た電子的なプロセスが必要となる。そのためにはそのような電子的なチェックに適した電子レセプトの導入が不可欠である。本研究では現行の電子レセプトの仕様とDPC調査で提出されている情報(様式1及び E/F ファイル)との整合性を踏まえた上で、望ましい DPC 電子レセプトの仕様を検討した。また、その基盤となる各種マスタとコーディングロジックについても作成及びバージョンアップを行った。

ところで、DPC については包括支払方式のツールとしての議論が中心となっているが、その本来の目的は医療情報の標準化と透明化である。このような観点から DPC データの臨床研究への応用や医療の質評価への可能性を実証的に検討した。医療の質は一般的に構造、プロセス、アウトカムの3つから評価されるが、DPC データはそのいずれの視点からも評価指標を作成することが可能である。特に、臨床評価で最も重要なプロセスのデータが取れるという点は、他の国の医療システムにない利点であり、抗生物質の使用状況や化学療法の実態、さらには悪性症候群の発症に関する臨床疫学的分析など、種々の応用が可能であることが示された。

E. 結論

本研究では以下のような成果が得られた。

1.新たな機能係数を設定するための基礎資料の作成(医療機関の機能評価)

2. 標準的DPC電子レセプトのモデルの作成

3. DPCを用いた医療サービスの原価推計

4. DPCを用いた医療サービスの評価方法の検討

本研究の成果は、現在中医協で議論されている DPC 制度の今後を検討するための有用な資料をなると考えられる。

F. 健康危険情報

特に関係なし。

G. 研究発表

1. 論文発表

1. ○ Matsuda S: Diagnosis Procedure Combination - the Japanese original casemix system-, In: Kimberly J and Pouvourville G (ed), the Globalization of Managerial Innovation in Health Care, Cambridge University Press (2008).
2. ○松田晋哉：臨床医のための DPC 入門第２版、東京：じほう (in press)
3. ○Matsuda S, Ishikawa BK, Kuwabara K, Fujimori K, Fushimi K and Hashimoto H: DPC: Japanese casemix system-its outline and application for health research-, EuroHealth (in press).
4. ○Matsuda S, Ishikawa BK, Kuwabara K, Fujimori K, Fushimi K and Hashimoto H: DPC based health service planning for cancer medicine , APJDM (in press).
5. ○松田晋哉： DPC 公開データを用いた医療評価、社会保険旬報 (in press).

6. ○Matsuda S, Fujimori K and Hashimoto H: Health care system reform in Japan- Development of Casemix based evaluation system -, Proceedings of Provider Payment Incentives in the Asia-Pacific conference, Beijin, 2008.
7. ○松田晋哉： 周産期医療の DPC、周産期医学、38(1): 111-115, 2008.
8. ○松田晋哉： DPC の現状と課題、社会保険旬報、No.2341: 18-27, 2008.
9. ○松田晋哉： DPC と医療連携、社会保険旬報、No.2344: 6-11, 2008.
10. ○松田晋哉： DPC 導入と（急性期）リハビリテーション医療、Jpn J Rehabil Med、45(5):278-284, 2008.
11. ○松田晋哉： DPC と医療の質、社会保険旬報、No.2352: 18-25, 2008.
12. ○松田晋哉： DPC を用いた支払い方式、社会保険旬報、No.2357: 16-21, 2008.
13. ○松田晋哉： DPC 対象施設における救急医療の現状と展望、医学のあゆみ、226(9):659-663, 2008.
14. ○松田晋哉：臨床医のための DPC 入門第２版、東京：じほう, 2009.
15. ○松田晋哉、石川ベンジャミン光一、藤森研司、堀口裕正： DPC 電子レセプトの仕様に関する検討、社会保険旬報、No.2393: 8-13, 2009.
16. ○松田晋哉： DPC データの傷病登録への活用可能性、社会保険旬報、No.2403: 6-10, 2009.
17. ○松田晋哉： DPC と医薬品、社会保険旬報、No.2381:20-25, 2009.
18. ○松田晋哉： DPC 公開データを用いた医療評価、社会保険旬報 、No.2372:22-27, 2009.
19. ○松田晋哉、藤森研司、桑原一彰・他：DPC における精神科医療の評価、臨床精神医学 39(2): 241-252, 2010.
20. ○松田晋哉、藤森研司、桑原一彰・他：DPC データを用いた脳梗塞急性期リハビリテーションの現状分析、Journal of Clinical Rehabilitation（in press）.
21. ○松田晋哉、藤森研司、桑原一彰・他：DPC データを用いたギラン・バレー症候群症例の検討、神経内科（in press）.
22. ○松田晋哉:DPC を用いたクリニカルパスの評価、日本クリニカルパス学会誌(in press).
23. ○伏見清秀編著. DPC データ活用ブック第２版.東京：じほう、2008.
24. ○伏見清秀. 医療崩壊の原因は「非効率な配分」. 週刊エコノミスト 2008 年 9 月 16 日号 46-49.
25. Yamamoto, K., ○Fushimi, K. Travel of patients to distant hospitals for elective surgery in Japan: A cross-sectional analysis of a nationally representative sample.

