表 2.　解析項目例

大項目	中項目	小項目	例
症例数		疾患別	1 年間に急性心筋梗塞の診断を受けて入院した全患者数
		術式別	1 年間の CABG 施行数
在院日数		全在院日数	急性心筋梗塞の診断にて入院した全患者の平均在院日数
		術前在院日数	胆嚢切除術を受けた患者の術前平均在院日数
		術後在院日数	胆嚢切除術を受けた患者の術後平均在院日数
1 入院あたり医療費	出来高払い	手術・処置・麻酔費	
		薬剤費	
		画像診断費	
		検査費	
		入院費	
	包括支払い	出来高部分の医療報酬	
		包括部分の医療報酬	
治療	術式の違い		子宮筋腫に対して外科的治療を受けた患者に対する術式の違い
	抗生剤の使用量		胃切除術における患者 1 人あたりの平均抗生剤投与量と抗生剤の種類
	輸血の施行率		入院中に輸血を受けた大腿骨頚部骨折患者の割合
	治療のタイミング		急性心筋梗塞に対して、Primary PCI が施行された割合
	特定の患者群における手術施行率		子宮筋腫に対して外科的治療を受けた 35 歳以下の患者における子宮全摘出術の割合
患者アウトカム	死亡率	疾患別（リスク調整済）	急性心筋梗塞患者の入院死亡率
		術式別（リスク調整済）	CABG 後 1 ヶ月以内の死亡率
	退院時の状態	ADL、神経学的予後など	
		退院先	脳梗塞で入院した患者のうち、自宅に退院した患者の割合
	再入院率	6 ヶ月（2 週間・1 ヶ月）以内の予期せぬ再入院率	急性心筋梗塞の診断にて入院し、退院した患者のうち、6 ヶ月以内に虚血性心疾患のために予期せぬ再入院をした患者の割合
	入院中の合併症	合併症登録率	肺炎・尿路感染症など
		医療エラーを示唆する合併症の登録率	中心静脈カテーテル挿入後、気胸が報告された症例数

Ⅲ．大腿骨頚部骨折患者の医療資源消費の関連要因の検討

Association of hospital resource use with comorbidity status and patient age among hip fracture patients in Japan.

〔要約〕

本研究では、整形外科手術を受けた大腿骨頚部骨折患者を対象に、副傷病の存在や患者の年齢が入院医療における資源消費量との間に関連が認められるかどうか検討した。解析に用いたデータは、日本国内の代表的な民間の臨床研修施設の中から得られた４施設の入院データである。1996年1月から2000年8月までの間に、大腿骨頚部骨折で入院し手術を受けた65歳以上の患者778名を解析対象とした。対象者の平均年齢は80.3（標準偏差7.3）歳であった。

入院医療資源として、総在院日数、術前・術後在院日数、入院医療費総額、検査・画像診断費、手術・麻酔費、手術時間を用い、線形混合モデルを用いて入院医療資源に関連する要因を解析した。

平均在院日数は45.9日、平均入院医療費総額は1,740,000円(14,495.0米ドル)であった。線形混合モデルによる解析の結果、年齢（高齢）は手術時間（短時間）と有意に関連しており（$P < 0.01$）、また、副傷病名の存在は総在院日数（長期）、術後在院日数（長期）、検査・画像診断費（高額）、そして手術時間（短時間）と有意に関連していた（$P < 0.05$）。

これらの解析結果から、手術を受けた大腿骨頚部骨折患者で副傷病名を有する患者は、入院中により多くの医療資源を必要とするが、高齢患者が多くの医療資源を必要とすることについては有意な関連は認められなかった。

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Association of hospital resource use with comorbidity status and patient age among hip fracture patients in Japan.

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Abstract

Objectives: This study examined the association of resource use with comorbidity status and patient age among hip fracture patients who underwent surgical treatment. Design: We used a database from the Voluntary Hospitals of Japan Quality Indicator Project that involved 10 privately owned leading teaching hospitals in Japan. Setting: Four of these hospitals in Japan. Participants: We selected 778 operable hip fracture patients aged 65 or older who were admitted to these hospitals between January 1996 and August 2000 (mean age: 80.3±7.3 years). Measurements: A linear mixed model was performed to identify factors associated with the resource use, such as total length of stay (LOS), LOS before surgery, LOS after surgery, total hospital charges, charges for diagnostic examinations, charges for surgery, and length of theater time, among operable hip fracture patients. Results: The mean LOS was 45.9 days, and the mean total hospital charges were US$14,495.0. Results from linear mixed models revealed that higher age was significantly associated with shorter length of theater time ($P < 0.01$), and that the presence of comorbidity among hip fracture patients was significantly associated with longer total LOS ($P < 0.01$), longer LOS after surgery ($P < 0.001$), higher charges for diagnostic examinations ($P < 0.001$), and shorter length of theater time ($P < 0.01$). Conclusion: These results suggest that the presence of comorbidity among operable hip fracture patients requires greater resource use during their hospital stay, but higher age is not significantly associated with greater resource use at all.

