Economic Estimation of Nursing Services under the Diagnostic Procedure Combination/Per-Diem Payment System

Tomoya Akiyama[1], Naomi Akiyama[2]*, Kenshi Hayashida[3] and Hiroshi Tamura[1]

[1]*Kyoto University Hospital, Kyoto, Japan*
[2]*Department of Nursing, School of Health Sciences, Bukkyo University, Kyoto, Japan*
[3]*University of Occupational and Environmental Health, Kokura, Japan*

Abstract

Aim: The purpose of this study was to determine whether the amount of nursing services estimated under the classification of Nursing Need Degree is adequately evaluated for each Diagnostic Procedure Combination (DPC) reimbursement.

Methods: A longitudinal cohort study design was employed to examine all 28,757 hospitalizations, except for those due to tuberculosis, in Hospital A in Japan between July 2008 and March 2010. We excluded the following patients from analysis: patients who were not applicable to the DPC system; patients who were hospitalized beyond the specified DPC period; and patients who were applicable to the specified hospital fee. We collected data from the administration system of medical business and Nursing Need Degree (NND). We calculated the mean of the hospital fee portion (i.e., fees for room and nursing services) per total number of nurses required and created a list of per-nurse-day unit price for each DPC group, only if the number of patients included in the identical DPC group exceeded 20. We described about the number of assigned DPC codes, in such a way as to distribution of percent difference from the mean of hospital fee portion/total necessary number of nurses for each DPC group. In addition, we focused on the difference from the mean by 30%.

Results: A significant correlation was found between the hospital fee portion and total number of nurses required under the DPC system. However, the distribution of percent differences among the mean of the hospital fee portion per total number of nurses required revealed that 39 of 179 DPC code groups were either underestimated or overestimated. The underestimated group included a number of obstetrics- and gynecology-related diseases, whereas the overestimated group included many non-surgical, cancer-related diseases.

Conclusions: Our results significantly contribute to the identification of DPC codes that do not adequately reflect nursing services required under the present DPC payment system.

Keywords: Health care costs; Payment system; Nursing services; Personnel staffing and scheduling; Nursing administration research

Abbreviations: DPC: Diagnostic Procedure Combination; OECD: Organization for Economic Co-operation and Development; PPS: Prospective Payment System; DRGs: Diagnostic Related Groups; NND: Nursing Need Degree

Introduction

Many developed countries share growing concerns over care methods and increased health care expenditures due to improved life expectancy among the elderly. Health care costs in Japan are lower compared to the United States and other countries according to the 2008 Organization for Economic Co-operation and Development (OECD) report [1].

In the United States, a prospective payment system (PPS), such as Medicare's system of reimbursement based on a set of predetermined in-patient care costs, is employed to establish separate payments according to Diagnostic Related Groups (DRGs) [2]. The DRG system is a patient classification scheme that provides a means to relate the type of patients treated by a hospital to the costs incurred in the hospital [3]. In 2003, a new reimbursement system known as the Diagnostic Procedure Combination (DPC) was introduced in acute-care hospitals [4]. The DPC is not a case payment system, but is a per diem payment system based on patient classifications. The cost depends on the length of hospital stay, and if hospitalization is prolonged beyond the specified period, the DPC-based payment will no longer be applied; instead, a traditional fee-for-service payment system will be adopted [3].

In the 1980s, nursing professionals examined the effect of DRGs and PPS on nursing costs or nursing services [5-8]. Previous studies suggest that DRGs properly reflect nursing services involved in the provision of nursing care for patients classified under the DRG system [2,7-9]. Meanwhile, a comprehensive nursing index was developed at Johns Hopkins University, introducing the first nursing patient classification system [10]. Many case-mix studies, such as the measurement of severity of patients' illnesses, were conducted in relation to nursing care [8,10].

In Japan, a new nursing patient classification system called the "Nursing Need Degree (NND)," which is categorized by the need for nursing care services, was introduced in 2000 in order to estimate nursing manpower for each patient day. Since 2006, it has been recommended that hospitals measure the NND daily for each patient and allocate nurses accordingly under the regulations of the hospital fee reimbursement system. Japanese nurses can measure the total amount of nursing services according to the universal scale of NND.

