is expressed as 1, 2, 3, 4 or 5, which represent good condition to serious condition in numeric order.

To assess a patient's comorbidity status, we used an adaptation of the Charlson comorbidity index [10,11]. A patient was identified as having comorbidity if he/she had any of nine diseases coded in his/her diagnosis. The Charlson index score was then dichotomized as either having one or more comorbidity conditions or no comorbidity.

THC was calculated by summing up charges billed during hospitalization (1US$ = 120 Japanese Yen; JY) on a very detailed fee-for-service basis according to the social insurance medical fee schedule, which is uniform all over Japan. As a result, the charges are considered as very good estimates of the costs of health care.

Generally, THC consists of ten main items: first consultation charge, prescription charge, injection charge, treatment charge, operation charge, anesthesia charge, laboratory examination charge, diagnostic imaging charge, admission charge, and another generic charge covering hospital care and incidental expenses.

Under Japan's health insurance system, physician's fees are not identified as a separate line item on in the social insurance medical fee schedule. Instead, the Health Ministry groups all hospital employee labor fees into a single category. Though the law has strictly regulated these charges since the initiation of the medical fee schedule in 1961, prices have never been set on the basis of cost valuation [12].

In this study, we used two additional variables: the drug and examination charge (DEC) and DEC per day. DEC was calculated by adding up prescription, injection, laboratory examination, and diagnostic imaging charges. DEC per day was calculated by dividing DEC by LOS. In order to more closely examine the relationship between hospitals and total health care charges, we employed the following strategies: 1) we reduced the influence of LOS by dividing charges associated with hospitalization by LOS; 2) we excluded admission fees, which are fixed per day, and operation fees, which vary little among hospitals. Applying these rules we derived a new variable, which we call drug and examination charges (DEC) per day. In the following analysis, we review how this new variable is influenced by differences between hospitals.

During a five-year period, the hospitals we selected had a total of 1,589 elective surgical cases with LC, excluding one death case and eight urgent cases from all of the surgical cases with LC, and 576 elective surgical cases with OC, excluding six death cases and 19 urgent cases from all of the surgical cases with OC. Thus, a total of 2,165 patients who received cholecystectomy was analyzed in this study.

Statistical methods

We used the software package SPSS (version 11.0 for Windows) for statistical analysis. Continuous variables were analyzed by the Mann Whitney's test and discrete variables were analyzed by the chi-square test. An association between the use of LC and independent variables was described by an odds-ratio (OR) and a 95% confidence interval (CI) in logistic regression analysis. LOS was used as a dependent variable, with age, gender, comorbidity condition, ASA-PS, and three dummy variables for the four hospitals as independent variables in hierarchical multiple regression analysis. THC was also used as an independent variable in the analysis. LOS, age, gender, comorbidity condition, ASA-PS, and three dummy variables for the four hospitals were also used as independent variables in the hierarchical multiple regression analysis for total health care charges (THC). For variance among hospitals in LOS, THC and DEC per day, we made comparisons between the R^2s of each model. All reported p values were two-tailed, and the level of significance was $p < 0.05$.

Results

Table 1 shows the number of all elective surgical cases with cholecystectomy and those with LC and OC, by hospital. Hospital A had the most, with 742 LC cases, and Hospital B had the least, with 130 LC cases. Again, Hospital A had the highest proportion of LC to total cholecystectomy (742/810; 91.6%) within these hospitals and Hospital B had the lowest (130/378; 34.4%). The trend varied by hospital, but with the exception of the year 2000, the overall number of LCs performed increased year by year. Table 1 also presents the mean +/- S.D. of age, LOS, preoperative and postoperative days, and THC. As mentioned before, health care charges are good estimates of costs in the Japanese health insurance system.

Additionally, it reveals comorbidity condition and preoperative physical status (ASA-PS). The mean age of patients receiving LC and OC was 54.7 +/- 13.5 and 62.7 +/- 13.5 years, respectively. The mean LOS, preoperative and postoperative days (hospital stay before and after surgery) for LC and OC patients were 16.5 +/- 12.6 and 32.2 +/- 20.4 days, 9.2 +/-10.5 and 18.1 +/- 12.4, and 6.4 +/- 6.2 and 13.5 +/- 14.3 days, respectively, and the mean THC was 6,683 +/- 3,395 and 9,557 +/- 5,914 US$, respectively.

There were significant differences between and within the four hospitals in terms of LOS (p<0.001), preoperative and postoperative days (p<0.001), and DEC (p<0.001), although the data were not described in the text. Preoperative days varied by hospital and contributed to differences in LOS. Though it was not statistically significant, DEC varied by hospital and contributed to variation in THC (p=0.103).