INTRODUCTION

It is often said that total health expenditures increase with age among older patients. Some studies have failed to identify any association between advanced age and higher health expenditure [1], while others identified just such an association [2-4]. On the other hand, some studies revealed that comorbidity status rather than age was significantly associated with

higher costs in acute care settings [1, 5]. Since we consider that inconsistency among these results may be caused by differences in required treatment among study subjects [3, 5, 6], we must take into account each specific disorder when we examine whether or not resource use for older patients is greater than that for younger patients.

In an aging society, hip fracture is an important outcome for patients with osteoporosis. In Japan, the incidence of hip fracture among women aged 70 to 79 was estimated as 40 per 10,000 persons per year in 1997 [7]. Because patients with hip fracture are almost always in need of hospitalization, surgical treatment, and rehabilitation, they become a heavy socioeconomic burden to any society. However, few studies have examined the association of hospital resource use with patients' age and comorbidity status among hip fracture patients [8], despite several studies having identified actual costs for acute care as well as rehabilitative care for them [9-11]. Because the national health expenditures in Japan annually increase as the population of older people increase, the Japanese government tries to reform payment system of health care for older people. We believe that it is important for health authorities in aging countries to examine whether or not resource use for older patients is greater than that for younger patients. In this study, we examined the association of patient age and comorbidity status versus hospital use among hip fracture patients in Japan.

METHODS

Data Sources

This study was approved by the Institutional Review Board of Faculty of Medicine, Kyoto University Graduate School of Medicine, Japan. We used a database from the Voluntary Hospitals of Japan Quality Indicator Project that involved 10 privately owned leading teaching hospitals in Japan [12]. These hospitals are located in Hokkaido, in the north, throughout Honshu, the main island of Japan, to Kyushu, in the south. Records of all discharged cases have been collected from these hospitals since 1995. In this particular study, we selected four out of 10 teaching hospitals that had more than 90 admissions of hip fracture patients from January 1996 to August 2000. All four hospitals provided community residents with tertiary care. The mean number of general beds in the four hospitals was 692 in 2000. Each hospital in this study had similar characteristics to the teaching hospitals. Because the database involved all inpatient admissions, only hip fracture patients who underwent surgical treatment were included as the subjects in this study. To identify hip fracture patients among all inpatients admissions in the database, we used the International

Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM). We used the selected hip fracture diagnostic code (820.xx) for primary diagnosis. In addition, to determine the type of hip fracture surgery performed, we used ICD-9-CM procedure codes. We used hip replacement (81.51 and 81.52) and open reduction of hip fracture with internal fixation (79.3).

Definition of Variables

The variables used in this study were age, gender, hospital, surgical procedure, comorbidity status, place of residence before admission, discharge destination, total length of hospital stay (LOS), LOS before surgery, LOS after surgery, total charges during hospitalization, charges for diagnostic examinations, charges for surgery, and length of theater time. The surgical procedure was classified as either hip replacement or open reduction of hip fracture with internal fixation. To assess comorbidity conditions we used the Dartmouth-Manitoba adaptation of the Charlson comorbidity index [13-15]. A patient was identified as having comorbidity if he/she had any of the following diseases coded in his/her diagnosis: peripheral vascular disease, dementia, chronic pulmonary disease, connective tissue disease, mild liver disease, diabetes, diabetes with end organ damage, renal disease, any tumor including leukemia and lymphoma, moderate and severe liver disease, or metastatic solid tumor. Then comorbidity status was divided into two groups with one or more comorbidity condition and no comorbidity. Total charges for the study subjects were calculated by summing any charge billed during hospital stay (US$1 = JPN¥120) (e.g. diagnostic tests, imaging, prescriptions, injections, surgery, anesthesia, in addition to room, board, nursing, and physician's management on a daily basis). Charges for diagnostic examinations were calculated by summing charges for laboratory tests and imaging. Charges for surgery were calculated by summing charges for surgery and anesthesia.

Four hospitals had a total of 865 hip fracture admissions with surgical treatment over a four-year and eight-month period. We excluded 87 hip fracture patients who stayed in hospital for more than 90 days. Thus, a total of 778 patients who underwent surgical treatment were analyzed in this study.

Statistical Analysis

Differences in patients' characteristics by hospital were analyzed for continuous variables by one-way analysis of variance, and for categorical variables by Fisher exact test.