Siferd and Benton [8] reported that, traditionally, the costs of nursing services have been included in the hospital room fees. The same can be said for the costs of nursing services in Japan. Since the costs of

*Corresponding author: Naomi Akiyama, Department of Nursing, School of Health Sciences, Bukkyo University, 2-7 Nishinokyo Boo-tyo, Nakagyo-ku, Kyoto, Japan, 604-8415, Tel: +81-75-491-2141; Fax: +81-75-366-5757; E-mail: n-akiyama@bukkyo-u.ac.jp

in-patient nursing services comprise the hospital fee portion (i.e., fees for room and nursing services) under the DPC system, it is not clear whether nurses' work would be subjected to adequate evaluation. To provide high quality nursing care for patients in Japan, it is important to determine how properly nursing services are estimated under the DPC system; however, few reports exist on the relationship between the DPC and NND in Japan. Accordingly, this study aimed to determine whether the amount of nursing services estimated under the classification of NND is adequately evaluated for each DPC reimbursement.

Methods

Patients

A longitudinal design was employed to examine all 28,757 hospitalizations, except for those due to tuberculosis, in Hospital A between July 2008 and March 2010. Hospital A is an acute-care university hospital with more than 1,000 beds. We excluded the following patients from analysis: patients who were not applicable to the DPC system; patients who were hospitalized beyond the specified DPC period; and patients who were applicable to the specified hospital fee (e.g., intensive care unit fee, hospital fee for the elderly aged 75 years or over) if only for a day through his/her hospitalization.

Data collection

We collected data from the administration system of medical business and NND. Medical business data included patient number, sex, date of admission and discharge, age at discharge, DPC code at discharge, length of hospital stay, gross income under the DPC payment system, gross income under the fee-for-service payment system, the sum of hospital fee elements (room and board, nursing services, and laboratory costs) under the fee-for-service payment system, application to the specified hospital fee, death before/after discharge, and whether or not hospitalization was prolonged beyond the specified DPC period. NND data included patient number, daily NND score of severity and nursing care needs assessment indicator for general ward, daily NND score of severity and nursing care needs criteria, and daily patient classification levels. The NND consists of two scores: score A, which measures the level of medical care and the number or presence/absence of monitoring and treatment consisting of 15 items (e.g., blood pressure taking, electrocardiogram monitoring, respiratory care), and score B, which measures the patient condition, including 13 items (e.g., rolling-over, transfer, dietary intake), those items should be answered selecting an appropriate one from two or three choices (e.g., without assistance, some assistance, full assistance) [11,12]. Each of those choices is assigned a score from 0 to 1 or 2. Score A and B are calculated respectively by adding together. The NND for each patient is determined by the combination of score A and B.

Assumed hospital fee portion under the DPC payment system

Under the DPC payment system, reimbursement of medical fees is calculated based on the sum of the prospective payment and fee-for-service payment portions. The prospective payment portion consists of hospital fee elements, which include a portion of fees associated with medical care (i.e., examination, diagnostic imaging, medication/injection/treatment, medication during rehabilitation, mental treatment). The fee-for-service portion corresponds to all other fees not included in the prospective payment portion.

The assumed hospital fee portion under the DPC payment system was calculated by subtracting the difference between the sum of hospital fee elements and the gross income under the fee-for-service payment system from the gross income under the DPC payment system.

Calculation of the total number of nurses required

Sovie et al. [7] assigned nursing care hours to categories of nursing acuity in a detailed time study of nursing hours spent for patient care and unit related activities. During the process of developing NND, the government investigation team conducted extensive time studies on nursing care hours [12]. In the present study, we estimated the total number of nurses required for each patient hospitalization based on his/her daily NND data from the date of admission to discharge.

Analysis

We used one-way ANOVA to analyze data and the chi-square test to compare characteristics between surgical, non-surgical, and other cases. In addition, the Tukey-Kramer test was performed for multiple comparisons between groups. We used generalized liner modeling to investigate the relationship between the hospital fee portion under the DPC system and the total number of nurses required.

We calculated the mean of the hospital fee portion per total number of nurses required for each patient hospitalization, and created a list of per-nurse-day unit price for each DPC group, only if the number of patients included in the identical DPC group exceeded 20. We described the number of assigned DPC codes in a way that distribution of percent difference from the mean of hospital fee portion per total number of nurses required for each DPC group. In addition, we focused on the difference from the mean by 30%.

All statistical analyses were performed using JMP Statistical Software Version 9.0. $p < 0.05$ was considered statistically significant. This study was approved by the Ethics Committee of the Kyoto University.

Results

Patient characteristics and costs

The extracted dataset included 28,757 observations between July 2008 and March 2010. Of these, 476 observations could not be connected to either medical business data or NND data; 7,247 observations were excluded for not adopting the DPC system (n=2,307), having a prolonged length of hospital stay beyond the specified period of DPC (n=3,870), or adopting the specified hospital fee (n=1,651). Consequently, we analyzed 21,007 observations.

