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Ⅲ

政策・資源と医療の費用・質

DPC/PDPS 導入の費用･質への影響、高額検査・薬剤使用の効率改善の余地、療養病床の将来の地域別需給ギャップ、を定量化した。費用の把握方法を多角的に検討した。これらは、医療の資源や費用の管理の関連施策に重要な情報となる。

DPC/PDPS 政策導入の効果
「在院日数・医療費」と「医療の質」を評価

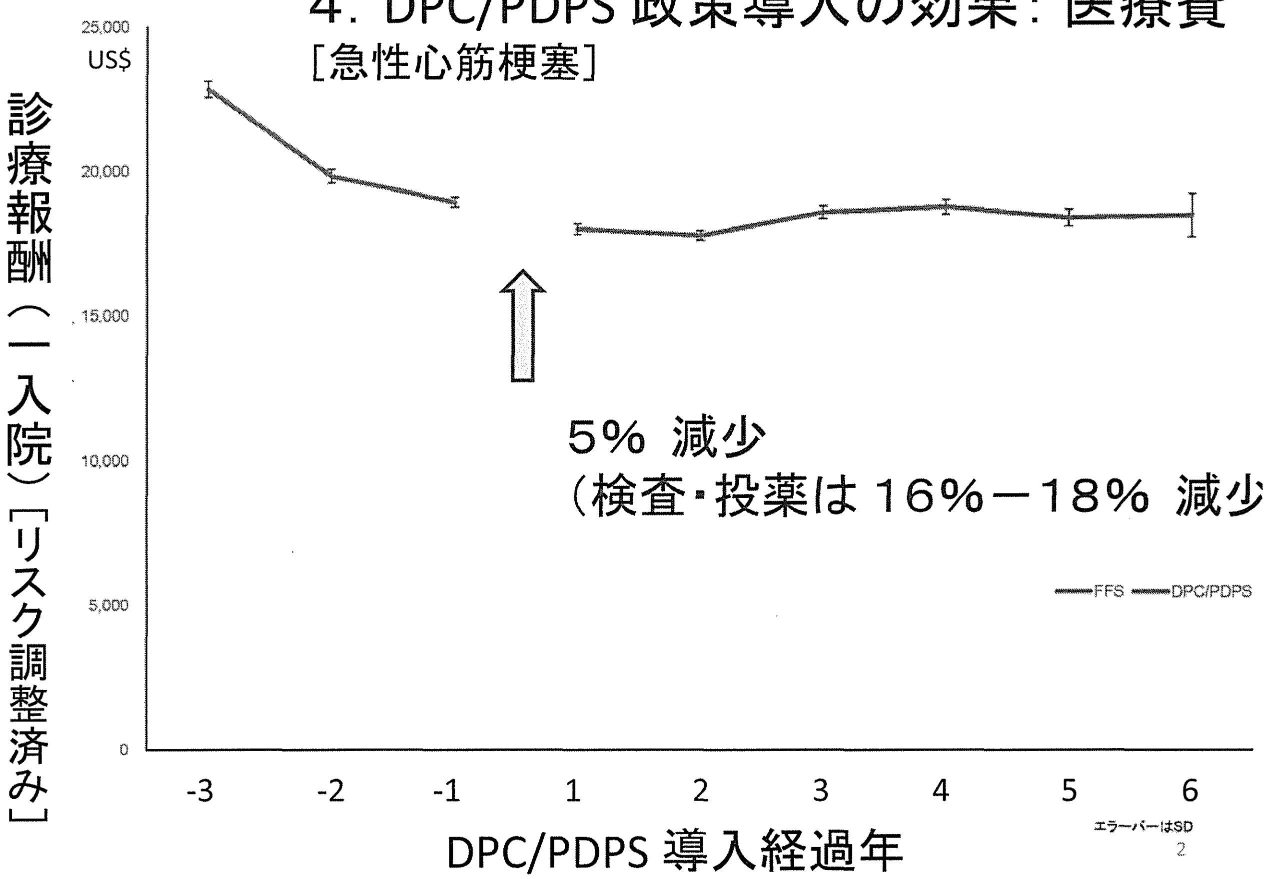
データ: 全国約300病院参加のDPCデータ (QIPﾌﾟﾛｼﾞｪｸﾄ)
DPC/PDPS導入前と後、両方のデータを提出した病院
（2001～2009年の急性心筋梗塞 11,159 症例）

解析: Quasi-Experimental Design. 多施設ﾃﾞｰﾀをﾏﾙﾁﾚﾍﾞﾙで多変量解析でﾘｽｸ等調整し、「時勢」と「DPC/PDPS政策」の影響を分離。

