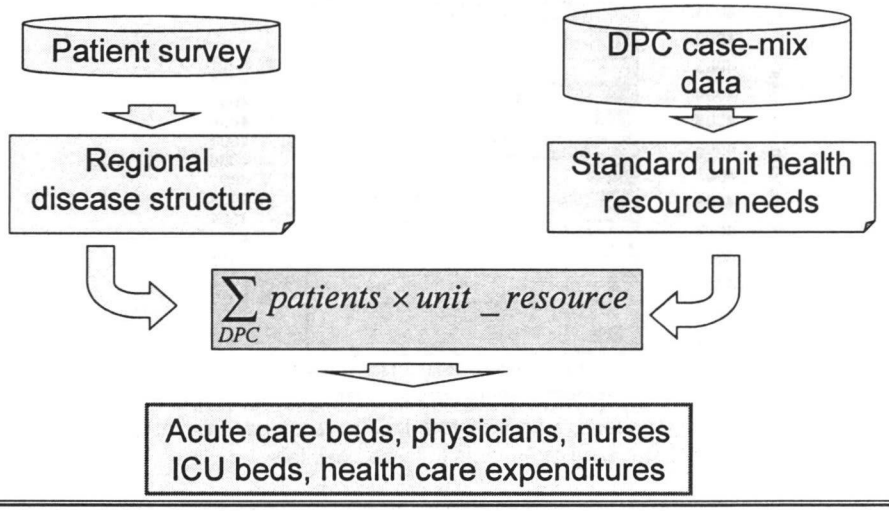
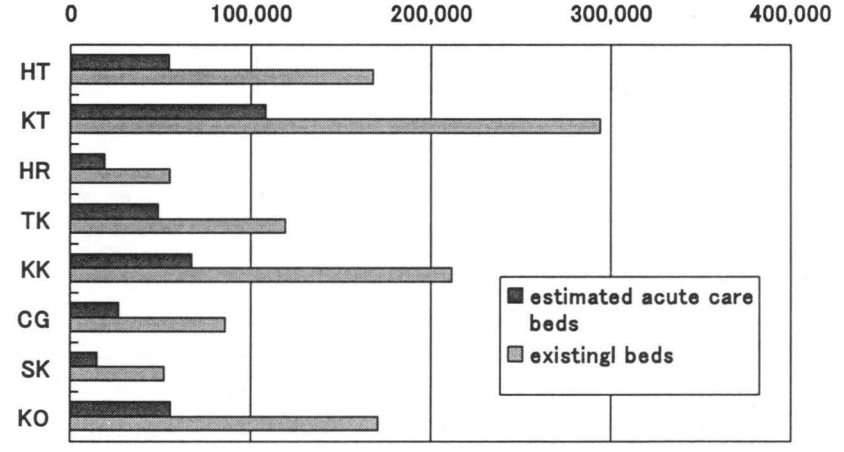
Results - Regional needs and supply of health services

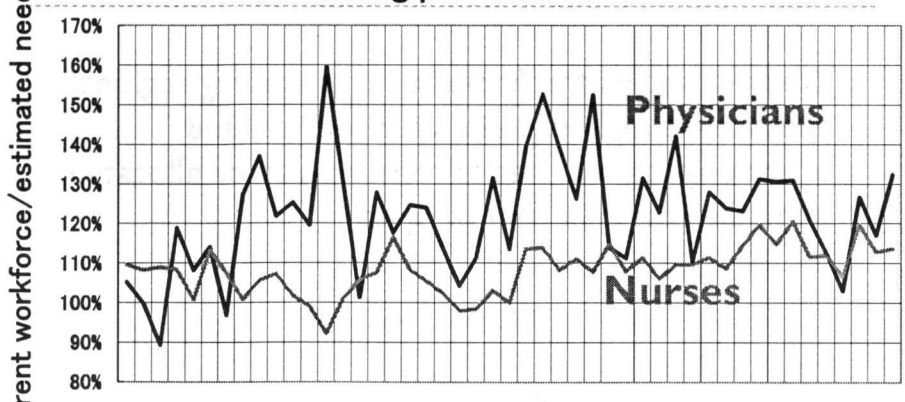
Model for estimating regional health resource needs



Estimation of needs of acute care beds



Regional difference in work force supply among prefectures



- Work force needs were estimated from estimated bed needs for acute and chronic care.
- Physicians are deficient in northern rural area.
- Nurses are deficient in large cities.