Differences in hospital resource use by age group and comorbidity status were analyzed for continuous variables by either Mann Whitney test, a one-way analysis of variance, or the Kruscal Wallis test, and for categorical variables by Fisher exact test. A linear mixed model, which involved both fixed- and random-effects factors, was then performed to identify factors associated with the resource use [16]. Dependent variables in the linear mixed model were total LOS, LOS before surgery, LOS after surgery, total hospital charges, charges for diagnostic examinations, charges for surgery, and length of theater time. All of them were assumed to be normally distributed in each model. Independent variables in the model were age, gender, surgical procedure, hospital, and comorbidity status. Discharge destinations were also used as an independent variable in the model for total LOS, LOS after surgery, and total hospital charges. LOS was also used as an independent variable in the model for total hospital charges. In the linear mixed models in this study, hospital was used as a random-effects factor and other independent variables were used as fixed-effects factors. Fitting hospital as a random-effects factor, we assume that there is an infinite set of privately owned teaching hospitals in Japan (a population of privately owned and leading teaching hospitals in Japan) and we consider the hospitals in the present study as a random sample from that population [16]. All analytical procedures were performed using the SAS statistical package Version 8.2 [17]. All reported P values were two-tailed, and the level of significance was $P < 0.05$.

RESULTS

Table 1 shows characteristics of 778 hip fracture patients, such as age, gender, surgical procedure, comorbidity status, and place of residence upon discharge. There were no patients with two comorbidity conditions such as mild liver disease and moderate or severe liver disease. Table 2 shows results of bivariate analyses to examine differences in resource use by either age class or comorbidity status among all hospitals. The results show that there were significant difference in total charges, charges for surgery, and length of theater time by age ($p < 0.01$). Total charges, charges for surgery, and length of theater time, decreased with increasing age. In addition, the results indicated that hip fracture patients with any comorbidity condition had significantly longer total LOS, longer LOS after surgery, higher total charges, higher charges for diagnostic examinations, and higher charges for surgery ($p < 0.05$).

Tables 3 and 4 show results from linear mixed models to identify factors associated with hospital use, such as total LOS, LOS before surgery, LOS after surgery, total hospital

charges, charges for diagnostic examinations, charges for surgery, and length of theater time. The variance components for hospitals were much smaller than the residual in all models. This indicates that most of the variation in the data was due to differences between hip fracture patients and not to differences between hospitals. After adjustment for the random-effects of hospitals in the mixed models, these analyses revealed that higher age was significantly associated with shorter length of theater time ($p < 0.01$), and that patients with any comorbidity condition were significantly associated with longer total LOS ($p < 0.01$), longer LOS after surgery ($p < 0.001$), higher charges for diagnostic examinations ($p < 0.001$), and shorter length of theater time ($p < 0.01$).

DISCUSSION

We examined the association of patient age and comorbidity status with hospital use among hip fracture patients in four teaching hospitals in Japan using a linear mixed model that treated hospital as a random-effects factor. The linear mixed model in this study identified that higher patient age was significantly associated with shorter length of theater time. Other linear mixed models identified that the presence of a comorbidity condition among hip fracture patients was significantly associated with longer LOS, higher charges for diagnostic examinations, and shorter length of theater time. Thus, these results suggest that the presence of comorbidity among operable hip fracture patients requires greater resource use during their hospital stay, but higher age is not significantly associated with greater resource use at all.

This study identified that higher age of operable hip fracture patients was associated with neither longer length of stay, higher total charges, nor higher charges for surgery. Contrary to these results, one study showed that mean hospital cost and length of stay for surgical patients in an academic medical center in the US increased with age by a bivariate analysis, and concluded that surgical patients aged 70 or older were probably more severely ill on average than younger patients [3]. Our study focused on only hip fracture patients who underwent hip surgery in four teaching hospitals in Japan. Hip fracture surgery for older patients in Japanese hospitals is often undergone as delayed surgery rather than emergency surgery. One possible reason for this is that Japanese orthopedists are likely to undergo hip fracture surgery for older patients after the patients' comorbidity conditions were completely examined. In the present study, 99% of the subjects underwent hip surgery two days after admission and their average length of hospital stay before surgery was about six days. In

this study, we consider that patients who underwent delayed surgery are more likely to be healthy and less likely to have iatrogenic complications after surgery than patients with emergent surgery. In addition, only 84% of hip fracture patients involved in this study had no comorbidity, despite their average age being 80 years (Table 1). Furthermore, the mean age of hip fracture patients with comorbidity did not significantly differ from that of patients without comorbidity (data not shown). Therefore, we suppose that this study did not identify an association between higher age and higher resource use because higher age of hip fracture patients in this study did not indicate greater frailty, although it is plausible to suppose that older inpatients are more likely to have higher costs due to their greater susceptibility to have comorbidity conditions [1].