結果：DPC/PDPS導入により、在院日数と医療費は減少、再入院率は上昇、死亡率は変化しなかった。

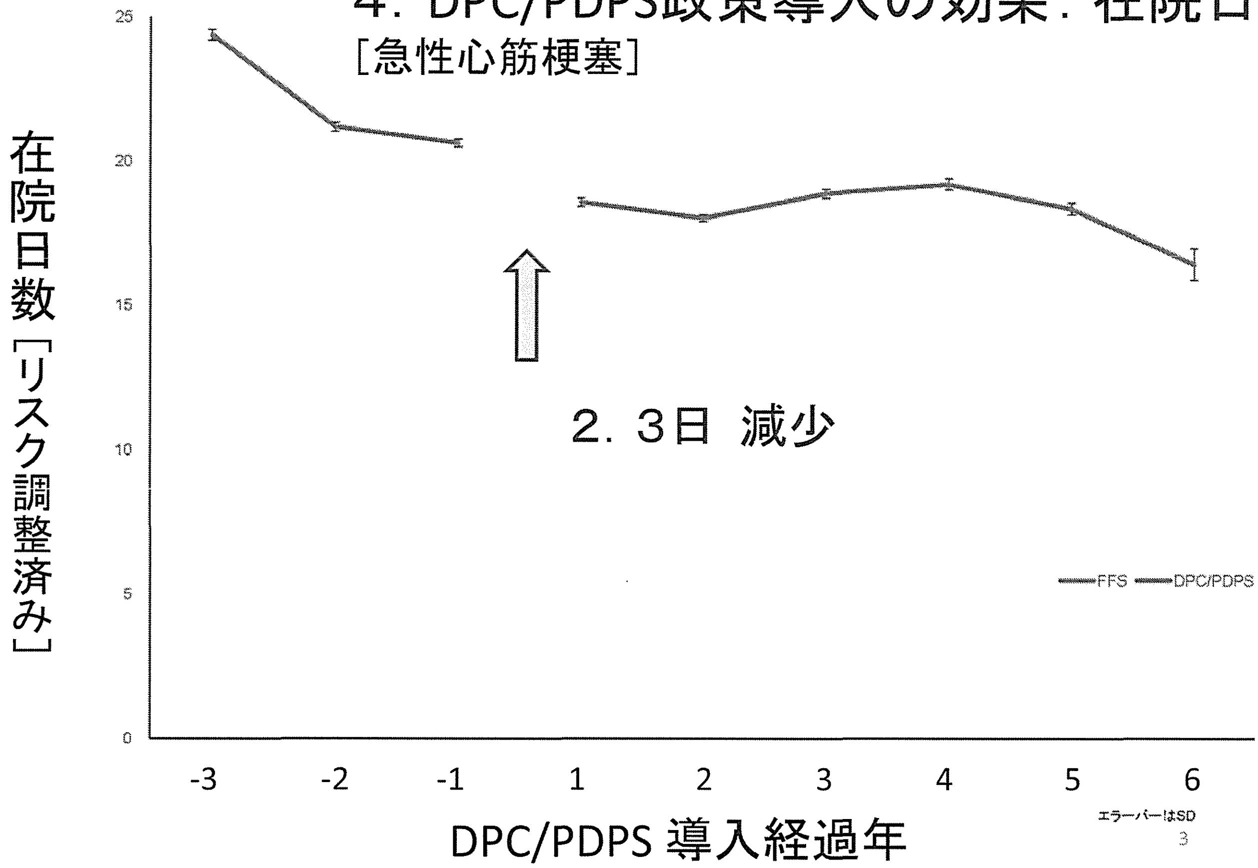
1

4. DPC/PDPS 政策導入の効果: 医療費
[急性心筋梗塞]

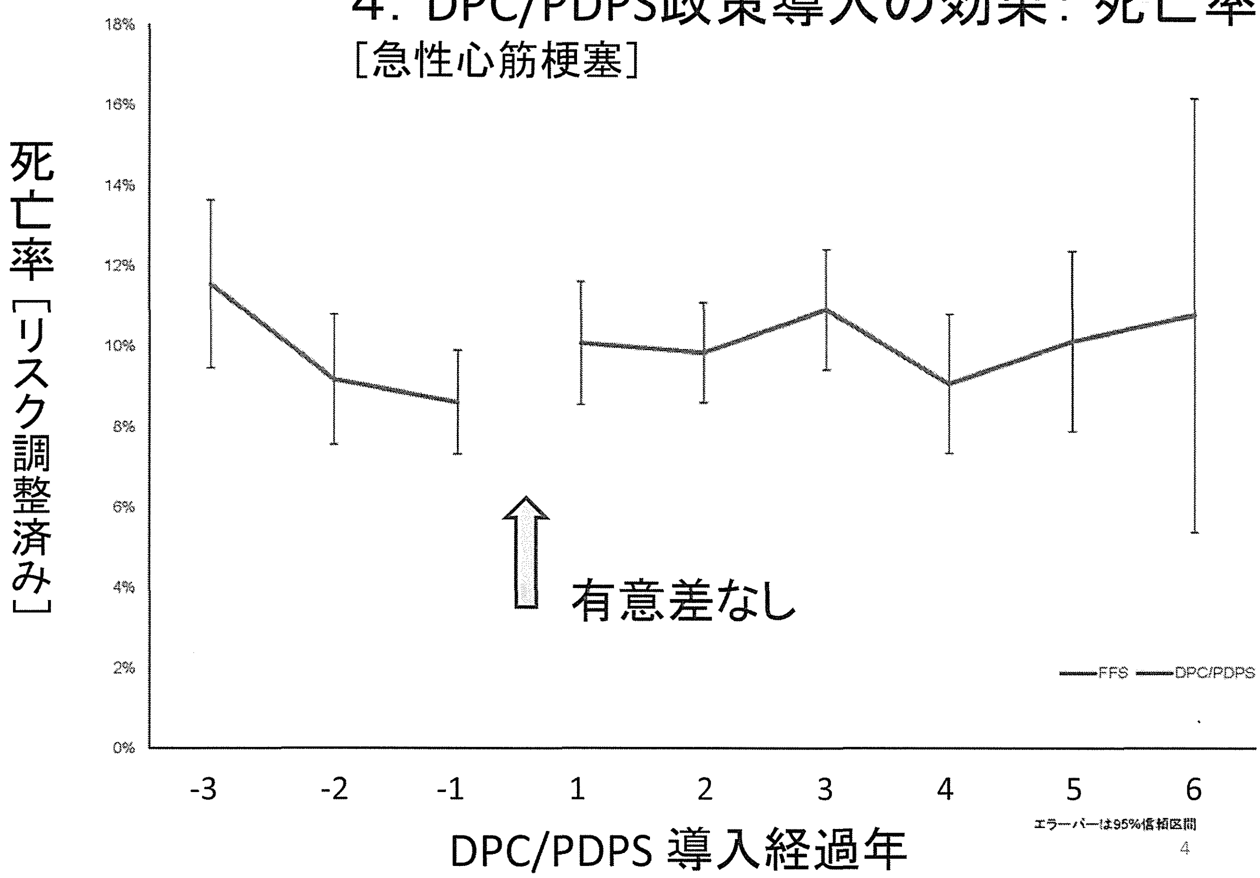


2

4. DPC/PDPS政策導入の効果：在院日

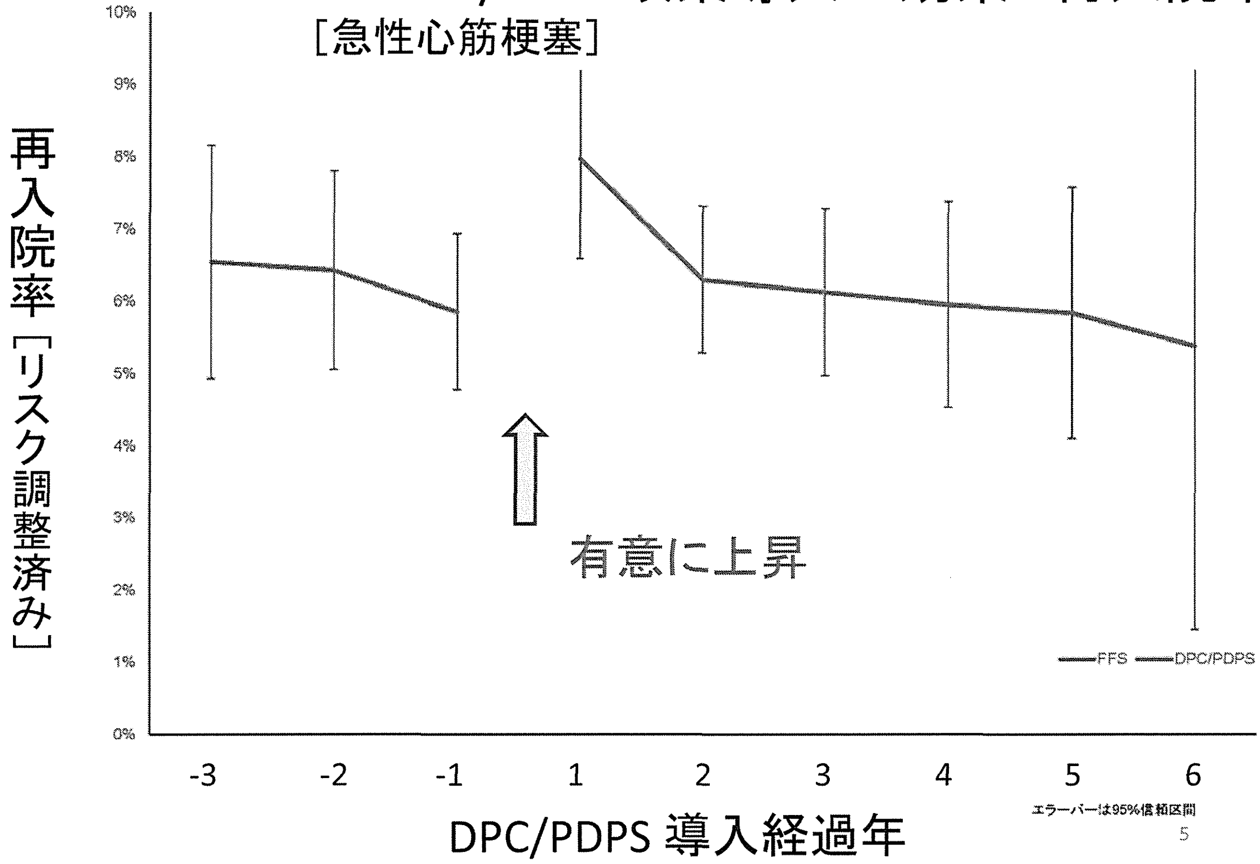


4. DPC/PDPS政策導入の効果：死亡率



4. DPC/PDPS政策導入の効果: 再入院率

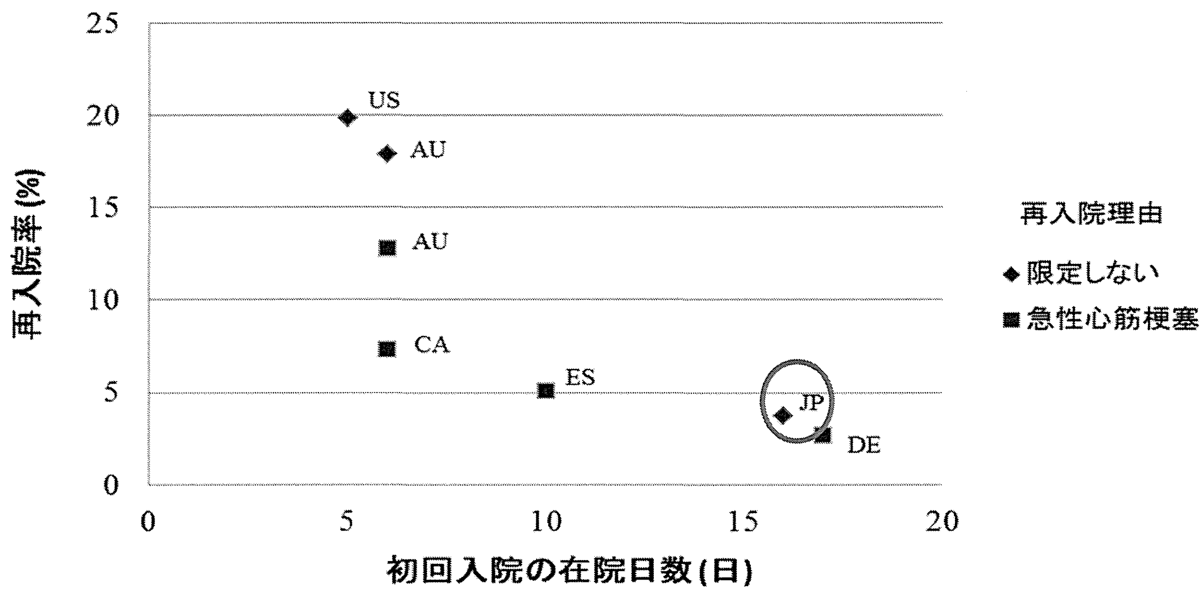
[急性心筋梗塞]



エラーバーは95%信頼区間

5

【参考】 再入院率と在院日数: 国際比較



国名コード	国名	再入院理由	参照年度	再入院率の引用元*
US	アメリカ	限定しない	2009	U.S. Department of Health and Human Services.
AU	オーストラリア	限定しない	1999-2000	Scott I,et al. Qual Saf Health Care. 2004
AU	オーストラリア	急性心筋梗塞	1999-2000	Scott I,et al. Qual Saf Health Care. 2004
CA	カナダ	急性心筋梗塞	1998	Canadian Institute for Health Information.
ES	スペイン	急性心筋梗塞	1992-1994	Lupón J,et al. J Am Coll Cardiol. 1999
DE	ドイツ	急性心筋梗塞	2000-2006	Schreyögg J,et al. Health Serv Res. 2010
JP	日本	限定しない	2009	Present study

6

*: 在院日数は、日本を除くいずれの国においてもKaul P,et al. Lancet. 2004.を参照した。

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Effects of the per diem prospective payment system with DRG-like grouping system (DPC/PDPS) on resource usage and healthcare quality in Japan

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ABSTRACT