Summary

- Centralization of medical technology was quantitatively assessed from procedure volume and local contribution of hospitals, showing the existence of large regional difference.
- It was shown that spatial allocation of health resources needs to be arranged considering differences in travelling behavior of patients by health care needs.
- Estimation of health resource needs from disease structure and case-mix unit data showed necessity of reduction of acute care beds to less than half of current general beds and substantial medical work force deficiency in some area of Japan.

Conclusion

- We have shown the feasibility of visualizing regional needs and supply of healthcare services and estimating regional health resources to be allocated, using the case-mix data of Japan,

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Development and analysis of a nationwide cost database of acute-care hospitals in Japan

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Keywords
cost database, health care costs, health policy, hospital management, payment system, pricing

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Abstract

Objectives Understanding of hospital cost is crucial to achieve an ideal balance between the assurance and improvement of patient safety and quality, and efficient use of finite resources. However, neither a standardized calculation methodology nor a large-scale database of costs in acute-care hospitals exists in Japan. This study aims to develop a standardized methodology, construct a nationwide cost database in Japan, analyse the characteristics of the database and examine the relationship between the cost and the charge from the viewpoint of an appropriate reflection of the cost to the price.

Method We designed the costing framework, gathered the data for patients discharged from 139 acute-care hospitals in Japan between July 2004 and October 2004 and constructed a database containing information on 284 730 patients. The characteristics of the database and the relationship between the cost and the charge were investigated.

Results In the nationwide database we constructed, a wide range in the average cost per hospitalization and average cost per diem was observed. A wide variation of cost components was seen across major diagnostic categories. Moreover, there was a high correlation between the cost and the charge (Correlation coefficient = 0.94).

Conclusions After designing a costing framework, a nationwide database comprised of individual case-level costs with components for acute-care hospitals in Japan was successfully developed. We hope this study contributes to appropriate decision making and helps motivate further research geared towards efficient hospital management and a rational payment system in Japan.

Introduction

Understanding of hospital cost is crucial to achieve an ideal balance between the assurance and improvement of patient safety and quality, and efficient use of finite resources. From the viewpoints of both the government and individual hospitals, interest in standardized cost calculation has increased [1,2]. In the government perspective, standard cost calculation represents essential evidence in the process of health care policy making, such as the planning of the reimbursement system, estimation of financial resources required for health care services and decision making based on economic evaluation. For example, previous research

discussed the need for payments for appropriate care to reflect the necessary costs [3,4]. Examining this issue from a government viewpoint is especially relevant in Japan, where the government sets a uniform medical service fee under the universal health care system.

Also, at the individual hospital level, standard cost calculation is necessary for business management, such as preparation and control of the budget, evaluation of cost and performance, establishment of the management master plan, information for negotiation of fund procurement and reference data for benchmarking. The importance of each hospital's management skill is increasing, because hospital managers need to assess the cost that can be controlled in the context of expanding medical expenditure that is occurring in many developed countries [5–7]. Therefore, examining cost data from an individual hospital-level viewpoint is important.

While there are previous studies [8–11] regarding cost calculation in Japan, it is difficult to apply their findings to government policy making and hospital management. Caveats to interpretation of the majority of these studies are that they explored only limited cost coverage (as personnel costs, which accounted for the largest portion of the total cost were not included), or limited diagnoses, or limited hospital departments. Furthermore, the previous research investigated the costs of only a few participant hospitals. Another limitation is that, because the data to calculate cost is not collected routinely, standardized methodology for calculating cost in Japan did not exist.

Recently in Japan, standardization of the health care service at the patient level has been facilitated by a new, case-mix, patient classification system. Some research utilizing this new classification system has analysed the health care service in Japan [11,12]. In April 2003, a prospective payment system based on this new case-mix classification was introduced into the Japanese reimbursement system for hospital inpatients [13,14]. Titled the Diagnosis Procedure Combination (DPC), the new reimbursement system was integrated into 82 specialized function hospitals (80 university hospitals, the National Cancer Center and the National Cardiovascular Center). Currently, 360 hospitals receive medical fee reimbursements through the system.

Under these circumstances, it has become increasingly important and feasible to assess standardized cost information and analyse its characteristics in Japan. Despite these needs, neither a standardized cost calculation methodology nor a large-scale inpatient cost database is available to generate such information. Therefore, the goals of this study are to develop a standardized methodology, construct a nationwide uniform cost database at the inpatient level that covers a wide range of diseases in Japan, analyse the characteristics of the database and examine the relationship between cost and charge from the viewpoint of an appropriate reflection of the cost to the price.