Table 2 presents the results of the logistic regression analysis to identify factors associated with the choice of LC among all surgical cases with cholecystectomy at these four hospitals. The analysis revealed that patients who were female (p<0.001) and admitted to any of the four hospitals between 1998 and 2000 (p<0.001), and who had preoperative status of ASA-PS 1 (p=0.019), were significantly more likely to have an LC procedure. Comparison between the hospitals shows that patients who were admitted to Hospital D were significantly more likely to have an LC procedure than those admitted to Hospital A (p= 0.003). On the other hand, patients who were admitted to Hospital B and C were significantly less likely to have an LC procedure (p<0.001).

Tables 3, 4, and 5 present an exploration of factors associated with LOS, THC and DEC per day. We can see how the characteristics of hospitals influence LOS by excluding Model 1 from Model 2 (Table 3), and THC by excluding Model 4 from Model 5 (Table 4). We can also see how patients' characteristics influence THC by examining Model 3 (Table 4) and how LOS influence THC by excluding Model 3 from Model 4 (Table 4). Further, by excluding Model 6 from Model 7 we can see how the characteristics of hospitals influence DEC per day (Table 5).

Excluding characteristics of hospitals, Model 1 indicates that age (p<0.001), gender (p=0.003), and comorbidity condition (p<0.001) are significant factors contributing to LOS. The increment between the R^2_1 (0.080) of Model 1, which excluded the characteristics of hospitals, and the R^2_2 (0.108) of Model 2, which included the characteristics of hospitals, was 0.028 (p<0.001). This suggests that LOS is significantly associated with the characteristics of hospitals excluding the influence of patients' factor. The difference between the R^2_1 and the R^2_2 reveals the influence of hospitals, excluding the influence of patients in Model 1. That is, long LOS is explained by the increment between these two statistics.

The unexplained variance in Model 2 was 0.892 (1.000 - 0.108). This factor demonstrates a large remainder, which is not explained by the characteristics of patients and hospitals. Finally, the difference between hospitals was substantial, because it accounted for about one-quarter (0.028/0.108) of the explained R^2_2 (0.108).

On the other hand, Table 4 shows that THC was significantly associated with LOS, because the increment between the R^2_3 (0.105) of Model 3, which included patients' factors only, and the R^2_4 (0.635) of Model 4, which included both patients' factors and LOS, was 0.530 (p<0.001). Also, the increment between the R^2_4 (0.635) and the R^2_5 (0.649) of Model 5, which included patients' factors, LOS and the characteristics of hospitals, was 0.014 (p<0.001). By this analysis, THC has a small but statistically significant association with the characteristics of hospitals.

Similarly, when we consider Models 3, 4, and 5, THC is shown to be dependent on the hospital by the increment (0.014) between the R^2_4 and the R^2_5. Additionally, of the three factors, LOS, patients, and hospitals, THC was most explained by LOS, as shown by the increment (0.530) between the R^2_3 and the R^2_4. THC was therefore not heavily influenced by the hospital.

We also explored what factors were associated with DEC per day, which was calculated by summing up charges for prescriptions, injections, laboratory examinations and diagnostic imaging, and dividing by LOS. As presented in Table 5, DEC per day was not associated with age, gender, or ASA-PS, though there was a small but significant association with comorbidity condition (p=0.046). The increment between the R^2_6 (0.005) of Model 6, which included patients' factors only, and the R^2_7 (0.192) of Model 7, which included both patients' factors and hospitals' characteristics, was 0.187 (p<0.001). Therefore, DEC per day had a large and statistically significant association with the characteristics of hospitals.

The results of this analysis show that THC is heavily influenced by the patients' factors and LOS, and somewhat influenced by the hospitals' characteristics. LOS in turn is associated with the patients' factors. The influence of the hospital on THC was hidden by the influence of LOS. Finally, the unexplained variance in Model 5 (0.351=1.000 - 0.649) may be a large remainder caused by variation in the practice of LC.

Discussion

This study observed that the LOS and THC for LC across all elective surgical patients in the study were 16.5 +/- 12.6 days and 6,683 +/- 3,395 US$, respectively, shorter and lower than those of OC, which were 32.2 +/- 20.4 days and 9,557 +/- 5,913 US$, respectively. The mean THC for LC varied between the four hospitals from 6,070 to 9,031US$ and the mean LOS varied between 15.5 and 23.7 days.