Objectives: In 2003, Japan introduced the prospective payment system (PPS) with diagnosis-related groups (DRG) rearranged grouping system called the diagnostic procedure combination/per-diem payment system (DPC/PDPS). Even after eight years, little is known about the effects of DPC/PDPS. The purpose of this study was to examine the effects of DPC/PDPS on resource usage and healthcare quality.
Methods: Using 2001–2009 (fiscal year) administrative data of acute myocardial infarction patients, four indices, including inpatient total accumulated medical charges, length of stay (LOS), mortality rate, and readmission rate, were compared between patients reimbursed by DPC/PDPS or by fee-for-service.
Results: DPC/PDPS significantly reduced total accumulated medical charges by $1061 (95% confidence interval [CI], −2007, −116) and LOS by 2.29 days (95% CI, −3.71, −0.88) after risk adjustment. However, mortality rate (Odds ratio [OR], 0.94; 95% CI, 0.73, 1.21) was unchanged. Furthermore, DPC/PDPS increased the readmission rate (OR, 1.37; 95% CI, 1.03, 1.82).
Conclusions: This study showed that DPC/PDPS was associated with reduced resource usage, but not improved healthcare quality, as with DRG/PPSs in other countries. To achieve successful healthcare reform, further discussion on additional motives will be required.