Materials and methods

Data collected

In this study, we gathered cost data about institutions playing a leading role in providing acute-care medicine and patients from 138 hospitals (including 20 national university hospitals, 29 private university hospitals and 89 non-university hospitals) throughout Japan in 2004. The data obtained about institutions included, but was not limited to, financial data, the number of beds, staff assignment, floor space and number of patients. Claim data and discharge summary data on patients included information on all patients discharged between July 2004 and October 2004 from 139 hospitals (21 national university hospitals, 29 private university hospitals and 89 non-university hospitals). Claim data was charge data based on the nationally uniform fee-for-service system, rather than the prospective payment system. For the model, it was assumed that the exchange rate was 110 Japanese yen (JPY) per US dollar.

This study was performed as part of a Japanese case-mix classification project. In the present study, each patient had any DPC code (14 digits), which consists of disease category [the first 6 digits, compatible with the International Classification of Diseases (ICD), tenth edition], major surgical procedure (2 digits: from the ninth to the tenth digit), other 2 minor procedures (2 digits, from the eleventh to the twelfth digit), the existence of co-morbid and/or complication conditions (1 digit: the thirteenth digit) and other complementary information (3 digits). Moreover, the first two digits of the disease category code are compatible with the major diagnostic category (MDC) (Table 1). In 2004, the Japanese payment system that is based on the DPC codes had about 2500 classifications, consisting of 16 MDCs and 591 disease categories. Only the patients whose DPC code was registered in ≥5 cases were included in our database of 284 730 patients.

Cost calculation and construction of database

The standard costing framework for the database was designed to generate the following information: (i) Processing of contents of the standardized claims data (based on the nationally uniform

Table 1 Major diagnostic categories of Diagnosis Procedure Combination (DPC)

01	Diseases and Disorders of the Nervous System
02	Diseases and Disorders of the Eye
03	Diseases and Disorders of the Ear, Nose, Mouth and Throat
04	Diseases and Disorders of the Respiratory System
05	Diseases and Disorders of the Circulatory System
06	Diseases and Disorders of the Digestive and Hepatobiliary System and Pancreas
07	Diseases and Disorders of the Musculoskeletal System and Connective Tissues
08	Diseases and Disorders of the Skin and Subcutaneous Tissue
09	Diseases and Disorders of the Breast
10	Endocrine, Nutritional and Metabolic Diseases and Disorders
11	Diseases and Disorders of the Kidney, Urinary Tract and Male Reproductive System
12	Diseases and Disorders of the Female Reproductive System
13	Diseases and Disorders of the Blood and Blood-Forming Organs and Immunological Disorders
14	Newborns and Other Neonates with Conditions Originating in the Perinatal Period
15	Diseases and Disorders of Childhood not covered by other MDCs
16	Diseases and Disorders (Injuries, Burns, Toxicosis and Others) not covered by other MDCs

fee-for-service reimbursement schedule) for direct attribution of medications and materials; (ii) Detailed subdivisions for allocation of each service cost by activity indicators or substitutes; and (iii) Individual case-level costs with components characterized by the two parameters of cost sources and service functions. Figure 1 illustrates the flow in our cost calculation process. Direct medical care costs (e.g. medications and materials) that can be charged directly to patients are differentiated from indirect medical care costs (e.g. staff salaries and other expenses) that cannot be charged directly to patients. While the former are charged directly to patients, the latter are allocated by the measurement of activity indicators or substitutes.

To calculate patient cost, we utilized a 7-step algorithm (Fig. 2). Step 1 involved establishing cost items (such as salary cost, material cost, overhead and depreciation) based on cost items included in profit-and-loss statements. According to whether or not the cost items could be directly charged to the patients, the model continued at an appropriate step in the algorithm. If the cost item could be directly charged to patients, the model continued at step 5. On the other hand, if the cost item could not be directly charged to patients, the model continued at step 2.

In step 2, we established the cost units, consisting of direct and indirect departments. Direct departments (such as wards, radiology and specialized medical departments) were involved directly in diagnosis and/or care of patients. Indirect departments (such as medical administration, accounting and medical records management) were not directly involved in diagnosis and/or care of patients.

In step 3, the cost of each department was calculated on the basis of the cost item and the proper allocation. For example, the salary cost within each department was calculated based on departmental activity. Costs of materials were calculated based on dispensing of materials. Other costs were calculated based on appropriate allocated parameters, such as staff assignment, floor space and the number of patients.

Step 4 was department cost accounting, which was similar to that performed in step 3. In step 4, however, all department costs were summarized into only the direct department cost, on the basis of appropriate allocated parameters, such as the number of beds, staff assignment, floor space and the number of patients.

Step 5 involved assessment of only the cost items (i.e. medicines and medical materials) that could be directly charged to the patient. Data on most of these directly charged items could be extracted from claim data in the Japanese payment system. In our model, we charged the cost of medicines and medical materials directly to each patient.