Surgery Today 2009; 39:758-763.

26. ○ Fushimi, K. A prescription for better medical care. Japan Echo. 2009;36(1):10-13.

27. Sato, E., ○ Fushimi, K. What has influenced patient health-care expenditures in Japan?: Variables of age, death length of stay and medical care. Health Economics. 2009;18: 843-853.

28. ○伏見清秀. DPC データの蓄積で病院も患者も利益を得る. 週刊エコノミスト. 2009.9.1号 34-35.

29. ○伏見清秀. 医療の効率化～医療経営の視点から. 日本オペレーション・リサーチ学会雑誌. 2009 54:373-8.

30. ○伏見清秀. DPC 地域患者データが示すわが国の循環器医療提供体制の課題. 日本冠疾患学会雑誌. 2009 15:83-90.

31. ○伏見清秀. ベンチマーク. NursingBusiness. 2009 33:72-75.

32. ○伏見清秀. 統計を医療政策にどう反映させるか. 病院. 2009 68(2):100-103.

33. ○伏見清秀. 簡単にできる DPC データの戦略的活用法. 自院の強み・弱みが一目瞭然. 日経ヘルスケア. 2009 229:54-57.

34. ○伏見清秀. 診療報酬制度における DPC 包括評価の意義. 次世代型医療制度改革（田近栄治、尾形裕也編著）. 2009 177-200. ミネルヴァ書房.京都.

35. ○Kuwabara K, Imanaka Y, Matsuda S, et al. The association of the number of comorbidities and complications with length of stay, hospital mortality and LOS high outlier, based on administrative data. Environ Health Prev Med 2008; 13:130- 137.

36. ○Kuwabara K, Imanaka Y, Matsuda S, et al. Cost of open versus laparoscopic appendectomy. Clin Ter 2008; 159 (3):155-163.

37. ○Kuwabara K, Matsuda S, Imanaka Y et al. The effect of age and procedure on resource use for patients with cerebrovascular disease. Journal of Health Services Research & Policy 2008; 13(1): 26- 32.

38. ○Kuwabara K, Imanaka Y, Matsuda S, et al. Impact of age and procedure on resource use for patients with ischemic heart disease. Health Policy 2008; 85: 196- 206.

39. ○ Kuwabara K, Matsuda S, Anan M, Fushimi K, Ishikawa KB, Horiguchi H, Hayashida K, Fujimori K. Difference in resource utilization between patients with acute and chronic heart failure from Japanese administrative database. Int J Cardiol. 2009.

40. ○Kuwabara K, Matsuda S, Fushimi K,

Anan M, Ishikawa KB, Horiguchi H, Hayashida K, Fujimori K. Differences in practice patterns and costs between small cell and non-small cell lung cancer patients in Japan. Tohoku J Exp Med. 2009 217; 1 :29-35.