This study shows that, after controlling for potential confounders, the lengths of theater time for hip surgery among patients aged 75-84 and patients aged 85 or older were estimated as significantly shorter by about 6 minutes and about 12 minutes than hip fracture patients aged 65-74, respectively. In addition, a significant association between the presence of comorbidity and shorter length of theater time was also identified in this study. The length of theater time for hip surgery among patients with any comorbidity was estimated as significantly shorter by 9 minutes than that for patients without comorbidity. We hypothesize that these results may be due to the surgeon's attitude, i.e. that they tried to finish hip surgery for either higher age patients or patients with any comorbidity as soon as possible because of the potential vulnerability of older patients to surgery.

The linear mixed models also revealed that the LOS after surgery of hip fracture patients with a comorbidity condition was estimated as significantly longer by about 5 days than patients without comorbidity. The association between the presence of comorbidity condition and longer LOS has been identified among Medicare patients in the US [18] and among discharged patients in the Valencia region, Spain [19]. This direct effect of the presence of comorbidity among hip fracture patients on longer LOS may be explained by the hypothesis that hip fracture patients with comorbidity may be required to stay in hospital for a longer period due to additional treatment for their comorbidity. Another possible explanation is that patients with a comorbidity condition may show delayed functional recovery due to their comorbidity, and such patients may be more likely to become functionally dependent during their hospital stay [20]. Consequently, such functionally dependent patients may be more likely to stay in hospital for a longer period than patients without functional dependence [21, 22].

Linear mixed models also revealed that the presence of comorbidity condition among

hip fracture patients was significantly associated with higher charges for diagnostic examinations ($p < 0.001$). Patients with any comorbidity were estimated to cost significantly more by $207 than those without comorbidity. In addition, the model also revealed a marginally significant association between the presence of any comorbidity condition and higher total charges ($p = 0.060$). Patients with comorbidity were estimated as costing significantly more by $635 than those without comorbidity. Despite the difference of payment system between Japan and the US, these results are concordant with the results that Medicare beneficiaries with chronic conditions had higher expenditure than those without chronic condition [23]. Because all patients who receive medical care in any medical facility in Japan are covered by Japan's universal health insurance system based on a fee-for-service payment with governmentally-defined universal point-fee tables, the total charges for hip fracture patients with comorbidity conditions are charged for hip fracture treatment as well as charges for diagnosis and treatment of the comorbidity [24, 25]. Therefore, we consider that hip fracture patients with any comorbidity condition are more likely to have higher diagnostic examination charges, and marginally higher total charges, than those without comorbidity.

When we interpret the results of our study, some limitations must be considered. First, as a general limitation of this study, the study subjects in this study were hip fracture patients who received hip surgery in four teaching hospitals in Japan. In particular, we were unable to involve incident hip fracture patients who did not receive surgical treatment, because we do not have such information in our database. It is reasonable to consider that an incident hip fracture patient whose general condition is too poor to undergo surgical treatment will be treated by conservative treatment at first, and then undergo hip surgery after improvement of their general condition. Thus, the proportion of hip fracture patients who did not undergo hip surgery among all incident hip fracture patients in this study may be small.

Second, the hospitals selected in this study are not representative of all hospitals in Japan. However, the inference in this study can be statistically applied with more confidence to a wider population of hospitals in Japan, because the mixed linear models in this study fitted hospitals as a random-effects factor [26]. On the other hand, operable hip fracture patients in this study stayed in hospital for about six days before surgery and they remained in hospital for about 40 days after hip surgery (Table 2). Although this is much longer than in other OECD countries [27], we consider that the average LOS in the four teaching hospitals in this study was not biased towards a longer LOS than in other Japanese hospitals. The estimated average LOS of all patients discharged from general wards in Japanese hospitals

was 32 days in 1998, while the average LOS in the four hospitals in this study was ranged from 22 to 31 days. There are a few possible explanations for the 46-day hospital stay among operable hip fracture patients in this study. First, because Japanese hospitals provide post-operative patients with acute and post-acute care during the same hospital care episode, Japanese surgeons are likely to let post-operative patients stay in hospitals until they can recover their abilities to perform similar activities of daily living to the level before hip fracture. Such patients may need rehabilitative training for walking during an approximate 40-day in-hospital stay after surgery. Second, there is no financial risk for Japanese surgeons in letting their patients continue to stay in hospital for about six days before surgery for preoperative evaluation and six to seven weeks for rehabilitative care, because charges during in-hospital stay are basically reimbursed in a fee-for-service manner with governmentally-defined universal point-fee tables under the Japan's universal health insurance system [24, 25]. In addition, because Japanese hospitals generally provide both acute care and sub-acute care at the same in-hospital episode, the LOS is far longer than other OECD countries. However, these characteristics of Japanese health care to patients have some benefits for examining resource use during acute care as well as sub-acute care simultaneously. Furthermore, out of the total charges, two fifths were charges for hotels, and another two fifths were for surgery. We hypothesized that the attribute of the effect of age or comorbidity condition on in-hospital resource use might be different between acute care and sub-acute care.