Step 6 involved allocation of department cost to each patient, based on the activity indicators or substitutes, such as weighted intensity of the procedure and length of stay in a hospital.

Step 7 involved cost calculation at the patient level. The sum of the cost that could be directly charged to patients and the cost that was allocated from the department cost was determined.

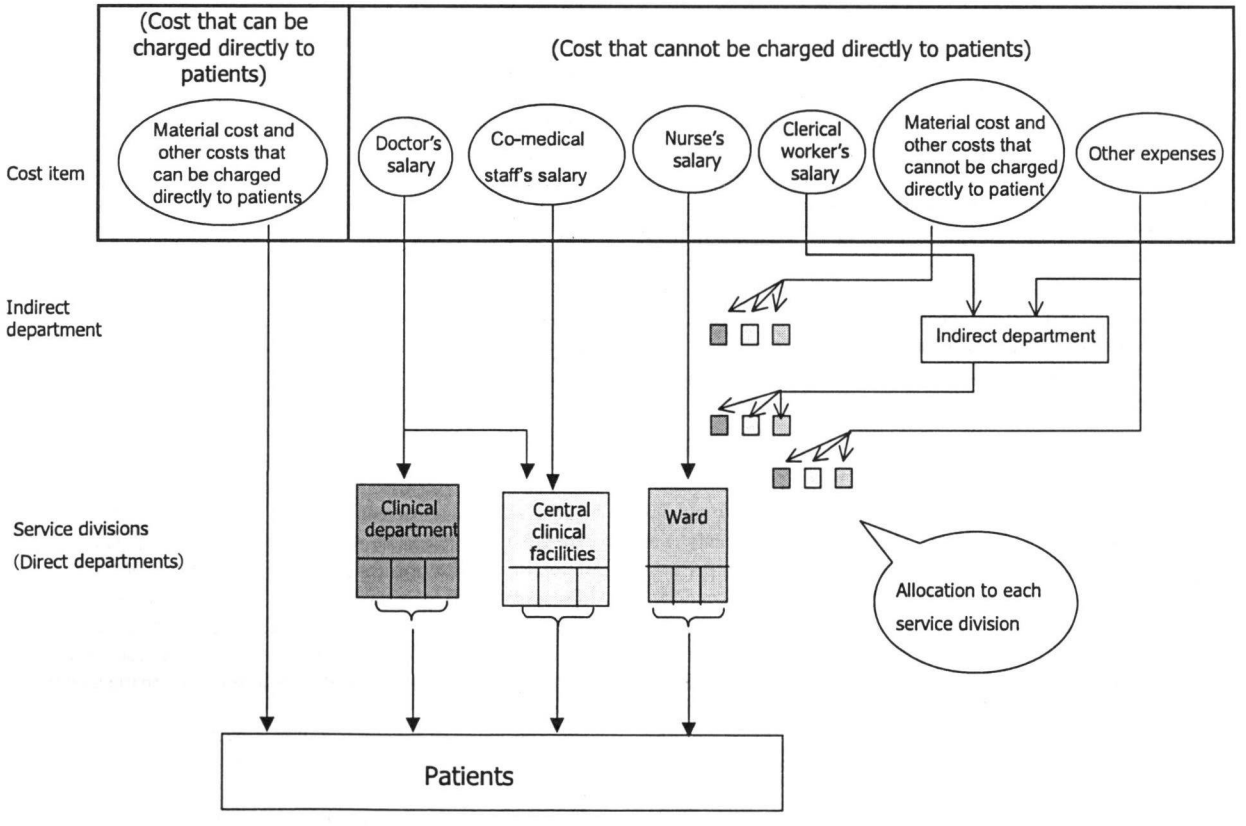

Figure 1 Flow-sheet for calculation of costs of medical care.