41. ○Kuwabara K, Matsuda S, PhD; Imanaka Y, Fushimi K, Hashimoto H, Ishikawa KB, Horiguchi H, Hayashida K, Fujimori K, Ikeda S, Yasunaga H. Injury Severity Score, resource use, and outcome for trauma patients within a Japanese administrative database. J Trauma. 2010 68:463-470.
42. ○Kuwabara K, Matsuda S, Fushimi K, Ishikawa KB, Horiguchi H, Fujimori K. Probability of survival, early critical care process, and resource use in trauma patients. Am J Emerg (in press).
43. ○Kuwabara K, Matsuda S, Fushimi K, Ishikawa KB, Horiguchi H, Fujimori K, Hayashida K. Impact of timing of cholecystectomy and bile duct interventions on quality of cholecystitis care. Int J Surg. 2009 7; 3: 243-249.
44. ○Kuwabara K, Matsuda S, Fushimi K, Ishikawa KB, Horiguchi H, Hayashida K, Fujimori K. Contribution of bile duct drainage on resource use and clinical outcome of open or laparoscopic cholecystectomy in Japan. J Eval Clin Pract 2010.
45. ○Kuwabara K, Matsuda S, Fushimi K, Ishikawa KB, Horiguchi H, Hayashida K, Fujimori K. Impact of timing of bile duct interventions on resource use and clinical outcome of cholecystectomy patients in Japan. J Eval Clin Pract (in press).
46. ○Kuwabara K, Matsuda S, Fushimi K, Ishikawa KB, Horiguchi H, Fujimori K. Variations in the preoperative resources use and the practice pattern in Japanese cholecystectomy patients. Surg Today (in press).
47. ○Kuwabara K, Matsuda S, Fushimi K, Ishikawa KB, Horiguchi H, Fujimori K. Impact of hospital case volume on the quality of laparoscopic colectomy in Japan. J Gastrointest Surg. 2009 13; 9: 1619-1626.
48. ○Kuwabara K, Matsuda S, Fushimi K, Ishikawa KB, Horiguchi H, Fujimori K. Hospital volume and quality of laparoscopic gastrectomy in Japan. Dig Surg 2009 26:422-9.
49. ○Kuwabara K, Matsuda S, Fushimi K, Ishikawa KB, Horiguchi H, Fujimori K.

Quantitative comparison of the difficulty of performing laparoscopic colectomy at different tumor locations. World J Surg. 2010 34: 133- 139.

50. ○Hayashida K, Imanaka Y, Otsubo T, Kuwabara K. et al. Development and analysis of a nationwide cost database of acute-care hospitals in Japan. Journal of Evaluation in Clinical Practice 2009,15: 626-33.

51. 小野田学時，伊勢雄也，井上忠夫，大江洋一，恩田光子，佐藤博，田中克巳，飛野幸子，○池田俊也：DPC における薬剤師のクリニカルパスと医薬品マネジメントに関する調査研究、日本病院薬剤師会雑誌 44 巻 1 号，24-25，2008

52. ○石川 B 光一、松田晋哉： 厚生労働省平成 19 年度 DPC 調査データに基づく病院の診療実績一覧、東京：じほう、2008.

53. Miyata H, ○Hashimoto H, Horiguchi H, Matsuda S, etaal. Performance of in-hospital mortality prediction models for acute hospitalization:Hospital Standardized Mortality Ratio in Japan. BMC Health Serv Res. 2008 Nov 7;8(1):229.

54. ○橋本英樹 DPC システムにおける施設別係数の理論的批判 社会保険旬報 2008 年 1 月 11 日 (No. 2339) pp6-13.

55. ○藤森研司： DPC データによる放射線診療の分析可能性、新医療 398:58-61、2008

56. ○藤森研司： DPC 制度導入で変化する業務、Nursing Business 2:519-526、2008.

57. ○藤森研司、中島稔博 ： DPC データ分析 アクセス・SQL 活用編、東京：じほう、 2009.

58. ○藤森研司、松田晋哉（編者）：明日の医療に活かす DPC データ分析手法と活用、東京：じほう、 2009.

59. ○藤森研司：DPC データたからみる心臓核医学検査の状況を考察する、新医療 411：65-68、2009.