Finally, we used charge data rather than actual cost data in this study. Because to date only a few Japanese hospitals tentatively estimate actual cost for hospital care, these data are not available in our database. However, we believe that, for countries that calculate annual health care expenditure based on charge data, it must be useful to analyze charge-based data to examine optimal resource allocation.
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Table 1. Characteristics of 778 hip fracture patients who received surgical treatment at four teaching hospitals in Japan (%)

	Total (n = 778)	Hospital				
		A (n = 99)	B (n = 107)	C (n = 281)	D (n = 291)	P value[b]
Age[a]	80.3 (7.3)	82.5 (7.7)	79.4 (6.8)	80.0 (7.3)	80.0 (7.2)	0.012
65–74	24.4	17.2	24.3	26.0	25.4	0.147
75–84	45.8	40.4	48.6	45.6	46.7	
≥85	29.8	42.4	27.1	28.5	27.8	
Gender						
Women	78.4	75.8	76.6	77.9	80.4	0.704
Men	21.6	24.2	23.4	22.1	19.6	
Place of residence before admission						
Home	81.2	55.6	63.6	88.6	89.3	< 0.001
Hospital/nursing home	18.8	44.4	36.4	11.4	10.7	
Surgical procedure						
Hip replacement	35.3	37.4	39.3	33.1	35.4	0.675
Internal fixation	64.7	62.6	60.7	66.9	64.6	
Comorbidity status						
Any comorbidity condition	16.3	27.3	18.7	8.9	18.9	< 0.001
Peripheral vascular disease	0.8	1.0	1.9	0.0	1.0	0.147
Dementia	3.5	9.1	0.0	2.1	4.1	0.002
Chronic pulmonary disease	1.5	6.1	1.9	0.4	1.0	0.004
Connective tissue disease	0.9	2.0	0.9	0.4	1.0	0.331
Diabetes	0.9	3.0	0.0	0.0	1.4	0.023
Diabetes with end organ damage	4.4	7.1	5.6	1.4	5.8	0.009
Renal disease	1.7	2.0	0.0	0.4	3.4	0.013
Any tumor	4.4	3.0	8.4	2.8	4.8	0.115
Metastatic solid tumor	1.0	0.0	0.9	2.1	0.3	0.133
Place of residence upon discharge						
Home	59.8	29.3	41.1	59.4	77.3	< 0.001
Hospital/nursing home	39.1	68.7	57.9	40.2	21.0	
Death at discharge	1.2	2.0	0.9	0.4	1.7	

Table 2. Hospital resource use among 778 hip fracture patients aged 65 or older by age and the presence of comorbidity status at four teaching hospitals in Japan

	Total length of stay (days)		Length of stay before surgery (days)		Length of stay after surgery (days)		Total charges (US$)		Charges for diagnostic exams (US$)		Charges for surgery (US$)		Length of theater time (min)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Total (n = 778)	19.9	18.7	6.1	7.6	13.8	18.1	7419.0	5798.7	918.6	753.9	6255.3	5294.4	82.9	38.7
Age class (years)														
65–74 (n = 190)	15.8	19.2	6.2	3.8	12.2	18.7	15012.0	5912.7	856.9	725.4	6773.2	3273.1	92.9	42.6
75–84 (n = 356)	17.4	18.6	6.7	6.9	12.6	17.8	14793.5	5715.9	902.2	828.6	6501.6	3064.8	84.0	37.5
≥85 (n = 232)	15.2	18.4	6.1	6.8	12.2	17.8	13950.4	5435.0	903.0	666.3	6755.6	3233.2	72.9	34.0
P value[a]		0.050		0.070		0.075		0.006		0.581		0.008		< 0.001
Comorbidity status														
None (n = 651)	15.0	18.5	6.4	4.4	10.8	17.9	14260.6	5552.1	856.7	731.8	6201.0	3146.8	83.7	39.7
≥1 (n = 127)	30.6	19.2	6.3	5.7	24.3	18.3	16568.2	6281.3	1276.0	852.1	6535.9	3072.5	78.6	29.8
P value[a]		0.002		0.081		0.001		< 0.001		< 0.001		0.042		0.270

S.D.—standard deviation. Charges for diagnostic exams involved laboratory tests and imaging. Charges for surgery involved surgery and anesthesia.