1. Introduction

Health expenditure has been steadily increasing throughout the world [1]. The control of health expenditure has become a priority for every government. Sufficient evidence indicates that the performance of healthcare providers is affected by payment methods [2,3]. For instance, Wennberg et al. pointed out that losses in hospital revenues resulting from diagnosis-related groups (DRG) could be offset if physicians modify their admission policies to produce more profit, thereby leading to hospital cost inflation. Based on this, they concluded that cost-containment systems based on fixed, per-admission hospital prices would be needed to control hospitalization rates [2]. Moreover, Ellis and McGuire proposed that a supply-side cost-sharing system, such as a prospective payment system (PPS), would provide strong incentives to providers to contain medical expenses, but that this

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occurs only in the unlikely case that the physician is a perfect agent, i.e., without conflicts of interest. However, physicians obviously cannot function as perfect agents, given that under PPS, they face the conflicting interests of patients and providers. To address this issue, Ellis and McGuire proposed a mixed reimbursement system, which is part prospective and part cost-based [3]. These studies underscore the notion that reimbursement system reform is the key to controlling health expenditure and improving efficiency.

In 1983, the United States Government introduced a prospective payment system (PPS) with diagnosis-related groups (DRG) for Medicare patients nationwide to control costs. To date, many studies have examined the effects of DRG/PPS [4–8]. For instance, Davis and Rhodes compared Medicare patients before and after the implementation of DRG/PPS, and reported that DRG/PPS reduced hospitalization and length of stay (LOS), although mortality and readmission rate did not increase [4]. In another study, Cutler et al. examined mortality and readmission rate of Medicare patients, and found that while 1-year mortality rate remained unchanged, readmission rate increased. This appeared to reflect accounting changes in hospitals, rather than true changes in morbidity [5]. Kahn et al. also documented that LOS decreased by 24%, although 180-day adjusted mortality and readmission rate remained unchanged [6]. These findings demonstrate that DRG/PPS reduces cost and average LOS without affecting healthcare quality.

The success of DRG/PPS encouraged other governments to adopt DRG/PPS-like systems. Over the past 20 years, many countries have introduced DRGs or similar grouping systems as instruments for hospital reimbursement. These reimbursement systems have reduced cost and average LOS, as in the United States [9–17].

Japan has experienced approximately a 3-fold increase in health expenditure over the past 20 years under the fee-for-service (FFS) reimbursement system. This has raised the imminent issue of controlling health expenditure. A pilot program to test the validity of a DRG/PPS-like system was implemented in 1998. In 2003, PPS with a DRG rearranged grouping system called the diagnostic procedure combination/per-diem payment system (DPC/PDPS) was formally introduced [18,19]. At first, only 82 hospitals (less than 1% of all hospitals in Japan) were enrolled. Since then, each acute care hospital has voluntarily chosen whether and when to apply DPC/PDPS, and it has expanded rapidly to other hospitals. In 2009, the enrollment included more than 1200 hospitals, which cover about half of the acute care beds.

DPC/PDPS is similar to DRG/PPS in that reimbursements are pre-determined according to the classification of each inpatient activity. However, it differs in two important aspects. First, DPC/PDPS classifies inpatient activities first by diagnoses and then by procedures, whereas the DRG/PPS classification is a procedure dominant system. For instance, an acute myocardial infarction (AMI) patient who underwent percutaneous coronary intervention (PCI) is first classified as DPC code "050030" based on the disease, and then coded as DPC code "050030xx03" for PCI. Moreover, given the 14-character DPC code, the patient is further classified if additional procedures are carried out, such as intra-aortic balloon pumping (IABP), or by severity or comorbidities. Second, inclusive payments are not "per episode," but rather "per diem." Medical charges under DPC/PDPS consist of inclusive and FFS components. Similar to DRG/PPS, the FFS component reimburses charges for expensive procedures (e.g., surgeries and hemodialysis). In contrast, the inclusive component covers charges for hospitalization, examinations, and medication, and has a flat-rate per diem fee based on diagnostic categories.

The goals of DPC/PDPS are to deliver quality healthcare efficiently and to construct a clinical database. The per diem reimbursement system is assumed to have weaker incentives to reduce resource usage [8]. However, despite being implemented eight years ago, only a few studies have examined whether DPC/PDPS contributes to reduced resource usage, as does DRG/PPS, or its effects on healthcare quality. Accordingly, the aim of this study was to elucidate the effects of DPC/PDPS on resource usage and healthcare quality in Japan.

2. Materials and methods

2.1. Database and data collection

The Quality Improvement/Indicator Project (QIP) was designed to improve clinical performance and healthcare quality through data analysis, and has been in existence since 1995. Patient-based administrative data (DPC data) for inpatient activity, including clinical information and claims, are routinely collected from voluntarily participating hospitals, which are located nationwide and provide acute care [20,21]. The project was initiated in 1995 with 10 participating hospitals; the current number is approximately 300. Data from this database were used for this study.

We extracted data on all patients who had a principal diagnosis of AMI and were admitted between April 1, 2001 and September 30, 2009 in the QIP database. AMI was defined according to the International Classification of Diseases (ICD) version 10 codes (I21.x, I22.x). AMI was selected for analysis because it is associated with a high mortality rate, a clear definition of the disease exists, and it is associated with the largest number of cases and highest medical expenses in the DPC database, thus representing acute illnesses. Only data from hospitals that submitted data both before and after DPC/PDPS implementation were included, given that the purpose of this study was to compare resource usage and healthcare quality across the period of implementing DPC/PDPS. Hospitals with less than 20 AMI patients were excluded to minimize unstable estimates of the outcome. Patients were excluded if they were younger than 20 years of age at admission, and/or if data were missing or inadequate. A few patients who were admitted to DPC/PDPS implementing hospitals were reimbursed by FFS when classified as severely ill or underwent very rare surgeries, or if their LOS was overly long. For instance, AMI patients who underwent ventricular aneurysm resection were reimbursed by FFS. Practice patterns for these patients probably do not reflect the behavioral changes due to the implementation of DPC/PDPS. Thus, these patients