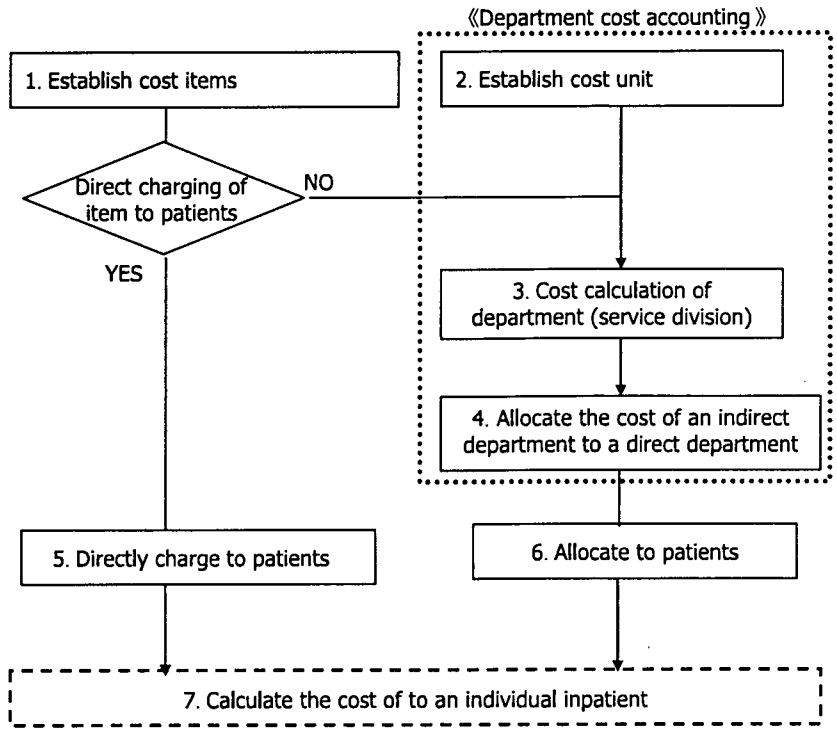

Figure 2 Steps to calculate costs to inpatients.

Analysis of cost data

Cost was analysed by using aggregated data derived from DPC code, disease category with/without surgical procedure and MDC. First, the variation (minimum, maximum and quartile) in the average cost per hospitalization and the average cost per diem was measured across DPC codes (14 digits). Next, the five most costly and least costly disease categories in terms of the average cost per hospitalization and the average cost per diem were determined. Third, the variation of cost components across MDCs was examined. Lastly, from the viewpoint of appropriate pricing, we investigated the relationship between the cost and the corresponding charge based on the nationally uniform fee-for-service system. All statistical analyses were performed using SPSS 15.0J for Windows.

Results

A large-scale cost database containing data on 284 730 patients and individual patient case-level costs with components was successfully constructed. A wide range of average costs per hospitalization, from $820 to $65 737 (first quartile: $4373; median: $7163; third quartile: $12 712) was observed across DPC codes (14 digits). Also, average costs per diem varied from $300 to $2475 (first quartile: $437; median: $491; third quartile: $565) across DPC codes (14 digits). Table 2 compares the five most expensive and least expensive disease categories between surgical and non-surgical inpatients in terms of the average cost per hospitalization and per diem.

Table 3 shows the average cost of each cost source, the total cost per hospitalization and the total cost per diem across MDCs. The costs of materials for inpatients with MDC05 (diseases/disorders of the circulatory system) and MDC13 (diseases/disorders of the blood and blood-forming organs and immunological disorders) comprised a large portion of the total cost, in comparison with costs of materials for inpatients with other MDCs. For example, the costs of materials for inpatients with MDC05 who underwent surgical treatment represented 52% of the total costs for these patients. Also, the cost per hospitalization with a surgical procedure was higher than for non-surgical inpatients, except for inpatients with MDC08 (diseases and disorders of the skin and subcutaneous tissue). The cost per diem for inpatients with any MDC who underwent a surgical procedure was higher than for non-surgical inpatients with any MDC. The differences in hospitalization costs for surgical versus non-surgical cases tended to be larger than the ratios of costs per diem for surgical versus non-surgical cases.

Moreover, the cost of materials in hospitalizations involving surgery and the percentage of the cost of materials as a component of total cost were higher than for non-surgical inpatients with almost all MDCs. In contrast, the cost of materials was more expensive and the cost of materials represented a higher proportion of total cost in non-surgical inpatients with MDC08, MDC09 (diseases/disorders of the breast), MDC11 (diseases/disorders of the kidney, urinary tract and male reproductive system) and MDC12 (diseases/disorders of the female reproductive system) compared with the cost of materials in surgical inpatients with the same MDCs.

Figure 3 is a scatter-plot that illustrates the relationship between the average cost and the average charge per hospitalization, in terms of disease categories of surgical (△) and non-surgical cases (□). A high correlation (correlation coefficient = 0.94) between the cost and the charge was observed. For example, the charge for

Table 2 The five most costly and least costly primary diagnoses in terms of average cost per hospitalization and average cost per diem for surgical and non-surgical cases*