In a recent Japanese study to investigate costs of surgery for cholelithiasis, the mean LOS for LC was found to vary between 6.6 and 29.3 days among 11 large Japanese teaching hospitals, including nine university hospitals, one community-based and one company-based hospital, with 837 general type beds (range: 353- 1,479). In the same study, the mean THC for LC was 6,187 +/- 2,539 US$ [13]. In a separate study, the first author of this study demonstrated a mean THC and LOS of 5,170 US$ and 10.9 days for patients without comorbidity, and 7,488 US$ and 20.5 days for patients with comorbidity, respectively, at a local, privately owned, mid-scale, teaching hospital in Japan. The LOS and THC reported in this study therefore were not especially long or expensive.

Though the WHO gave Japan top marks for overall health system attainment, compared with other developed countries, LOS in Japan is unusually long [14].

According to Jonsson's the documentation review with respect to LOS for LC in foreign countries [15], McIntyre's 1992 report from the US indicated a mean LOS for LC of 1.6 days. In the UK in 1994, Fullarton reported a mean LOS for LC of 4.8 days. Moreover, an LOS for LC of 5.1 days was reported in a study involving three countries: Germany, France, and the UK. In 1993, Health Care Technology observed a one-day LOS in a US-based study, and Beggren et al. reported an LOS for LC of 1.8 days in Sweden.

In terms of cost, research from other developed countries reports lower costs for LC. For example, in the US, the costs of LC varied between 4,693 and 6,471 US$. The costs in Belgium and the UK were about 2,035 and 3,500 US$, respectively. When Japan's unusually long LOS for LC is taken into account, hospital charges for LC may be comparable, or even lower, than in other developed countries. Though the LOS in the US was about one-third of that in Japan, the average of total charges during hospitalization in the was about 2.2 times higher than that in Japan [16].

In this study, we observed that length of hospital stay (LOS) increased as hospital stay before LC increased, that total health care charges (THC) increased as LOS increased, and that a combination of drug and examination charges (DEC) increased as THC increased. Specifically, DEC may be attributed to high THC, because the THC at Hospital B was 1.14 times that of Hospital D, and the DEC at Hospital B was 2.27 times that of Hospital D. Though other studies have attributed high health care charges to high admission charges, our data suggest that THC depended on DEC.

The results of this logistic regression analysis clearly illustrate the factors associated with the choice of LC. Though the four hospitals in this study were similar in terms of location and function, odds ratios for the choice of LC varied between 0.04 at Hospital B and 2.30 of Hospital D. Given the similarities between these four hospitals we would have expected odds ratios to be more uniform.

Most of the surgeons practicing at the four hospitals that participated in this study have been performing LC according to clinical pathways adopted by each hospital. The ratio of LC to OC therefore does not vary widely between the four study hospitals.

Hierarchical multiple regression revealed that the large variation in LOS for LC is better explained by patient factors ($R^2{}_1$=0.080) than by hospital factors ($R^2{}_2$ - $R^2{}_1$ = 0.028). Total charges associated with hospitalization were more influenced by LOS ($R^2{}_4$ - $R^2{}_3$ = 0.530) than by hospital factors (R^2_5 - R^2_4 = 0.014). Though combined drug and examination charges were less associated with hospitals factors, DEC per day was more significantly influenced by hospitals factors (R^2_7 - R^2_6 = 0.187) than by patient factors (R^2_6 = 0.005).

In short, LOS and total charges varied greatly even after adjusting patient factors, and DEC per day, which is closely related to practice patterns, was observed to vary widely both within and between the four hospitals. We may conclude that treatment for LC was not standardized and that length of stay was driven by social factors other than patient clinical characteristics.

From the socioeconomic viewpoint it is important for health care professionals to consider why this kind of practice variation occurs. However, previous to this study, few published reports examined the relationship between LOS, charges, and their socioeconomic factors. From the patient's perspective, socioeconomic factors contributing to LOS and total charges can include the following: 1) social insurance beneficiaries (patients) are responsible for co-payments that amount to only 30% of their total health care charges [17]; 2) patients typically expect to stay in the hospital, until their injuries are completely healed [18]; 3) popular belief in numerology leads patients to request discharge on a "good day" [16]; 4) patients who have private supplemental health insurance are likely to receive larger reimbursements for longer hospital stays.

Another factor that contributes directly to overall LOS and DEC per day is preoperative length of stay. At Hospital B for example, as not shown in the text, preoperative days were 9.2 +/- 10.5 and total LOS was 17.4 +/- 9.3. LOS increased as preoperative days increased. In Japan, laboratory tests and diagnostic imaging before surgery are often performed in an in-patient care setting. As another common practice, antibiotic treatment of cholecystitis is sometimes continued for a few days in an in-patient care setting before the surgery is performed. Both practices contributed to longer preoperative and overall LOS.