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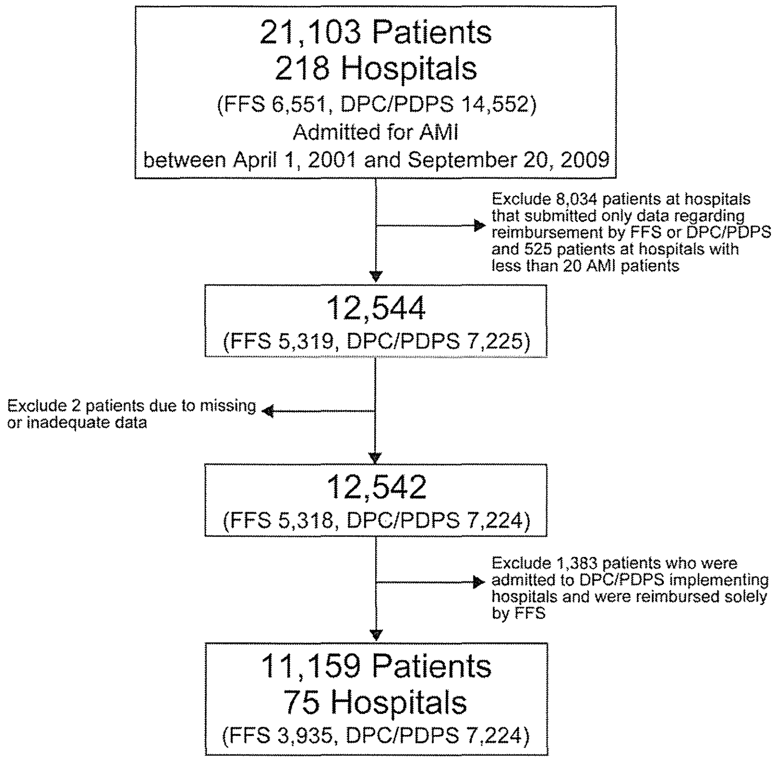

Fig. 1. Inclusion and exclusion criteria applied to identify the study population. This figure displays how inclusion and exclusion criteria were applied to identify the study population. From the initial population of AMI patients admitted between April 1, 2001 and Septemper 30, 2009, exclusion criteria were applied sequentially. FFS: fee-for-service, DPC/PDPS: diagnostic procedure combination/per-diem payment system.

were excluded from our analysis. Fig. 1 summarizes how exclusion and inclusion criteria were applied to obtain the final study population.

To assess the influence of DPC/PDPS on resource usage and healthcare quality, we examined total medical charges, LOS, mortality rate, and rate of readmission within 30 days [4–9,11–16]. To assess the difference between FFS and PPS reimbursement systems, medical charge calculations were based on total accumulated charges for hospitalization according to the FFS schedule. Furthermore, the breakdown of charges for procedures (surgeries), examinations (e.g., blood tests, diagnostic imaging, ultrasonography), and medications were calculated to determine changes in resource usage following the introduction of DPC/PDPS. Medical charges were based on official prices in Japanese yen (JPY) and converted to US dollars (USD). One USD corresponds to 110.22 JPY based on purchasing power parities (PPPs) from the International Comparison Program (ICP) of the World Bank [22]. No discounts were performed.

To evaluate the effects of DPC/PDPS on healthcare quality, the survival/death of each patient and their readmission within 30 days after discharge were examined. These were measured as binary variables. Confounding factors included sex, age at admission, comorbidity status (Charlson index [23]), and whether each patient underwent percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG). Age at admission was divided into three groups (i.e., <65, 65–74, and ≥75 years) and dummied.

This study included AMI cases in our database between 2001 and 2009. It is likely that this research period of nine years is long enough to influence resource usage and healthcare quality. The research period affected both DPC/PDPS and control (FFS) groups. Therefore, we adopted a difference in differences (DID) technique to incorporate this effect. DID is a type of quasi-experiment with a before and after design, and includes an untreated comparison group [24]. The advantage of DID is that it uses the control group to subtract out changes other than that of DPC/PDPS over the research period. With this technique, variables that represent the time of admission of each patient were added to the model.

2.2. Statistical analysis

To compare variables across DPC/PDPS application, one-way analysis of variance, chi-square test, and the Mann–Whitney test were performed for continuous variables, categorical and binary variables, and ordinal variables, respectively. Multivariate analysis was performed to estimate the effect of DPC/PDPS after adjusting for confounders. Patients in a hospital are more alike than randomly chosen patients, due to similarities in socio-demographic status, and each hospital has its own style of examining and treating patients. Traditional multivariate regression and logistic models ignore this correlation within clusters (hospitals) and tend to overestimate the significance of null hypothesis tests [25]. To incorporate this cluster-related correlation, we adopted a multilevel (mixed-effect) regression model for continuous variables (e.g., medical charges and LOS) and a multilevel (mixed-effect) logistic regression model for binary variables (e.g., mortality and readmission). The multilevel regression model includes two levels: the individual patient level and the hospital level.Level 1 (Individual patient level)

$$y_{ij} = \beta_{0j} + \sum_p \beta_p x_{pij} + \varepsilon_{ij}$$

Level 2 (Hospital level)

$$\beta_{0j} = \gamma_{00} + u_{0j},\ u_{0j} \sim N(0, \sigma^2)$$

where i denotes the patient, j denotes the hospital, β_p is the fixed-effect coefficient, ε_{ij} is the random error at the patient level, and β_{0j} is the random intercept, which includes u_{0j} (i.e., random error at the hospital level).

The multilevel (mixed-effect) logistic regression model also consists of two levels.Level 1 (Individual patient level)

$$\text{logit}(P_{ij}(Y = 1)) = \beta_{0j} + \sum_p \beta_p x_{pij} + \varepsilon_{ij}$$

Level 2 (Hospital level)

$$\beta_{0j} = \gamma_{00} + u_{0j},\ u_{0j} \sim N(0, \sigma^2)$$

Intra-class correlations (ICCs) were calculated to examine the cluster effect in multilevel regression models. However, given the difficulty of interpreting the effect of clusters using ICC in multilevel logistic models, the median odds ratio (MOR) was calculated as described by Larsen and Merlo [26].

IBM SPSS Ver.18 (SPSS Japan Inc., an IBM company, Tokyo, Japan) was used to extract and transform the administrative date, and Stata/IC Version 11 (StataCorp LP, College Station, Texas) was used to build the multilevel regression models. In the multilevel models, ICC and MOR were calculated using the xtmrho module [27]. $p < 0.05$ was considered significant.