		With surgical procedure				Without surgical procedure			
		Per hospitalization		Per diem		Per hospitalization		Per diem	
Relative degree of expense		Primary diagnosis	Average cost (in US$)	Primary diagnosis	Average cost (in US$)	Primary diagnosis	Average cost (in US$)	Primary diagnosis	Average cost (in US$)
Most costly	1	Dissecting aneurysm (050161)	45 217	Tachycardiac arrhythmia (050070)	1708	Malignant laryngeal tumour (030090)	14 566	Other congenital cardiovascular anomalies (140380)	975
	2	Valvular disorder (050080)	40 491	Other auditory disorders (030425)	1683	Malignant tumour of mesopharynx (030070)	14 300	Disseminated intravascular coagulation (130100)	732
	3	Subarachnoid haemorrhage, ruptured cerebral aneurysm (010020)	35 712	Cardiac anomaly without shunt (140340)	1663	Myasthenia gravis, neuropathy (NEC) (010130)	14 022	Congenital cardiac anomaly in neonate and infant (140360)	698
	4	Congenital cardiac anomaly in neonate and infant (140360)	33 782	Dissecting aneurysm (050161)	1567	Disseminated intravascular coagulation (130100)	13 539	Myasthenia gravis, neuropathy (NEC) (010130)	693
	5	Spinal deformity (070180)	31 794	Bradyarrhythmia (050210)	1538	Metastatic malignant tumour of neck (030110)	13 357	Ventricular septal defect (140310)	677
Least costly	1	Miscarriage (120140)	1 211	Ganglion (070380)	369	Sleep apnoea (030250)	994	Decubitus ulcer (070550)	296
	2	Polyp of female genitalia (120220)	1 758	Nail disease (080150)	378	Intussusception (060200)	1 231	Impairment from fracture of thoracic or lumbar vertebra or lower (including thoracic/lumbar spinal cord injury) (160690)	305
	3	Disease of penis/ prepuce (110230)	1 847	Fracture/dislocation of ankle joint or foot (160850)	387	Ranula (030220)	1 268	Acute nephritis (150060)	312
	4	Condyloma acuminatum (060250)	1 898	Periarticular fracture/ dislocation of knee (160820)	388	Miscarriage (120140)	1 619	Diabetes (NEC) (100340)	313
	5	Intussusception (060200)	1 938	Suppurative arthritis of knee (070120)	390	Benign disease of small and large intestine (including benign tumor) (060100)	1 630	Subcutaneous injury of soft tissue/ crush injury, open wound (160660)	313

NEC, not elsewhere classified (in ICD-10 code).
*Equal and more than 20 cases registered.

Table 3 Average cost of each cost source, total cost per hospitalization and cost per diem, across Major diagnostic categories (MDCs)