Table 1 shows patient characteristics, including income. The mean age was 56 years, and 52% of patents were male. The mean length of hospital stay was 13 days, and the sum of hospital fee elements under the DPC payment system (A) was $3626 and the total number of nurses required (B) was 5 person.

Patient characteristics were evaluated based on three classifications: surgical, non-surgical, and "others." Patients in the surgical group were older and had a longer length of hospital stay than the "others" group (Tukey-Kramer test, p<0.001).

The mean of the sum of hospital fee elements under the DPC payment system (A) and the total number of nurses required (B) were higher in the surgical group than the "others" group (Tukey-Kramer test, p<0.001). The non-surgical group had the highest mean (A)/(B) ($953/nurse-day), followed by the "others" group ($831/nurse-day) and the surgical group ($776/nurse-day) (Tukey-Kramer test, p<0.001).

DPC codes

We divided 582 groups according to the first six digits of the DPC code (diagnosis) and the 9-10th digits (surgical/non-surgical/others). Small groups consisting of less than 20 observations demonstrated the

		All	Non-surgical	Surgical	Others	p-value
		n=21,828	n=10121	n=9812	n=1895	
Age	mean ± SD	55.9 ± 21.7	54.1 ± 22.4	58.4 ± 20.2	52.6 ± 23.5	***a)
Sex (male)	n(%)	10846(51.6)	4978(51.5)	4949(52.0)	919(50.4)	n.s.b)
Length of hospital stay (day)	mean ± SD	12.8 ± 12.1	10.6 ± 11.0	14.9 ± 13.1	13.4 ± 10.7	*** a)
Gross income, prospective	mean ± SD	9160.0 ± 9623.6	5845.9 ± 5631.3	12865.5 ± 11581.8	7376.4 ± 8097.0	*** a)
Gross income, fee-for-service	mean ± SD	8762.2 ± 9363.8	5284.9 ± 5004.7	12617.7 ± 11388.5	7060.7 ± 7464.7	*** a)
Sum of hospital fee elements under the DPC system; (A)($)	mean ± SD	3626.1 ± 3491.2	3219.5 ± 3305.9	4017.2 ± 3640.1	3739.0 ± 3412.9	*** a)
Total number of nurses required ; (B) (person)	mean ± SD	5.3 ± 7.0	4.1 ± 5.5	6.5 ± 8.0	5.4 ± 7.0	*** a)
A/B ($)	mean ± SD	862.2 ± 506.6	953.4 ± 615.3	775.7 ± 373.9	831.3 ± 369.7	*** a)
a) One-way ANOVA, b) chi-square test					(1 US dollar = 80 JP yen in 2010)	

* p < 0.05, ** p < 0.01, *** p < 0.001 n.s.: not significant

Table 1: Patient characteristics.

Percent difference	Range	Number of assigned DPC codes
> 30% more	X < $577.9	21
25-30% less	$577.9 ≤ X < $619.1	8
20-25% less	$619.1 ≤ X < $660.4	11
15-20% less	$660.4 ≤ X < $701.7	9
10-15% less	$701.7 ≤ X < $743.0	11
5-10% less	$743.0 ≤ X < $784.2	15
0-5% less	$784.2 ≤ X < $825.5	13
No difference	$825.5	0
0-5% more	$825.5 < X ≤ $866.8	24
5-10% more	$866.8 < X ≤ $908.1	14
10-15% more	$908.1 < X ≤ $949.3	12
15-20% more	$949.3 < X ≤ $990.6	10
20-25% more	$990.6 < X ≤ $1031.9	10
25-30% more	$1031.9 < X ≤ $1073.2	3
> 30% more	X> $1073.2	18

X: The mean of the hospital fee portion per total number of nurses required by DPC.

Table 2: Distribution of percent differences among the hospital fee portion per total number of nurses required for each DPC group.

large dispersion of the sum of hospital fee elements under the DPC payment system per total number of nurses required (Min: $-11; Max: $2774) compared to that of larger groups consisting of 20 observations or more (Min: $190; Max: $1647) (data not shown in tables). We analyzed 179 groups consisting of over 20 observations.

We found strong positive relationship between the sum of hospital fee elements under the DPC payment system and the total number of nurses required (GLM, Residual Deviance: 2.32e+10, AIC: 350314.0, p<0.001).