Table 3. Factors associated with total length of stay (LOS), LOS before surgery, and LOS after surgery of hip fracture patients at four teaching hospitals in Japan (linear mixed models) (n = 778)

Explanatory variable	Total LOS			LOS before surgery			LOS after surgery		
	Estimate	Standard error	*P* value	Estimate	Standard error	*P* value	Estimate	Standard error	*P* value
Fixed-effects factor									
Intercept	48.806	2.525	< 0.001	5.690	0.413	< 0.001	43.200	2.579	< 0.001
Age									
75–84 vs. 65–74 (referent)	1.180	1.606	0.463	0.590	0.420	0.161	0.598	1.540	0.698
≥85 vs. 65–74 (referent)	−1.482	1.777	0.405	0.065	0.460	0.888	−1.449	1.705	0.396
Gender									
Men vs. women (referent)	−1.870	1.563	0.232	0.183	0.409	0.655	−2.066	1.499	0.169
Comorbidity									
Present vs. absent (referent)	5.237	1.743	0.003	−0.084	0.451	0.853	5.390	1.672	0.001
Type of hip surgery									
Hip replacement vs. internal fixation (referent)	0.400	1.335	0.764	1.056	0.349	0.003	−0.674	1.281	0.599
Discharge destination									
Other hospitals vs. home (referent)	−8.893	1.393	< 0.001				−8.837	1.338	< 0.001
Died at discharge vs. home (referent)	0.248	5.979	0.967				−6.100	5.735	0.288
Random-effects factor									
Hospital A	−1.3353	2.3013	0.588	−0.04861	0.1746	0.827	−1.1268	2.3892	0.659
Hospital B	2.1708	2.2675	0.386	−0.04782	0.1737	0.829	2.4473	2.3574	0.352
Hospital C	−4.2493	2.1128	0.118	0.1289	0.1657	0.579	−4.8043	2.2142	0.101
Hospital D	3.4137	2.1265	0.186	−0.03249	0.1652	0.876	3.4838	2.2267	0.196
Variance components									
Hospital	13.9	12.5	0.134	0.034	0.115	0.382	15.9	14.1	0.129
Residual	309.6	15.8	< 0.001	21.3	1.1	< 0.001	284.8	14.5	< 0.001

Table 4. Factors associated with total charges, charges for diagnostic exams, charges for surgery, and length of theater time of hip fracture patients at four teaching hospitals in Japan (linear mixed models) (n = 778)

Explanatory variable	Total charges			Charges for surgery			Charges for diagnostic exams			Length of theater time		
	Estimate	Standard error	*P* value	Estimate	Standard error	*P* value	Estimate	Standard error	*P* value	Estimate	Standard error	*P* value
Fixed-effects factor												
Intercept	4546.8	784.7	< 0.001	4655.9	293.1	< 0.001	69.4	143.6	0.629	71.0	6.3	< 0.001
Age												
75–84 vs. 65–74 (referent)	−358.2	928.7	0.699	−731.4	190.0	0.224	99.3	54.9	0.071	−5.9	2.8	0.041
≥85 vs. 65–74 (referent)	−290.7	341.8	0.396	−270.7	206.7	0.181	103.3	60.3	0.092	−12.0	3.0	< 0.001
Gender												
Men vs. women (referent)	400.6	300.6	0.118	271.6	184.9	0.142	80.0	53.4	0.134	8.9	2.7	< 0.001
Comorbidity												
Present vs. absent (referent)	635.2	537.2	0.060	−12.5	205.7	0.951	207.2	59.7	< 0.001	−8.6	3.0	0.004
Type of hip surgery												
Hip replacement vs. internal fixation (referent)	5019.7	256.6	< 0.001	5009.2	157.7	< 0.001	−21.7	45.5	0.634	41.2	2.3	< 0.001
Discharge destination												
Other hospitals vs. home (referent)	144.5	275.9	0.601									
Died at discharge vs. home (referent)	7784.5	1139.0	< 0.001									
Length of stay												
1 day	176.0	6.9	< 0.001				16.3	1.2	< 0.001			
Random-effects factor												
Hospital A	307.7	684.9	0.502	212.9	274.6	0.137	21.6	149.8	0.877	−4.2	6.2	0.537
Hospital B	−419.1	679.7	0.573	−49.4	271.6	0.863	40.3	150.1	0.773	−8.3	6.2	0.243
Hospital C	1502.5	658.0	0.063	−500.3	253.7	0.060	−318.9	126.5	0.077	−3.7	6.0	0.598
Hospital D	1143.9	659.6	0.170	286.8	252.7	0.204	257.0	126.4	0.125	16.4	6.0	0.063
Variance components												
Hospital	1.57E + 06	1.33E + 06	0.119	2.02E + 05	1.81E + 05	0.119	5.90E + 04	4.93E + 04	0.119	150.2	109.9	0.119
Residual	1.14E + 07	2.93E + 06	< 0.001	4.54E + 06	2.21E + 06	< 0.001	5.62E + 05	1.85E + 04	< 0.001	515.5	46.6	< 0.001

Charges for diagnostic exams involved laboratory tests and imaging. Charges for surgery involved surgery and anesthesia.