2.3. Ethical considerations

This study was approved and registered by the Kyoto University Graduate School and Faculty of Medicine, Ethics Committee.

3. Results

A total of 21,103 AMI cases were found in our database. Of these, 8559 were excluded because they were admitted to hospitals that submitted only data regarding reimbursements by FFS or PDPS (8034), or were admitted to hospitals with less than 20 AMI patients (525). Two patients were excluded due to missing or inadequate data. Moreover, 1383 patients were excluded because they were admitted to DPC/PDPS implementing hospitals and were reimbursed solely by FFS. Thus, data were available for a total of 11,159 cases from 75 hospitals. The DPC/PDPS group and the non-DPC/PDPS (FFS) group included 7224 and 3935 cases, respectively. Table 1 shows that the two groups were not significantly different with respect to age, sex, and proportion of those who underwent PCI and CABG; however, the comorbidity status (Charlson index) was more severe (1.76 vs. 1.43; $p < 0.001$) in the DPC/PDPS group than in the FFS group. Patients in the DPC/PDPS group were admitted later than those in the FFS group. This reflects the transition of the Japanese reimbursement system from FFS to DPC/PDPS.

Univariate analysis (see Table 2) revealed that total accumulated medical charges were significantly lower in the DPC/PDPS group ($18,218 vs. $20,686; $p < 0.001$). Charges for examinations and medications were lower by as much as 35% in the DPC/PDPS group (−38% and −36%, respectively). LOS was also shorter in the DPC/PDPS group (17.1 vs. 20.2 days; $p < 0.001$). With respect to healthcare quality, mortality rate (10.1% vs. 9.5%) and readmission rate (6.5% vs. 6.3%) were similar in both groups.

The results of multilevel regression and logistic models are presented in Table 3. Resource usage significantly increased and healthcare quality was aggravated when patients were older or had more severe comorbidity status. Both PCI and CABG significantly improved mortality rate, while they increased resource usage. DPC/PDPS significantly reduced total accumulated medical charges (−$1061; 95% Confidence Interval [CI], −2007, −116), and also shortened LOS (−2.29 days; 95% CI, −3.71, −0.88). With respect to the effect on healthcare quality, DPC/PDPS significantly increased rate of readmission within 30 days (Odds Ratio [OR], 1.37; 95% CI, 1.03, 1.82), although mortality rate was unchanged. Table 4 shows the adjusted effects on the breakdown of medical charges in multilevel regression models. When compared with FFS group averages, DPC/PDPS reduced charges for examinations and medications by more than 15%. However, the reduction in charges for procedures was modest at only 3%.

Trends had a marked influence on resource usage and healthcare quality as seen in the multivariate analysis. Compared to 2001, the 2009 cases had much lower total accumulated medical charges (−$4725; 95% CI, −6530, −2919), much shorter LOS (−7.45 days; 95% CI, −10.15, −4.74), and much lower readmission rate (OR, 0.44; 95% CI, 0.25, 0.77). The effect of time trend on mortality rate was inconsistent. Furthermore, the variance between hospitals had considerable effects on mortality and readmission rate (MOR, 1.46 and 1.57, respectively).

4. Discussion

In this study, we examined the effects of DPC/PDPS in acute myocardial infarction (AMI) patients. Since DPC/PDPS is mainly tailored to reimbursements in acute care hospitals, we selected AMI as a representative acute illness.

With respect to effects on resource usage, DPC/PDPS reduced total accumulated medical charges by approximately 5%. Among various medical charges, reductions in examination and medication charges amounted to as much as 15% after adjustment. These reductions may reflect three factors. First, some examinations and medications which had been traditionally used were considered

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Table 1
Characteristics of patients.

	FFS	DPC/PDPS	
No. of patients	3935	7224	
Sex			
Male	2785	5097	$p = 0.81$†
Female	1150	2127	
Age			
<65	1408	2556	$p = 0.07$†
65–74	1142	1980	
≥75	1385	2688	
Comorbidity (Charlson's index)	1.43	1.76	$p < 0.001$¶
Time of admission (No. of hospitals)			
2001	900 (8)	0 (0)	$p < 0.001$‡
2002	797 (8)	0 (0)	
2003	302 (6)	0 (0)	
2004	75 (4)	374 (8)	
2005	193 (10)	469 (9)	
2006	255 (15)	1179 (20)	
2007	1059 (39)	1333 (30)	
2008	354 (12)	2717 (60)	
2009	0 (0)	1152 (58)	
Rate of procedures			
PCI	77.8%	79.0%	$p = 0.15$†
CABG	2.8%	3.0%	$p = 0.74$†

FFS: fee-for-service, DPC/PDPS: diagnostic procedure combination/per-diem payment system.
† Chi-square test.
‡ Chi-square test for number of patients.
¶ Mann–Whitney test.

excessive and unnecessary, and hence withdrawn. For instance, broad-spectrum antibiotics, such as 3rd generation cephalosporin, were administered as prophylaxis for several days after surgery in Japan [28]. These prophylactic usages were replaced by a single administration of narrow spectrum antibiotics based on guidelines [29]. A second factor is the shift to the outpatient department. Since outpatient department reimbursements were paid by FFS as before, some preoperative checkups and medications for comorbidities, such as hypertension and diabetes, were shifted to the outpatient department. Finally, the introduction of generic drugs played a role in reducing medication charges. However, we did not examine the extent to which generic drugs were prescribed in this study due to the lack of detailed prescription data for some patients. In contrast, the reduction in procedure (surgeries) charges was much smaller than that of examination and medication charges. This was because expensive procedures, such as surgeries and hemodialysis, are not included in the prospective payment and are reimbursed by FFS in DPC/PDPS, and these procedures are essential for treatment and cannot be omitted or shifted to the outpatient department.

The per diem reimbursement system is viewed as providing weaker incentives to shorten LOS than per case reimbursement systems, such as DRG/PPS, and its effect on LOS depends on pre-determined hospital rates [8]. In this study, we found that DPC/PDPS significantly shortened LOS. This likely reflects gradual decreases in per diem payment as hospitalization lengthens under the DPC/PDPS system, which serves as an incentive to shorten LOS. These findings on the effects of resource usage are consistent with other reports.

We examined two indices for healthcare quality. Mortality rate was unchanged after DPC/PDPS implementation. However, the readmission rate due to premature discharge increased, which is inconsistent with previous observations made by studies that examined the effects of PPS. The increase in the number of patients who are discharged

Table 2
Univariate analysis of the effects of DPC/PDPS on resource usage and healthcare quality.