A lack of clinical guidelines for LC contributes to the strength of hospital factors as determinants of the observed variation. In addition, under a fee-for-service payment system, with a fee schedule that does not include surgeon fees, economic incentives exist to prescribe more drugs, order more laboratory tests and imaging.

In the Japanese health care payment system, the concept of "physician fees" does not exist. Physician-related expenses are supposedly amortized across various fee categories such as procedure, laboratory tests, diagnostic imaging, hospitalization and so on. Regarding in-patient care, the health insurance system reimburse to hospitals, not to physicians. Physicians are salaried and employed by hospitals. In fact, physicians may be censured for billing patients directly for their services. By law, patients are required to cover their fair share of medical services, but only as defined by the medical fee schedule.

Moreover, variations in claims review process between prefectures and a lack of claims review standards and reviewer selection criteria also contribute to the observed variation in total charges and DEC per day. However, these socioeconomic factors are complex and we were unable to determine the extent to which each of these factors influenced the participant hospitals.

Judging from the variation of LOS and total charges within and between the subject hospitals, under Japanese universal health care system on a fee-for-service basis, both the daily health care process and the total course of health care seem to vary widely within and among hospitals. For patients delivered with health care, health care should not be originally influenced by patient preference and provider practice patterns, and when health care is not provided fairly and equally, a health care system has to lead health care in the right direction through the standardization.

We propose several measures to manage the variations in LOS, total charges, and combined drug and examination charges observed in the study. One important measure is to standardize treatments and diagnostic examinations for LC on the basis of evidence.

Relevant surgical associations or the government must develop guidelines for LC covering laboratory tests, diagnostic imaging, procedures, and clinical pathways. In order to establish a standard for LC, it is desirable to have evidence data for clinical effectiveness and efficiency.

Secondly, one has to consider the scheme of economic incentives. In April 2002, the Health Ministry initiated a new per diem reimbursement system based on casemix classification similar to the DRG-PPS in the US, in hopes of achieving reductions, inpatient expenditures, and length of hospital stay, and a shift in emphasis from inpatient to outpatient care [19].

Third, the establishment of the standard training, evaluation and credential system of surgeon for LC could have the great potential for standardization of care process. This kind of credential movement will be facilitated particularly when the "physician fees" for such expertise are assured in a future reimbursement system.

In the current drastic changes under the health care reforms, potential measures for standardization like the above can be considered as feasible and promising. In such standardization process, analysis based upon actual data as seen in our study will play very important role in evaluation and planning for the new system of higher quality and efficiency.

Conclusion

After controlling for patient factors at the four participant hospitals, substantial variation in the length of hospital stay and charges associated with elective laparoscopic cholecystectomy remained. Combined drug and examination charges per day were strongly dependant on the hospital, which implies that the process of care also varied widely. Intra-hospital variation was also found to be very large.

This study demonstrates that a tremendous opportunity exists to improve the quality and efficiency of health care delivery in Japan through the standardization of treatment. The results of this study have serious implications for national policy and for individual providers engaged in the on-going process of health care reforms.

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References

[1] Cuschieri A, Dubois F, Mouiel J, et al. The European experience with laparoscopic cholecystectomy. Am. J. Surg. 1991;161:385-387

[2] Muhe E.: Die erste Cholecystektomie durch das Laparoskop, Langenbeck's Arch. Klin. Chir. 1986;369:804

[3] Kano N, Yamakawa T, Ishikawa Y, et al. Laparoscopic cholecystectomy: a report of 409 consecutive cases and its future outlook. Surg Today. 1994;24:399-402

[4] Rosen MJ, Malm JA, Tarnoff M, et al. Cost-effectiveness of ambulatory laparoscopic cholecystectomy. Surg. Laparosc. Endosc. Percutan. Tech. 2001;11:182-184

[5] Kitano S, Matsumoto T, Aramaki M, et al. Laparoscopic cholecystectomy for acute cholecystitis. J. Hepatobiliary Pancreat. Surg. 2002;9:534-537

[6] Bosch F, Wehrman U, Saeger HD, et al. Laparoscopic or open conventional cholecystectomy: clinical and economic considerations. Eur. J. Surg. 2002;168:270-277

[7] McPherson K, Wennberg JE, Hovind OB, et al. Small-area variations in the use of common surgical procedures: an international comparison of New England, England, and Norway. N. Engl. J. Med. 1982;307:1310-1314

[8] Perrin JM, Homer CJ, Berwick DM, et al.Variations in rates of hospitalization of children in three urban communities. N. Engl. J. Med. 1989;320:1183-1187

[9] American Society of Anesthesiologists. ASA Physical Status Classification System, Available from: http://www.asahq.org/clinical/physicalstatus.htm

[10] Charlson ME, Pompei P, Ales KL, et al. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J. Chronic Dis.