Ⅳ. 腹腔鏡下胆嚢摘出術のパフォーマンス測定に関する研究

Profiling hospital performance of laparoscopic cholecystectomy based on the administrative data of four teaching hospitals in Japan

わが国では、腹腔鏡下胆嚢摘出術は1992年の導入後、10年余の間に急速に普及した。腹腔鏡下胆嚢摘出術はクリニカル・パスを利用することなどにより治療の標準化が比較的可能であるが、この手術でさえその差異（バラツキ）が認められる可能性が認識されている。しかし、その差異の要因が患者側あるいは医療者側のいずれに起因するのかを明らかにした論文や報告は認めない。そこで、わが国の臨床研修病院での腹腔鏡下胆嚢摘出術に関するデータの分析によって、臨床あるいは医療経済上の指標について、その差異の要因を検討することを目的として本研究を実施した。

協力の得られた、わが国の４臨床研修病院で1996年～2000年に実施された待機的腹腔鏡下胆嚢摘出術施行症例1,589例を対象とし、以下のような変数を用いて階層的重回帰分析を行った。在院日数の関連要因を検討するために、在院日数を目的変数、患者因子である性別、年齢、Charlson comorbidity indexに基づく重要併存疾患の有無（以下、併存疾患の有無）、ASA-PS（米国麻酔学会による術前全身評価）および病院を説明変数とした。同様に、総治療費（入院中の治療費合計）の関連要因を検討するために総治療費を目的変数とし、性別、年齢、併存疾患の有無、ASA-PS、在院日数および病院を説明変数とした。さらに、１日あたり薬剤・検査費を目的変数とし、性別、年齢、併存疾患の有無、ASA-PSおよび病院を説明変数とした。

腹腔鏡下胆嚢摘出術について対象症例 1,589 例における在院日数は、16.5±12.6日（平均±標準偏差）、術前および術後日数は、9.2±10.5日および6.4±6.2日であり、同様に、総治療費および薬剤・検査費は 802,000 円±407,000 円(6,683±3,395米ドル)および185,000円±169,000円(1,541±1,411米ドル)であり、それらの変動係数は大きく、バラツキを認めた。しかも、４病院それぞれの在院日数、術前および術後日数の平均は病院間で有意差を認め、総治療費は病院間で有意差を認めなかったが薬剤・検査費では有意差を認めた。さらに、在院日数、総治療費および１日あたり薬剤・検査費に対する病院因子の寄与を検討するために、７つのモデルを用いて階層的重回帰分析を試みた。患者因子の相違を調整した後、在院日数のバラツキ（分散）の2.8%が病院因子によって説明された（$p<0.001$）。同様に、患者因子に加え在院日数の相違を調整した後、総治療費のバラツキ（分散）はその1.4%しか、病院因子によって説明できなかった（$p<0.001$）。一方、日常診療プロセスの差異を示す１日あたり薬剤・検査費は、病院因子によりそのバラツキ（分散）の18.7%が説明された（p

<0.001)。

待機的腹腔鏡下胆嚢摘出術症例について患者因子を調整した後、在院日数や総治療費について病院間で有意な差異を認めるものの病院因子の寄与は小さい。しかし、1日あたり薬剤・検査費に対する病院因子の寄与が大きいことから、在院日数として表される手術患者の総合的な診療経過に加えて、日常の診療プロセスにも病院間に差異（バラツキ）のあることが確認された。この差異の存在は、腹腔鏡下胆嚢摘出術の入院診療プロセスの標準化を通じて、限りある医療資源利用における効率性について改善すべき余地が残されていることを指摘するものである。

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Profiling hospital performance of laparoscopic cholecystectomy based on the administrative data of four teaching hospitals in Japan

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Abstract. Over the last decade in Japan, laparoscopic cholecystectomy (LC) has replaced traditional open cholecystectomy as the standard of elective surgery for cholelithiasis. LC has a clinical course relatively easier to standardize among the intra-abdominal surgery. However, its significant practice variation is suspected in Japan, but there has been little demonstration or discussion based upon empirical data.

Through the analysis of 1,589 elective LC cases of four leading teaching hospitals in Japan between 1996 and 2000, this study aims to demonstrate the variations and investigate their determinants regarding the length of hospital stay and the health care charge which is a good cost estimate in the current Japanese health insurance system.

Substantially and significantly large variation existed among the hospitals in terms of the length of hospital stay and the total health care charge, even after the differences in patient factors were adjusted. Particularly, the combined drug and exam charge per day was strikingly affected by the hospital difference, which indicated that the daily process also varied widely besides the total course of inpatient care. In addition, intra-hospital variation was also remained very large even after adjusting all the potential correlates studied.