	FFS $n = 3935$	DPC/PDPS $n = 7224$	
Resource usage			
Total medical charge (US$)	$20,686	$18,218	$p < 0.001$‡
Procedures (surgeries)	$12,637	$11,458	$p < 0.001$‡
Examinations	$1781	$1098	$p < 0.001$‡
Medications	$1347	$865	$p < 0.001$‡
Length of stay (day)	20.2	17.1	$p < 0.001$‡
Heathcare quality			
Mortality rate	9.5%	10.1%	$p = 0.31$†
Readmission rate within 30 days	6.3%	6.5%	$p = 0.54$†

FFS: fee-for-service, DPC/PDPS: diagnostic procedure combination/per-diem payment system.
† Chi-square test.
‡ One-way ANOVA.

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Table 3
Effects of DPC/PDPS on resource usage and healthcare quality.

	Resource usage				Healthcare quality			
	Total medical charges (US$)		Length of stay (day)		Mortality rate		Readmission rate	
	Coefficient (95% CI)	*p*-Value	Coefficient (95% CI)	*p*-Value	Odds ratio (95% CI)	*p*-Value	Odds ratio (95% CI)	*p*-Value
Fixed effect								
Sex								
Male	Reference		Reference		Reference		Reference	
Female	182 (−345, 707)	0.50	0.95 (0.15, 1.74)	0.02	1.44 (1.25, 1.66)	<0.001	0.93 (0.78, 1.11)	0.39
Age								
<65	Reference		Reference		Reference		Reference	
65–74	1024 (449, 1600)	<0.001	1.47 (0.60, 2.34)	0.001	2.06 (1.64, 2.59)	<0.001	1.43 (1.18, 1.74)	<0.001
≥75	1586 (1014, 2158)	<0.001	4.34 (3.47, 5.20)	<0.001	4.37 (3.56, 5.37)	<0.001	1.43 (1.17, 1.74)	<0.001
Comorbidity (Charlson's index)	1436 (1173, 1699)	<0.001	2.66 (2.26, 3.06)	<0.001	1.09 (1.01, 1.17)	0.03	1.22 (1.12, 1.33)	<0.001
Procedure								
No procedures	Reference		Reference		Reference		Reference	
Percutaneous coronary intervention (PCI)	11,387 (10,799, 11,976)	<0.001	3.45 (2.56, 4.34)	<0.001	0.18 (0.15, 0.20)	<0.001	0.85 (0.69, 1.04)	0.09
Coronary artery bypass graft (CABG)	41,682 (40,387, 42,977)	<0.001	26.46 (24.5, 28.41)	<0.001	0.57 (0.40, 0.82)	0.002	1.47 (1.02, 2.13)	0.04
Time of admission (fiscal year)								
2001	Reference		Reference		Reference		Reference	
2002	−2027 (−3183, −872)	0.001	−2.84 (−4.58, −1.09)	0.001	0.77 (0.54, 1.08)	0.12	0.95 (0.64, 1.40)	0.77
2003	−4263 (−5864, −2661)	<0.001	−4.86 (−7.28, −2.44)	<0.001	0.51 (0.30, 0.86)	0.01	0.80 (0.46, 1.39)	0.42
2004	−4059 (−5685, −2433)	<0.001	−3.12 (−5.57, −0.67)	0.01	0.41 (0.24, 0.70)	0.001	0.67 (0.40, 1.13)	0.13
2005	−4842 (−6298, −3386)	<0.001	−4.04 (−6.24, −1.85)	<0.001	0.29 (0.18, 0.48)	<0.001	0.47 (0.29, 0.76)	0.002
2006	−3546 (−4958, −2135)	<0.001	−3.21 (−5.33, −1.09)	0.003	0.89 (0.61, 1.31)	0.54	0.49 (0.31, 0.78)	0.003
2007	−3433 (−4776, −2091)	<0.001	−3.26 (−5.27, −1.24)	0.002	0.67 (0.47, 0.96)	0.03	0.54 (0.36, 0.83)	0.005
2008	−3863 (−5434, −2292)	<0.001	−4.75 (−7.10, −2.40)	<0.001	0.93 (0.62, 1.40)	0.70	0.55 (0.34, 0.90)	0.02
2009	−4725 (−6530, −2919)	<0.001	−7.45 (−10.15, −4.74)	<0.001	1.09 (0.68, 1.74)	0.73	0.44 (0.25, 0.77)	0.004
Application of DPC/PDPS	−1061 (−2007, −116)	0.028	−2.29 (−3.71, −0.88)	0.002	0.94 (0.73, 1.21)	0.60	1.37 (1.03, 1.82)	0.04
Cluster effects								
Intraclass correlation (ICC)	0.063		0.055		0.046		0.064	
Median odds ratio (MOR)	–		–		1.46		1.57	

CI: confidence interval, DPC/PDPS: diagnostic procedure combination/per-diem payment system.

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Table 4
Adjusted effects of DPC/PDPS on the breakdown of medical charges.

Breakdown of medical charges	Adjusted effect[a] (95% CI)	p-Value	Proportion of reduction[b]
Total medical charge	−1061 (−2006, −115)	0.03	5.1%
Procedures (surgeries)	−387 (−1021, 248)	0.23	3.1%
Examinations	−323 (−413, −233)	<0.001	18.1%
Medications	−220 (−387, −52)	0.01	16.3%

CI: confidence interval.
[a] Adjusted by sex, age, comorbidity status, procedures, and time trend in the multilevel regression models.
[b] Calculated compared with FFS group averages.

to facilities other than home and stay longer in nursing homes contributes to the unchanged readmission rate in the United States, despite premature discharge [6,7]. Japan has more beds in acute care hospitals and fewer care facilities, such as nursing homes, than countries like the United States. These circumstances, which facilitate access to inpatient care even when nursing home care would suffice, may increase readmission rates in Japan.