1987;40:373-383

[11] Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorobidity index for use with ICD-9-CM administrative databases. J. Clin. Epidemiol. 1992;45:613-619

[12] Campbell JC, Ikegami N. The art of balance in health policy. New York, Cambridge University Press, 1998

[13] Konishi T, Hiki Y, Yamaguchi T, et al. Costs of surgery for cholelithiasis at the 11 Japanese hospitals. J. Jpn. Surg. Assoc. 2000;61:587-594 [*in Japanese*]

[14] World Health Organization. The World Health Report 2000, Paris, 2000

[15] Jonsson B, Zethraeus N. Costs and benefits of laparoscopic surgery –A review of the literature. Eur. J. Surg. 2000;585:48-56

[16] Ikegami N, Campbell JC. Containing Health Care Costs in Japan. Ann Arbor, The University of Michigan University Press, 1996

[17] Hirose M, Imanaka Y, Ishizaki T, et al. How can we improve the quality of health care in Japan? –Learning from JCQHC hospital accreditation. Health Policy 2003;66:29-49

[18] Ishizaki T, Imanaka Y, Hirose M, et al. A first look at variations in use of breast conserving surgery at five teaching hospitals in Japan. Int. J. Qual. Health Care 2002;14:411-418

[19] Campbell P, Kane NM. Physician-management relationships at HCA: a case study. Journal of Health Politics, Policy and Law 1990;15:591-605

Table 1. Characteristics of cholecystectomy cases at four teaching hospitals

		Laparoscopic cholecystectomy	Traditional open cholecystectomy	P value
Number of cases		1,589	576	< 0.001*
Average age (mean +/-SD)		54.7 +/-13.5	62.7+/-13.5	< 0.001#
Gender male/female		719/870	311/265	< 0.001*
Length of hospital stay (mean +/-SD)		16.5+/-12.6	32.2+/-20.4	< 0.001#
Preoperative days (mean +/-SD)		9.2+/-10.5	18.1+/-12.4	< 0.001#
Total health care charges (mean +/-SD)		6,683 +/-3,395	9,557+/-5,914	< 0.001#
		Number of cases	Number of cases	
Comorbidity condition	absent	1,427	461	< 0.001*
	present	162	115	< 0.001*
ASA-PS	ASA-PS=1	626	157	< 0.001*
	ASA-PS=2+	900	388	< 0.001*
Year of Surgery	1996	295	172	< 0.001*
	1997	306	191	< 0.001*
	1998	348	79	< 0.001*
	1999	352	78	< 0.001*
	2000	288	56	< 0.001*
Hospitals	Hospital A	742	68	< 0.001*
	Hospital B	130	248	< 0.001*
	Hospital C	334	238	< 0.001*
	Hospital D	383	22	< 0.001*
Patients with any comorbodity (%)		10.2%	20.0%	< 0.001*

Note; *chi square test #t test
The number of unknown cases as following;
ASA-PS; laparoscopic cholecystectomy: 64, traditional open cholecystectomy: 1,
Comorbidity Condition: laparoscopic cholevystectomy: 1, traditional open cholecystectomy: 2
ASA-PS2+ includes ASA-PS2, ASA-PS3, and ASA-PS4.

Table 2. Factors associated with laparoscopic cholecystectomy between 1996 and 2000 -Logistic regression analysis

Independent variables (n)	Odds ratio	95% Confidence Interval	*P* value
Age	0.96	0.95- 0.97	<0.001
Gender			
male (719)	1.0		
female (870)	1.95	1.51- 2.52	<0.001
Comorbidity condition			
absent (1427)	1.00		
present (162)	0.78	0.55- 1.11	0.165
Preoperative status			
ASA-PS=1 (626)	1.00		
ASA-PS=2* (900)	0.69	0.51-0.94	0.019
Year of surgery			
1996 (295)	1.00		
1997 (306)	1.29	0.90- 1.84	0.160
1998 (348)	5.78	3.86- 8.66	<0.001
1999 (352)	4.01	2.67- 6.03	<0.001
2000 (288)	3.76	2.42- 5.84	<0.001
Hospitals			
Hospital A (742)	1.00		
Hospital B (130)	0.04	0.03- 0.06	<0.001
Hospital C (334)	0.12	0.09- 0.17	<0.001
Hospital D (383)	2.30	1.32- 4.00	0.003

(n) means number of cases

Table 3. Factors associated with length of hospital stay of laparoscopic cholecystectomy at four hospitals

