on data obtained from about 300,000 patients hospitalized in the special functioning hospitals from July 2002 and October 2002. The revisions were done in April 2004, April 2006, and April 2008, based on the renewed data.

3. In Japan, medical care fees are measured in points. This system was first launched in 1943. Under the system, each point corresponds to 10 yen, which has been effective since 1958.

4. In the case of 0201103x01x000 (cataract operations and insertion of prosthetic lens, no secondary disease and no secondary treatment), the per diem inclusive payment during the sample period was 2.536 points for up to 3 days, 1,882 points for 4–6 days, and 1,600 points for 7–10 days. After 10 days, the payment was determined by the conventional fee-for-service system.