MDC	Surgery	*N*	Salary [in US$] (% of total)	Costs of materials [in US$] (% of total)	Overhead [in US$] (% of total)	Outsource expense [in US$] (% of total)	Depreciation [in US$] (% of total)	Research & training cost [in US$] (% of total)	Corporate expense [in US$] (% of total)	Total cost per hospitalization [in US$]	Cost per diem [in US$]
MDC01	–	14 337	4 329 (61%)	1 245 (17%)	552 (8%)	415 (6%)	367 (5%)	120 (2%)	93 (1%)	7 120	482
	+	3 628	10 024 (54%)	4 832 (26%)	1 309 (7%)	857 (5%)	944 (5%)	312 (2%)	231 (1%)	18 508	732
MDC02	–	1 185	2 594 (64%)	434 (11%)	311 (8%)	280 (7%)	264 (6%)	102 (3%)	81 (2%)	4 067	423
	+	17 714	3 046 (64%)	545 (11%)	372 (8%)	280 (6%)	292 (6%)	136 (3%)	79 (2%)	4 751	516
MDC03	–	8 696	2 044 (63%)	412 (13%)	258 (8%)	210 (7%)	190 (6%)	61 (2%)	45 (1%)	3 220	402
	+	7 359	3 658 (63%)	785 (14%)	454 (8%)	319 (6%)	335 (6%)	139 (2%)	96 (2%)	5 785	501
MDC04	–	23 542	3 338 (61%)	916 (17%)	422 (8%)	345 (6%)	276 (5%)	84 (2%)	68 (1%)	5 450	420
	+	3 238	7 589 (60%)	2 274 (18%)	952 (8%)	678 (5%)	712 (6%)	263 (2%)	182 (1%)	12 648	611
MDC05	–	16 399	3 045 (58%)	1 062 (20%)	408 (8%)	339 (6%)	276 (5%)	84 (2%)	67 (1%)	5 281	548
	+	9 948	6 739 (35%)	10 164 (52%)	858 (4%)	623 (3%)	626 (3%)	224 (1%)	183 (1%)	19 418	1 218
MDC06	–	23 974	3 366 (61%)	916 (17%)	433 (8%)	346 (6%)	291 (5%)	98 (2%)	75 (1%)	5 525	417
	+	31 811	4 788 (60%)	1 488 (19%)	604 (8%)	438 (5%)	418 (5%)	156 (2%)	108 (1%)	8 000	518
MDC07	–	7 393	3 856 (63%)	828 (13%)	491 (8%)	393 (6%)	351 (6%)	119 (2%)	95 (2%)	6 132	426
	+	8 631	6 237 (53%)	3 164 (27%)	795 (7%)	582 (5%)	569 (5%)	226 (2%)	157 (1%)	11 729	562
MDC08	–	3 746	3 047 (64%)	618 (13%)	362 (8%)	305 (6%)	256 (5%)	92 (2%)	74 (2%)	4 753	403
	+	793	3 100 (66%)	492 (11%)	367 (8%)	279 (6%)	275 (6%)	102 (2%)	69 (1%)	4 685	445
MDC09	–	1 371	2 934 (56%)	1 253 (24%)	368 (7%)	296 (6%)	275 (5%)	84 (2%)	60 (1%)	5 270	485
	+	2 134	4 697 (65%)	818 (11%)	569 (8%)	417 (6%)	420 (6%)	155 (2%)	110 (2%)	7 186	542
MDC10	–	8 587	3 876 (66%)	586 (10%)	484 (8%)	433 (7%)	339 (6%)	110 (2%)	88 (1%)	5 917	393
	+	2 365	5 550 (63%)	1 191 (14%)	662 (8%)	523 (6%)	533 (6%)	178 (2%)	131 (1%)	8 767	524
MDC11	–	15 268	3 354 (61%)	910 (17%)	439 (8%)	349 (6%)	286 (5%)	96 (2%)	70 (1%)	5 504	461
	+	7 232	3 776 (62%)	883 (15%)	477 (8%)	353 (6%)	350 (6%)	130 (2%)	87 (1%)	6 055	502
MDC12	–	7 626	2 778 (60%)	877 (19%)	336 (7%)	262 (6%)	240 (5%)	78 (2%)	65 (1%)	4 635	464
	+	11 818	3 812 (65%)	733 (12%)	466 (8%)	334 (6%)	345 (6%)	126 (2%)	90 (2%)	5 906	518
MDC13	–	4 137	5 180 (49%)	3 475 (33%)	631 (6%)	483 (5%)	451 (4%)	180 (2%)	123 (1%)	10 522	595
	+	1 539	9 099 (43%)	8 420 (40%)	1 091 (5%)	864 (4%)	836 (4%)	371 (2%)	245 (1%)	20 926	671
MDC14	–	4 690	3 644 (69%)	379 (7%)	425 (8%)	303 (6%)	318 (6%)	101 (2%)	90 (2%)	5 259	487
	+	3 279	5 899 (61%)	1 721 (18%)	675 (7%)	432 (4%)	532 (6%)	253 (3%)	146 (2%)	9 659	683
MDC15	–	3 996	2 034 (63%)	505 (16%)	257 (8%)	202 (6%)	156 (5%)	45 (1%)	41 (1%)	3 241	419
MDC16	–	13 728	3 055 (65%)	571 (12%)	382 (8%)	298 (6%)	237 (5%)	94 (2%)	66 (1%)	4 703	439
	+	14 566	4 919 (55%)	2 307 (26%)	632 (7%)	440 (5%)	386 (4%)	125 (1%)	104 (1%)	8 914	535

+, surgery; –, non-surgery.