-Hierarchical multiple regression analysis

		Length of Hospital Stay				
		Non-Standardized coefficient		Standardized coefficient	*P* value	R^2_n
		B	SE	beta		
Model 1	Constant	7.85	1.67		<0.001	
	Age (for one year)	0.20	0.02	0.217	<0.001	
	Gender (for females)	-1.81	0.62	-0.072	0.003	$R^2_1 = 0.080$
	Comorbidity condition	5.44	1.04	0.131	<0.001	
	ASA-PS	0.11	0.68	0.004	0.877	
Model 2	constant	6.45	1.75		<0.001	
	Age (for one year)	0.19	0.02	0.206	<0.001	
	Gender (for females)	-1.88	0.61	-0.075	0.002	
	Comorbidity condition	4.79	1.03	0.116	<0.001	$R^2_2 = 0.108$
	ASA-PS	0.77	0.68	0.030	0.262	
	Hospital A	0.76	0.77	0.030	0.324	
	Hospital B	7.86	1.23	0.176	<0.001	
	Hospital C					
	Hospital D (Reference)	0.18	0.92	0.006	0.843	
					$R^2_2 - R^2_1$	$= 0.028$ ($p < 0.001$)

Table 4. Factors associated with total health care charges for laparoscopic cholecystectomy at four hospitals
-Hierarchical multiple regression analysis

		Total Health Care Charges				
		Non-Standardized coefficient		Standardized coefficient	*P* value	R^2_n
		B	SE	beta		
Model 3	Constant	4092.35	453.46		<0.001	
	Age (for one year)	50.82	6.56	0.213	<0.001	
	Gender (for females)	-574.54	168.29	-0.086	0.001	$R^2_3 = 0.105$
	Comorbidity condition	1811.69	283.85	0.165	<0.001	
	ASA-PS	334.58	185.91	0.049	0.072	
Model 4	Constant	2636.29	291.35		<0.001	
	Age (for one year)	12.64	4.27	0.053	0.003	
	Gender (for females)	-266.93	107.68	-0.040	0.013	$R^2_4 = 0.635$
	Comorbidity condition	792.30	182.66	0.072	<0.001	
	ASA-PS	251.42	118.73	0.037	0.034	
	LOS	199.86	4.42	0.757	<0.001	
					$R^2_4 - R^2_3 = 0.530$	($p < 0.001$)
Model 5	Constant	2236.00	301.34		<0.001	
	Age (for one year)	12.33	4.20	0.052	0.003	
	Gender (for females)	-263.22	106.18	-0.040	0.013	
	Comorbidity condition	739.63	179.72	0.067	<0.001	
	ASA-PS	408.30	118.60	0.060	0.001	$R^2_5 = 0.649$
	LOS	195.41	4.42	0.740	<0.001	
	Hospital A	478.16	131.92	0.072	<0.001	
	Hospital B	1072.43	215.97	0.089	<0.001	
	Hospital C	-292.11	154.24	-0.036	0.058	
	HospitalD (Reference)					
					$R^2_5 - R^2_4 = 0.014$	($p < 0.001$)

Note: LOS, length of hospital stay.

Table 5. Factors associated with drug and examination charges per day of laparoscopic cholecystectomy at four hospitals
-Hierarchical multiple regression analysis

		Drug and Examination Charges Per Day				
		Non-Standardized coefficient		Standardized coefficient	*P* value	R^2_n
		B	SE	beta		
Model 6	Constant	85.18	5.92		< 0.001	
	Age (for one year)	0.09	0.09	0.033	0.273	
	Gender (for females)	- 0.13	2.20	- 0.002	0.954	R^2_6 = 0.005
	Comorbidity condition	7.43	3.73	0.057	0.046	
	ASA-PS	- 0.93	2.45	- 0.012	0.704	
Model 7	constant	55.04	5.63		< 0.001	
	Age (for one year)	0.07	0.08	0.024	0.389	
	Gender (for females)	-1.15	1.99	-0.015	0.564	
	Comorbidity condition	4.82	3.38	0.037	0.154	
	ASA-PS	5.37	2.25	0.067	0.017	R^2_7 = 0.192
	Hospital A	37.62	2.39	0.478	< 0.001	
	Hospital B	38.84	3.84	0.285	< 0.001	
	Hospital C	9.10	3.23	0.082	0.005	
	Hospital D (Reference)					
					$R^2_7 - R^2_6 = 0.187$	($p < 0.001$)

V．手術における原価（人件費）と診療報酬

Inequity in the price of physician activity across surgical procedures

〔要約〕

医療システムにおいて診療報酬制度は合理的であることが求められており、例えば、医師の医療行為に対しては、費やされる時間や技術的な難度を反映した支払金額（医師技術料）を決定することが重要である。しかし、現在の手術に対する診療報酬においては、医師技術料のほかにどのような構成要素が含まれているのか、あるいは医師技術料相当分はどの程度なのかはっきりしていない。したがって本研究では、手術に対する診療報酬のうち、医師の医療行為に対する時間あたりの報酬額（医師技術料）相当分を明確にすることを通して、手術に対する診療報酬制度を考察することを目的とする。