We used a DID technique to incorporate the effect of trends. As a consequence, trends had considerable effects on both total medical charges and LOS. The official prices, which form the basis for reimbursement payments and had been reduced by the government every other year, contributed to reduced medical charges. However, the official price-induced reduction constituted only a small percentage of the total reduction. The remainder of the reduction can be attributed to improvements in efficiency, which must be further examined in future studies. Trends also remarkably shortened the LOS. This effect may also be due to improvements in efficiency. However, the mean LOS in Japan has been much longer than in other countries. The Organization for Economic Co-operation and Development (OECD) Health Data indicate that the mean LOS in Japan was 24.8 days in 2000 and 18.8 days in 2008 compared to 7.4 days and 6.5 days, respectively, for all the other OECD countries [1]. Thus, the major reason for reduced LOS may be that the LOS amended itself, irrespective of healthcare system reform. In addition to their effects on resource usage, trends also improved healthcare quality. While DID conferred some benefits, it also has some limitations. First, DID hypothesizes *a priori* that trends may affect both treatment and control groups. This hypothesis is difficult to verify. However, care fees are fixed by the government, and citizens are all insured and have universal access to healthcare in Japan. This universality of the Japanese healthcare system justifies the DID hypothesis. Another limitation is the possibility of an interaction between the implementation of DPC/PDPS and the time period [24]. Additional models used to examine the interaction between these two variables showed that the interaction had no significant effects on any of the four main outcomes. Finally, behavioral changes may occur just prior to treatment. To address this possibility, we tested models that included a dummy variable for one year before DPC/PDPS implementation and found no significant effects on any of the main outcomes.

In Japan, healthcare practice varies from hospital to hospital. Therefore, we adopted multilevel models to assess hospital-related variation and examine the effect of this variation on outcomes. These models revealed that the variance in hospitals accounted for only a few percent of the total variance in resource usage. Interestingly, these models determined that among all dependent variables, variation in hospitals was the most influential factor for healthcare quality. One of the goals of DPS/PDPS is to promote standardization of care. Further research will be needed to determine whether variations among hospitals influence standardization of care. Our results underscore the importance of other motives, such as public reporting for performance and pay for reporting, to improve healthcare quality. As with DID, multilevel models have some methodological challenges [30]. The main concern is model complexity. While a more complicated model likely reflects reality more accurately, such models require larger data sets and sample size calculations are complex. However, the dataset in this study was large enough to overcome this concern. The other issue is that group-level attributes cannot affect individuals independent of all individual-level attributes. This suggests an interaction between group-level and individual-level variables or between group-level variables and unaccounted individual-level attributes. In this study, we allowed only a random intercept for hospitals and did not include hospital-level variables. Hence, further studies are needed to examine the interaction between hospital-level and individual-level variables.

This study has some limitations. First, our study relied on inpatient claim data. This means that detailed clinical data are limited and, therefore, risk adjustment by severity of disease may be insufficient. Unavailable outpatient data made it impossible to examine the extent of the shift in activity from the inpatient to the outpatient department and to compare overall medical charges, including inpatient and outpatient activities, before and after DPC/PDPS implementation. On the other hand, the advantages of using administrative data are the large sample size and fast and inexpensive data collection [31]. These strengths overcame the shortcomings, particularly when considering that the purpose of the study was to examine the nationwide effect of healthcare system reform. The second limitation of this study is generalizability. We examined the effects of DPC/PDPS using AMI patients from our database. Hospitals were included in our database on a voluntary basis, which could have resulted in selection bias. However, characteristics of the participant hospitals were not so different compared to all hospitals which have implemented DPC/PDPS in Japan with respect to bed numbers, staffing, founders, teaching status, and geographical location. It would be interesting to determine how the results generalize to other diseases or other databases. The third limitation is that we assumed that the effect of DPC/PDPS was constant, irrespective of hospitals or the time period.

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But there is possibility that this effect was heterogeneous. However, the Japanese healthcare system is generally universal with respect to cost and access, and the interaction between the implementation of DPC/PDPS and the time period did not have significant effects on outcomes, which support our assumption about the constancy of the effect. Finally, DID and multilevel models have some methodological limitations, which have been discussed above.

5. Conclusions

Our results show that DPC/PDPS significantly reduced both inpatient total accumulated medical charges and LOS, and that these decreased over time. With respect to healthcare quality, mortality rate was unchanged, and the readmission rate was compromised. These results indicate that DPC/PDPS was associated with reduced resource usage, but not improved healthcare quality, as with DRG/PPSs in other countries. To achieve successful healthcare reform, further discussion on additional motives will be required.

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Conflicts of interest

None of the authors have any conflicts of interest associated with this study.

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Development of Patient-Oriented Costing System by Function Tracing

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1

Background

- Understanding patient-oriented costing is extremely important to developing an efficient system for providing high quality health care.
- The use of patient-oriented costing can also support the improvement of current levels of management efficiency and quality of health care.

2

Standardized Patient-Oriented Costing System

- Health care is an aggregate service in which patients receive treatment and care from various professionals in different settings and at different times, which makes the accurate calculation of patient-level costs extremely difficult.
- Despite these difficulties, there is increasing interest in the development of a standardized patient-oriented costing system from both individual hospitals and the government.

Lewis et al. 1996; Conteh et al. 2004.

Hospital-Level Perspective

- At the hospital level, standardized patient-oriented cost calculations are necessary for various aspects of business management
  - E.g. budget preparation and control, evaluation of cost and performance, establishment of management master plans.
- Cost calculations can also be used to support informed negotiations of fund procurement and as reference data for benchmarking.

Hospital-Level Perspective

- Accurate patient-oriented cost calculations may also improve certain attributes of care management, such as the planning and control of care, assessment of cost performance in care, patient safety and infection control. *Fukuda et al. 2009*
- The importance of the management ability of each hospital is also increasing, because hospital managers need to properly assess potentially-controllable costs in the context of rising medical expenditures.

Garattini et al. 1999; Madorran-Garcia et al.2004; Cardinaels et al. 2004.

Governmental perspective

- From a governmental perspective, standardized hospital cost calculations represent essential information used in the process of health care policy making, such as the development of reimbursement systems, estimation of financial resources required for health care services, and decision making based on economic evaluations.

Governmental perspective

- Previous studies have emphasized the need for payments to reflect the necessary costs.

- Although there have been previous studies that have addressed cost calculation for health care in Japan, it is difficult to apply their findings to hospital management and government policy making.

Governmental perspective

- A major caveat to the interpretation of the majority of these studies is the limitation of scope: these included limited cost coverage.
  - Personnel costs, which frequently account for the largest portion of the total cost, were not included
  - Limited diagnoses, and limited hospital departments.
- The traditional cost calculation systems used to quantify hospital costs are extremely time- and labor-intensive.

Objectives

The aim of this study was to develop a patient-oriented health care costing system that, when compared with traditional costing systems, is able to quantify costs with a greater accuracy using patient-oriented functions, as well as to produce these costs more efficiently with regard to data preparation and calculation.

9

METHODS
Database

- We developed a multi-institutional database in collaboration with the Ministry of Health, Labour and Welfare, Japan for a costing project based on traditional costing methods.

10