60. ○藤森研司： DPC(Diagnosis Procedure Combination) 収支分析 コスト把握の考え方と実務、Nursing Business 夏季増刊：76-79、2009.

61. ○藤森研司、中島稔博、松田晋哉：電子レセプトのデータベース化と活用、社会保険旬報 2399：10-14、2009.

62. ○藤森研司、松田晋哉、浅香正博： DPC データからみたい癌診療の状況、Helicobacter Research 13(5):385-390、2009.

63. ○藤森研司：DPC データからみた ICU 診療の状況、エンドトキシン血症救命治療研究会誌、 13：2226-232、2009.

64. ○Anan M, Kuwabara K, Hisatomi Y, at al: Evaluating the quality of ICD

coding in the DPC in Japan, Proceedings of the 24th PCSI conference, 2008.

65. ○阿南誠、久富洋子、桑原一彰、秋岡美登恵、柴田実和子、他、DPC 導入に伴う ICD コーディングの問題点：第 7 報、DPC 基礎調査における「.9」出現率の推移と診療情報管理士の存在、診療情報管理、21(2)：168、2009.
66. ○阿南誠、DPC の来し方行く先「現場で働く診療情報管理士からみた DPC」、診療情報管理、21(2)：60-61、2009.
67. ○阿南誠、第 2 章 DPC 制度と診療報酬制度との関わり、社団法人日本病院会 DPC コース通信教育テキスト、171 -206、2009.
68. ○堀口裕正，康永秀生，橋本英樹，石川ベンジャミン光一，桑原一彰，阿南誠，松田晋哉：標準 DPC コーディング・ロジックの開発、医療情報学、Vol28(2)73-82、2009.
69.

研究班作成の行政資料等

厚生労働省診療報酬調査専門組織（DPC 評価分科会）において、新たな機能係数策定のための基礎資料として、本研究班の調査結果を参考資料として提出し、説明を行った。

1. 平成 20 年度第 2 回 診療報酬調査専門組織・DPC 評価分科会（H20 年 7 月 30 日）
2. 平成 20 年度第 3 回 診療報酬調査専門組織・DPC 評価分科会（H20 年 10 月 3 日）
3. 平成 20 年度第 4 回 診療報酬調査専門組織・DPC 評価分科会（H20 年 11 月 7 日）
4. 平成 20 年度第 8 回診療報酬調査専門組織・DPC 評価分科会（H20 年 12 月 17 日）
5. 平成 20 年度第 9 回診療報酬調査専門組織・DPC 評価分科会（H21 年 1 月 21 日）
6. 平成 20 年度第 10 回診療報酬調査専門組織・DPC 評価分科会（H21 年 2 月 12 日）
7. 平成 20 年度第 11 回診療報酬調査専門組織・DPC 評価分科会（H21 年 2 月 23 日）
8. 平成 20 年度第 12 回診療報酬調査専門組織・DPC 評価分科会（H21 年 3 月 5 日）
9. 平成 20 年度第 13 回診療報酬調査専門組織・DPC 評価分科会（H21 年 3 月 23 日）
10. 成 21 年度第 4 回 診療報酬調査専門組織・DPC 評価分科会（H21 年 6 月 8 日）

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Profiling of resource use variation among six diseases treated at 82 Japanese special functioning hospitals, based on administrative data

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Abstract

Background: Profiling treatment in Japanese hospitals has rarely been conducted systematically with an administrative database. The study aims to present descriptive statistics of medical profiling and to examine the sources of variation in resource used for six common diseases.
Methods: Administrative records for 266,677 patients were analyzed to examine variation in length of stay (LOS) and total charge (TC) by hierarchical multiple linear regression for cases of ischemic stroke, ischemic heart disease (IHD), great vessel disease (GVD), respiratory neoplasm, gastric neoplasm and colonic neoplasm.
Results: Average LOS and TC increased with disease severity and invasiveness of surgical procedure. The coefficient of determination of the full model was highest for LOS in IHD (0.432), and for TC that was highest in GVD (0.702). Among various variable sets examined, surgical procedures explained largest variance in resource use.
Conclusion: With a standardized database derived from claims data, wide audience of stakeholders in Japanese healthcare will be able to access the profiling of practice or disease variation concerned.