This study alarmingly points out great room for improvement in the efficiency of health care resource use and potentially in the quality through standardization of care process in LC. It has serious implications for the national policy and individual providers under the on-going health care reforms towards higher efficiency and quality.

Introduction

Though some articles have reported that Mouret et al. performed the world's first laparoscopic cholecystectomy (LC) [1], the earliest LC was actually performed by Muhe in

1986 [2]. Since then, this surgical procedure has been rapidly adopted all over the world. In Japan, Yamakawa et al. performed the first LC in May 1990 [3]. Subsequently, LC became popular in Japan as a surgical procedure for elective cholelithiasis.

The brief history of advances in surgery for cholelithiasis in Japan can be divided into three phases. The first phase, ending in 1990, was concerned with traditional open cholecystectomy (OC). The decade that followed was a transition period from OC to LC. In April 1992, LC was added to the social insurance medical fee schedule. The third, and current phase, represents the establishment period of LC as a common surgery for cholelithiasis. LC has been adopted on a wide scale because it is less invasive and more cost effective than OC [4]. Many surgeons and hospitals now consider LC the standard for both elective and urgent surgical cases [5].

Compared with OC, the typical length of hospital stay (LOS) and total charges during hospitalization for LC are lower because patients are able to make a more rapid recovery after surgery [6]. Though few practice guidelines or treatment manuals have been published in Japan, LC for cholelithiasis is better standardized than most procedures. Nevertheless, LOS for LC in Japan is still longer than in other developed countries.

Total charges during hospitalization are calculated on a fee-for-service basis according to a fee schedule mandated by the Health Ministry. Though the fee schedule is not strictly based on cost valuation, charges are roughly equivalent to total costs during hospitalization. The official fee schedule sets the operation charge for LC higher than that of OC to reflect surgical difficulty. As a result, when surgeons choose to perform LC, they are affectively trading higher charges for shorter LOS, as compared with OC.

The Health Ministry has taken active steps toward reducing LOS. A system of diminishing returns was introduced whereby admission charges are reimbursed at a lower rate for hospitalization with excessively long LOS. This diminishing system and higher pricing for LC gives providers an incentive to favor LC over OC elective cases.

Even under these conditions, total charges during hospitalization for LC vary widely. The existing literature attributes practice variation in some surgical treatments to a wide variety of factors: geography, physician discretion, competing surgical procedures, and international differences [7,8]. Few Japanese reports have noted that these practice variations of LC in Japanese health care delivery. Though practice variation is inevitable, it is undesirable for variation to be dominated by institutional factors.

With data gathered from four geographically disparate teaching hospitals, this study seeks to investigate the total course as well as the daily process of the Japanese health care by

identifying clinical and socioeconomic factors contributing to variations in the practice of LC as a surgical standard for cholelithiasis in Japan, and to examine the efficiency of health care resource use and the potential in the quality through standardization of care process. It is our hope that a review of various clinical outcomes and socioeconomic factors will ultimately benefit the quality and safety of Japanese health care by promoting the standardization of clinical medicine.

Patients and Methods

Patients

This study was approved by the Institutional Review Board of the Faculty of Medicine, at the Graduate School of Medicine of Kyoto University. We used a database from the Voluntary Hospital of Japan Quality Indicator Project (VHJ-QIP), which includes data from ten leading private teaching hospitals in Japan. These hospitals are located in Hokkaido (in the north), throughout Honshu (the main island of Japan), and Kyusyu (in the south). The database represented all cases discharged from these hospitals since 1995.

In this particular study, we selected four of the ten hospitals where LC for cholelithiasis was performed between January 1996 and December 2000. All four hospitals provide community residents with primary and tertiary care in both inpatient and outpatient settings. The mean number of general type beds and surgical department beds in these four hospitals were 652 (range: 524 - 784) and 80.5 (range: 55 - 129), respectively, in 2000, and the mean number of surgeons was 11 (range: 7 - 14) in 2001. Each of the hospitals participating in this project has similar characteristics in that they are all teaching and community hospitals.

Subjects for this study were filtered based on International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) procedure codes. We selected cases with elective LC (ICD-9-CM code 51.22) or OC (ICD-9-CM code 51.23) from surgical cases with an ICD-9-CM diagnosis code of 21.15, which stands for "benign neoplasm of liver and biliary passage", or an ICD-9-CM diagnosis code between 57.40 and 57.70, which stands for "diseases of gall bladder, biliary tract, and pancreas".

Definition of variables.

Clinical indicators used in this study include age, gender, hospital, length of hospital stay (LOS), preoperative physical status (ASA-PS), and comorbidity condition. Economic indicators included total health care charges (THC), and a combination of drug and examination charges (DEC).

In order to evaluate a patient's preoperative condition, we used the preoperative physical status developed by the American Society of Anesthesiologists (ASA) [9]. The ASA-PS score