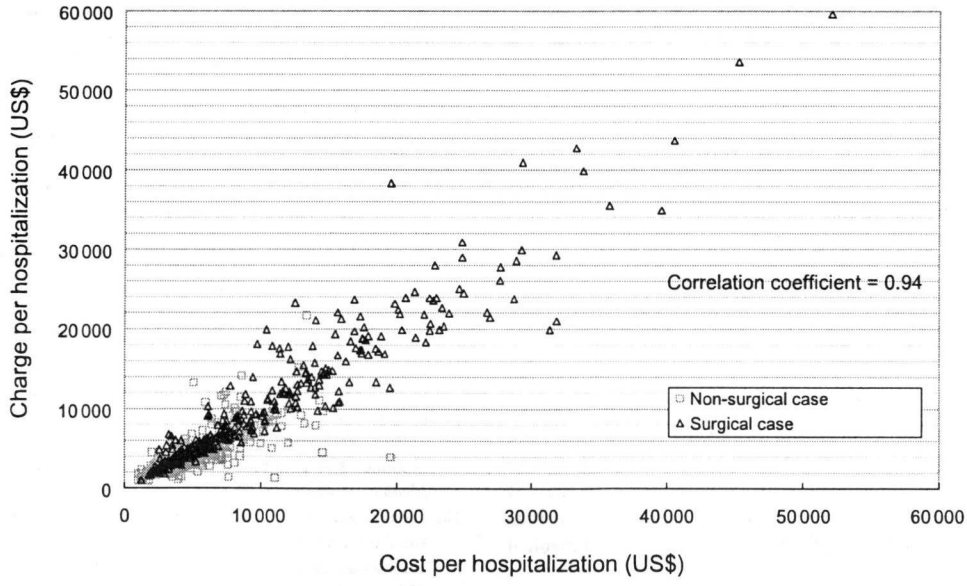

Figure 3 Relationship between average charge and average cost per hospitalization for surgical and non-surgical treatment of different disease categories (equal and more than 20 cases registered).

surgical cases tended to cover the cost. On the other hand, the cost for non-surgical cases in a variety of disease categories frequently tended to be higher than the charge.

Discussion

Prior to this study, no nationwide database of hospital costs was available in Japan. This study outlines the successful development of a standardized, large-scale database comprised of individual case-level costs with components and explores the costs of hospitalizations across DPCs and MDCs. A wide range of average cost per hospitalization and average cost per diem was observed across DPCs (14 digits) in Japan. The highest cost was from eight to nine times greater than the lowest cost. Also, the five most expensive and least expensive disease categories in terms of the average cost per hospitalization and the average cost per diem differed. Moreover, cost components varied across MDCs. Particularly, in MDC05 (diseases/disorders of the circulatory system) cases involving surgical treatment, the costs of materials amounted to 52% of the total cost. This finding may represent one reason why previous studies have noted disparities in the prices of cardiovascular medical devices [15–17] in Japan and the US. Furthermore, our database demonstrated a high correlation between the charge and the cost of hospitalization in Japan, especially for surgical inpatients. As obvious disparities exist between the cost and charge for the treatment of some disease categories, there certainly remains room for improvement in bridging this gap. On the other hand, we also recognize that the necessity of the financial incentive to expedite the broader adoption of highly cost-effective procedures over cost–charge disparity reduction.

When interpreting the results of this study, there are some limitations that should be noted. First, we used the simple length of hospital stay without considering the nursing intensity as a basis for cost allocation. In Japan, although a study regarding this issue is in progress, currently there are no standardized weighted measures. After standardized weighted measures are established in the future, we will introduce these measures into our cost calculation system. Second, consumable supplies and materials could not be charged directly to each patient in the database, because almost none of the hospitals used bar codes to manage distribution of consumable supplies. The cost of consumables, however, had an insignificant effect on patient cost, because the cost of consumables represented only a small part of the total hospital cost. Lastly, when we examined the relationship between the cost and the charge, two unpaired patients were present in the large patient sample studied. As we used the average value extracted from the large database, and there was little difference in financial data between the two patients originally, the inclusion of data on these two patients had an insignificant effect on the overall results.

One of the strengths of the present study is the simplicity of calculation of standardized patient cost per diem, without requiring use of an advanced information technology system. The simplicity of our cost calculation methodology makes it routinely feasible, and therefore allows us to cover a wide range of cost items, diagnoses and hospital departments from a large number of participant hospitals. Furthermore, the Japanese payment system is based on a nationally uniform fee-for-service reimbursement schedule. In the Japanese payment system, information about timing, specific procedures performed and specific materials utilized can be obtained through standardized data on medical claims. Therefore, it is possible to charge most medications and materials cost to the corresponding patient directly and to allocate other service costs by measuring activity indicators or substitutes in our calculation. Another strength of our study is that the methodology utilized and the database developed is valuable tools for policy making. For example, our examination of the relationship

between the cost and the charge can serve as a basis for discussion of cost-based pricing.

Conclusions

As it is increasingly important and feasible to assess standardized cost information, a nationwide database comprised of individual case-level costs with components was developed for acute-care hospitals in Japan, and the characteristics of the database were analysed. For example, a high correlation between the average cost of hospitalization of surgical patients and the charge was observed.

The successful development of this database can lead to further in-depth analyses in Japan. For example, it is possible to analyse the time series (e.g. daily) variation in costs and examine the difference in costs across varying hospital ownerships. Also, the database can facilitate comparison between hospital costs and revenue, which represents useful information for hospital managers. Moreover, the cost information in this large-scale database is essential in performing important economic evaluations, such as comparing the cost and the performance or outcome of a medical intervention.

We hope that this study contributes to appropriate decision making and helps motivate further research geared towards efficient hospital management and a rational payment system in Japan.

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