本研究では、協力の得られた 11 の臨床研修指定病院の診療情報データベースの中で、登録症例が多い 22 の手術を対象に以下の分析を行った。まず、手術に対する診療報酬のうち時間あたりの医師技術料相当分を明確にするために、現在の診療報酬の中に含まれていると考えられる原価構成要素を定義した。次に、手術に対する規定の診療報酬額から医師技術料以外の原価部分を差し引くことで医師技術料相当分を推定した。その際、手術の診療報酬に含まれる高額の診療材料費は外科系学会社会保険委員会連合（外保連）の試算や独自調査で収集したデータを用いた。また、医療機器・設備・施設費は、算出の方法により幅が生じることが想定されたため、ゼロとした場合（ケース 0)、外保連による試算を用いた場合（ケース 1)、医療経済研究機構による試算を用いた場合（ケース 2）の 3 つのケースで推定した。また、時間あたりや医師一人換算あたりの数値を求めるために、手術に携わるスタッフの職種や人数に関しては外保連が収集したデータを、手術時間に関しては上記の 11 協力病院から実際に収集したデータを用いた。最後に、算出した医師技術料相当分について手術間におけるばらつきの検討やその金額と手術時間や難度（外保連により該当手術を執刀するのに必要だと推定した経験年数）との関係についての検討を行った。（1 ドル 110 円換算）

一時間あたりの技術料相当分（医師一人あたり換算）の平均は、ケース 1 の場合 6,700 円(61.0 米ドル)、ケース 2 の場合 13,400 円(121.5 米ドル)となり、概して低い値であった。手術間の比較では、ケース 1 の場合-3,080～26,100 円(-28～237 米ドル)、ケース 2 の場合 660～36,100 円(6～328 米ドル)と大きくばらついた。手術時間との関係では、2 時間以内の手術では短時間の手術であるほど時間あたりの技術料相当分の金額が大きくなる傾向であった。難度との関係では難度が上がるほど金額が上がる傾向は明らかでなく、同じ難度の手術間でのばらつきは大きかった（難度 10 の手術で、-3,080～19,400 円(-28～176 ドル))。

手術に対する現行の診療報酬制度を分析したところ、「医師の技術に対する報酬は概して低く、マイナスと見なしうる場合もある」、かつ「手術間のばらつきが大きく、難度にもあまり関係しない」という結果であり現行の診療報酬制度は合理的と言えないことが示唆された。本研究結果に基づくと、合理的な診療報酬制度を確立するためには、①現在の手術に対する診療報酬における構成要素の整理とその主要部分である技術料の構成要素の定義を明確にすること、②技術料に関し

ては費やされる時間や難度を反映させるモデルを構築すること、③実際の価格は「実証データを用いたコスト評価」と「コストと報酬との関係のモデル化」を経て合理的に決定されること、が政策的に求められていると考えられる。

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Inequity in the price of physician activity across surgical procedures

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Abstract

Objectives: A rational payment system is being sought in Japanese health care - one that accurately reflects the required time and the level of technical difficulty when valuing physician activity. The objective of this study is to examine the current surgical payment system in Japan by clarifying the hourly values allocated to physician activity.

Methods: This study focused on the twenty two surgical procedures most frequently registered in our study database of administrative data gathered from eleven teaching hospitals in Japan. The current fee-for-service reimbursement system does not formally define which cost components surgical fees cover. It was therefore necessary for us to examine directly each reimbursement item to determine which component it represented. Next we examined the current system from the following viewpoints: 1) variation in the hourly values allocated to physician activity, for an individual surgeon or a surgical team, among types of surgery by using the actual data; and 2) the association between the hourly values and the operation time or the level of technical difficulty.

Results: The hourly values allocated to physician activity were low (61.0 dollars and 121.5 dollars per a surgeon: means of case 1 and case 2 estimations). The hourly values varied inequitably among types of surgery (from -28 to 237 dollars and from 6 to 328 dollars: ranges in the case 1 and case 2 estimations). When long surgeries were excluded, shorter surgeries tended to have higher hourly values. The association between the hourly values and the difficulty level was less clear and their variation was large even at the same difficulty level.

Conclusion: In the current payment system, the surgical fee is deemed to include fee for physician activity as well as materials, equipment and so on. To develop a rational payment system, first, the scope of the surgical fee and that of the physician activity fee should be separated and clearly defined. Second, the latter should be modeled to reflect the manpower volume and the level of technical difficulty needed for each surgical procedure. Third, fees should be set by utilizing the cost estimates with empirical data.