Distribution of percent differences among the mean of the hospital fee portion per total number of nurses required by DPC codes

Table 2 shows the distribution of percent differences among the mean of the hospital fee portion under the DPC payment system per total number of nurses required by DPC codes. The results indicate that approximately 108 of 179 DPC codes show variation within plus or minus 20% of the mean of the sum of hospital fee elements under the DPC payment system (A)/total number of nurses required (B).

Groups with a (A)/(B) less than 30% of the mean were assigned 21 of 179 DPC codes. We defined the cluster of these DPC codes as the underestimated group in terms of per-nurse-day unit price under the DPC payment system. On the other hand, groups with a (A)/(B) more than 30% of the mean were assigned 18 of 179 DPC codes. We defined this cluster as the overestimated group.

Per-nurse-day unit price under the DPC payment system for underestimated and overestimated groups

Table 3 lists the per-nurse-day unit price under the DPC payment system for the 21 DPC code groups classified as underestimated.

The minimum mean (A)/(B) was $190 for "Disorders of newborns related to short gestation and low birth weight," followed by $360 for "Diabetes in pregnancy," and $430 for "Malignant neoplasm of renal pelvis." As for diagnosis and treatment, 5 of 21 DPC codes were of the obstetrics and gynecology department, 4 of 21 of the hepato-biliary-pancreatic division, and 3 of 21 of the urology or neurosurgery department. Thirteen of 21 DPC codes were in the surgical group.

Table 4 lists the per-nurse-day unit price under the DPC payment system for the 18 DPC code groups classified as overestimated.

The maximum mean (A)/(B) was $1650 for "Malignant neoplasm of ovary," followed by $1600 for "Retinal vascular occlusions," and $1520 for "Malignant neoplasm of cervix uteri/corpus uteri." As for diagnosis and treatment, 3 of 18 DPC codes were of the ophthalmology department, and 2 of 18 of the obstetrics and gynecology, gastroenterology, or breast surgery department. Fourteen of 18 DPC codes were in the non-surgical group, and 8 of 18 were related to cancer.

Discussion

In this study, we aimed to identify an association between the NND and DPC. In the discussion, we will set forth the following

DPC codes	ICD-10 approximated to DPC code	Diagnosis and treatment department	Surgical or not	(A)/(B) $ per nurse day
Disorders of newborn related to short gestation and low birth weight	P07	Obstetrics and Gynecology, Pediatrics, etc.	Non-surgical	189.8
Diabetes in pregnancy	O249	Obstetrics and Gynecology	Others	364.3
Malignant neoplasm of renal pelvis	C65	Urinology	Non-surgical	430.7
Complete or unspecified spontaneous abortion without complication	O039	Obstetrics and Gynecology	Surgical	452.9
Other psychoactive substance related disorders	F190	Emergency or General Medicine	Others	462.3
Nontraumatic intracranial hemorrhage, unspecified	I629	Cranial Nerve Surgery	Non-surgical	463.6
Tachycardia, unspecified	R000	Cardiovascular Internal Medicine	Surgical	465.1
Calculus of gallbladder without cholecystitis	K802	Division of Hepato-Biliary-Pancreatic Surgery	Surgical	504.7
Abnormality of forces of labor, unspecified	O629	Obstetrics and Gynecology	Surgical	512.4
Disease of intestine, unspecified	K639	Urinology	Surgical	529.7
Pre-existing hypertension complicating pregnancy, childbirth, and the puerperium	O10	Obstetrics and Gynecology	Surgical	534.3
Hydrops of gallbladder	K821	Division of Hepato-Biliary-Pancreatic Surgery	Surgical	539.5
Intracranial injury	S06	Neurosurgery, etc.	Surgical	543.2
Intraoperative and postprocedural complications and disorders of digestive system	K91	Division of Hepato-Biliary-Pancreatic Surgery, etc.	Non-surgical	545.5
Hydrocephalus, unspecified	G919	Neurosurgery	Surgical	555.7
Other and unspecified atherosclerosiS	I709	Cardiovascular Medicine, etc.	Surgical	560.3
Enlarged prostate	N40	Urinology, etc.	Surgical	567.1
Other and unspecified cirrhosis of liver	K746	Division of Hepato-Biliary-Pancreatic Surgery, etc.	Non-surgical	567.3
Malignant neoplasm of thyroid gland	C73	Radiation Oncology, etc.	Non-surgical	571.8
Cerebral aneurysm, nonruptured	I671	Neurosurgery	Surgical	574.0
Longitudinal reduction defect of radius	Q714	Plastic and Reconstructive Surgery or Orthopedic Surgery	Surgical	574.1

A: Sum of hospital fee elements B: Total number of nurses required
Table 3: Per-nurse-day unit price under the DPC payment system for the underestimated group.