1. Introduction

In Japan, most health care providers are reimbursed on a fee-for-service basis according to the fee schedule that sets prices uniformly at the national level [1]. However, increasing medical demands and protracted economic recession necessitate a reform of this payment system. The Japanese Ministry of Health, Labour and Welfare has undertaken a review of the reimbursement system in an effort to determine the factors that drive hospital and physician fees [2]. In a trial initiated in April 2002, the majority of the fees billed by advanced treatment hospitals are being reimbursed through a prospective payment system based on a Japanese casemix classification. However, a concrete policy regarding physicians' fees remains open, although the policy direction has been decided: considering the difficulty level, the time, and the technical capability in evaluating physician activity.

The current fee-for-service reimbursement system does not formally define which cost components are covered by the surgical fee. The current system lists only the total prices for surgical procedures and some materials. This lack of detail gives the impression that the reimbursement scale is occasionally unfair. In fact, it is uncertain whether the prices are appropriate or not.

The Japanese Joint Committee of Social Insurance by the Multidisciplinary Group of Surgical Associations (GAIHOREN) developed the original calculation method for surgical fee reimbursements. According to the latest report [3] published in December 2003, the reimbursement levels are based exclusively on staff costs. The report explains how the level of technical difficulty, number of attending staff and the operation time are estimated based on data from the Japanese Surgical Societies, and presents approximate prices. However, this trial has the limitation of using only estimated values, and not actual data, such as operation time.

It is essential to judge as accurately as possible whether the evaluation of physician activity in the published surgical fees is appropriate. The purpose of this study is to examine the current surgical payment system in Japan from the following viewpoints: 1) variation in the hourly values allocated to physician activity, for an individual surgeon or a surgical team, among types of surgery by using the actual data; 2) the association between the hourly values and the operation time or the level of technical difficulty. This is a necessary first step toward establishing an appropriate surgical payment system in Japan.

2. Methods

2.1. Study surgery

We selected only those surgical procedures that were represented by 50 or more cases in our study database that included both appropriate coding and operation time data. Twenty two procedures met these criteria. Their names and corresponding procedure codes of International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9CM) were: 1) Open reduction of fracture (scapula, brachial, thigh) (79.21, 79.25, 79.29, 79.31, 79.35, 79.39); 2) Meniscectomy (80.6); 3) Arthroplasty with prosthetic replacement (shoulder, groin, knee) (81.52, 81.54, 81.81); 4) Incision of brain (01.39); 5) Clipping of aneurysm (one spot) (39.51); 6) Intraocular lens insertion with cataract removal (13.7); 7) Tonsillectomy (28.2); 8) Removal of lung cancer (lobectomy) (32.3, 32.4); 9) Coronary-artery bypass graft surgery (two or more grafts) (36.10, 36.12, 36.13, 36.14); 10) Repair of inguinal hernia (53.0, 53.1); 11) Cholecystectomy (51.22); 12) Laparoscopic cholecystectomy (51.23); 13) Appendectomy (47.09); 14) Colostomy (46.1); 15) Excision of hemorrhoids (49.46); 16) Removal of calculus or foreign body from bladder without incision (57.0); 17) Transurethral resection of prostate (60.29); 18) Excision of uterus lesion and hysteroscopy (68.29); 19) Total hysterectomy (68.4, 68.59); 20) Cesarean section (emergency) (74); 21) Cerclage of cervix (Shirodkar, Lash) (67.5); and 22) Abortion (less than 11 weeks of gestation) (69.01, 69.51).

2.2. Analysis framework

Neither the pricing mechanism of the surgical fee nor the scope of which costs are to be covered by the surgical fee is clear. We therefore clarified them by examining each reimbursement item to determine which component it represented, and by clarifying the remaining components that the surgical fee should cover. As Table 1 shows, it is reasonable that surgical fees basically include staff costs, partial material costs and facility and equipment costs. In this study, we assumed that this is the basic composition.

For material costs, in certain surgeries, large material costs are included. We therefore verified those costs when necessary. For facility and equipment costs, it is uncertain how facility and equipment unit costs should be estimated although they should probably increase in proportion to time. We therefore used three kinds of facility and equipment costs in calculating hourly values for physician activity. For the operation time, we increased the figure by 30 percent from collected actual data for estimating hourly values because we need to take pre- and post- operation time into consideration, but the time added was a minimum of 30 minutes and a maximum of 120 minutes. This value of 30 percent was adopted based on the method used by the GAIHOREN report (4th edition) [4] and the results of interviews to surgeons.