DPC codes	ICD-10 approximated to DPC code	Diagnosis and treatment department	Surgical or not	(A)/(B) $ per nurse day
Malignant neoplasm of ovary	C56	Obstetrics and Gynecology	Non-surgical	1646.7
Retinal vascular occlusions	H34	Ophthalmology	Non-surgical	1597.2
Malignant neoplasm of cervix uteri/corpus uteri	C539/C549	Obstetrics and Gynecology	Non-surgical	1522.0
Degeneration of macula and posterior pole	H353	Ophthalmology	Non-surgical	1409.6
Malignant neoplasm of breast of unspecified site	C509	Breast Surgery	Non-surgical	1314.5
Pulmonary heart disease, unspecified	I270	Pediatrics	Non-surgical	1296.8
Neoplasm of uncertain behavior of breast	D486	Breast Surgery	Surgical	1275.9
Melanoma in situ, unspecified	D039	Dermatology, etc.	Non-surgical	1261.3
Inflammatory polyneuropathy	G61	Neurology	Others	1243.5
Malignant neoplasm of esophagus, unspecified	C159	Gastroenterology, etc.	Non-surgical	1241.9
Malignant neoplasm of stomach, unspecified	C169	Gastroenterology and Hepatology or Gastroenterological Surgery, etc.	Non-surgical	1241.1
Malignant neoplasm of breast of unspecified site	C509	Breast Surgery	Surgical	1155.0
Non-Hodgkin's lymphoma, unspecified	C859	Hematology and Oncology, etc.	Non-surgical	1140.6
Spinal stenosis	M48	Anesthesia, etc.	Non-surgical	1113.9
Aortic aneurysm of unspecified site Aneurysm of iliac artery	I719/723	Cardiovascular Surgery	Non-surgical	1109.2
Atopic dermatitis	L20	Dermatology	Others	1101.6
Unspecified glaucoma	H409	Ophthalmology	Non-surgical	1088.0
Malignant neoplasm of prostate	C61	Urinology	Non-surgical	1074.1

A: Sum of hospital fee elements B: Total number of nurses required
Table 4: Per-nurse-day unit price under the DPC payment system for the overestimated group.

two major points based on our findings. First, there was a significant association between the hospital fee portion and total number of nurses required under the DPC system. However, the distribution of percent differences among the mean of the hospital fee portion per total number of nurses required revealed that 39 of 179 DPC codes fall under the underestimated or overestimated evaluation category. Second, the underestimated group included a number of obstetrics- and gynecology-related diseases, whereas the overestimated group

included many non-surgical, cancer-related diseases.

The strong correlation between the hospital fee portion and total number of nurses required under the DPC system suggests that DPC grouping properly reflects nursing services involved in the provision of care for patients classified under each DPC group. The same trend was observed in the United States with the DRG system regarding nursing services [5-8]. However, the range of the hospital fee portion per total number of nurses required for each DPC group was large.

In this study, we focused on both underestimated and overestimated DPC code groups. The underestimated group has two possible causes: first, the total number of nurses required might be overestimated under the classification based on NND; and second, the hospital fee portion might be underestimated in the DPC system. The underestimated group included a number of obstetrics- and gynecology-related diseases, as well as hepato-biliary-pancreatic diseases. Patients with these diseases are often considered incapable of conducting daily activities without extensive assistance; hence, the total number of nurses required might be overestimated.

On the other hand, the overestimated group has two possible causes; first, the total number of nurses required might be underestimated under the classification based on NND, and second, the hospital fee portion might be overestimated in the DPC system. Almost all DPC codes in the overestimated group were of non-surgical or cancer-related diseases. Furthermore, patients in this group were administered antitumor drugs. Antitumor drug therapy may require nursing services that are not properly evaluated by the NND. A number of studies have suggested that adequate staffing is associated with improved patient outcomes [13-15]. Moreover, high patient-to-nurse ratios more likely lead to low burnout and dissatisfaction [15,16]. Future studies are needed to clarify the number of nurses required for antitumor drug therapy under the classification of NND. Furthermore, the fact that the costs of antitumor drugs would be overestimated in the current DPC system should be taken into consideration.

There are several limitations to this study. First, the analyses were performed in only one acute-care hospital; therefore, generalization of the results requires caution, and further investigation involving other acute hospitals is warranted. Second, we excluded small groups consisting of less than 20 observations. Additional studies should be performed with a larger sample size. Despite these limitations, our results significantly contribute to the identification of DPC codes that do not adequately reflect nursing services under the present DPC payment system.

Acknowledgements

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