Keywords: Casemix classification; Profiling; Variation; Resource use

1. Introduction

Restrictive fiscal policy and increasing costs associated with the rapid evolution of healthcare technology are raising the stakes for healthcare reform in Japan. In addition to these financial pressures, patient safety and

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disclosure of hospital performance are also receiving more public attention. However, the tools necessary to assess the efficiency of resource allocation and quality of care have not been available. Since 2002, in collaboration of Ministry of Health, Labor and Welfare (MHLW) and 21 academic societies interested in healthcare insurance, we have been developing a new casemix classification system called diagnosis procedure combination (DPC), which can be used to measure hospital performance and costs for a comprehensive range of diseases.

DPC is made up of three core elements: diagnosis, procedures, and comorbidities and complications (CC) in this order. Following the expert opinions of participating medical societies, we classified a wide range of diseases into several clinically valid groups with an emphasis on homogeneous resource utilization. As for classification logic, our DPC takes priority in diagnosis, whereas other systems like All Patient Diagnosis Related Groups (AP-DRG) in procedure [1]. By enumerating procedures, supportive care, comorbidities and complications, and other severity indices specific to each principal diagnosis, we constructed a definition table for each DPC code. Eighty-two special function hospital (80 university hospitals, the National Cancer Center, and the National Cardiovascular Center) that play a leadership role in the delivery of medical care for acute illness, education and research, submitted clinical information from medical records and claims data. Information regarding severity, resource use and outcome from this detailed database were then used by the MHLW to develop a revised casemix classification, which has been applied to per diem payments to special functioning hospitals since April 2003.

We were asked to refine the DPC classifications to enhance their clinical validity and accounting accuracy by analyzing the DPC database. Through examining the factors affecting the variance of resource use, we were able to obtain the profiling specific for comparable disease or procedure. At the same time, the DPC claims database may be a promising tool for measuring relationships between volume and outcome by applying risk adjustment for various diseases and procedures [2–8]. In the course of refining the Japanese casemix classification system and DPC database, the aim of this study is to present descriptive statistics and resource use information for prevalent diseases and high-volume procedures in Japan, and to explore the amount of variance that can be explained by common or specific factors concerned in every six disease.

2. Materials and methods

This was a secondary data analysis that was embedded in the government research project on DPC development. Anonymous claim and clinical data were provided by the MHLW authority with research contract. From 82 special functioning hospitals, both clinical information and claim data, merged into standardized electronic format, were gathered by MHLW for 266,677 patients who were discharged between July 1, 2002 and October 31, 2002. From this initial dataset, we selected cases with high-volume principal diagnosis of ischemic stroke, ischemic heart disease (IHD), great vessel aneurysmal or dissecting disease (GVD), respiratory malignant neoplasm, gastric malignant neoplasm, or malignant neoplasm of the colon, excluding rectosigmoid colon, rectum or anus, because these were more prevalent among diseases of central nervous system, cardiovascular system or malignant neoplasm in Japan. We also excluded patients who died within 24 h of admission.

2.1. Variables definition

Study variables were age, gender, outcome at discharge, use of an ambulance, comorbidities and complications, severity of principal diagnosis, surgical procedures, supportive procedures, neoadjuvant therapy, hospital location, and hospital ownership. We also examined the length of stay (LOS), and total charges billed during one admission (TC; $1 = ¥105). In Japan, TC for hospital care is summed up with all the pricings for every performed procedure, which are uniformly determined under the standardized fee-for-service payment system and listed upon the nationally uniform fee table. Age was stratified as either less than or equal to and greater than 65 years of age. We defined transfer by ambulance as a proxy for emergency admission.

2.1.1. Comorbidity and complication

A maximum of four comorbidities and three complications were recorded. To assess comorbid conditions, we used the Dartmouth–Manitoba (MD) index, which we translated from its original ICD-9CM form into ICD-10 [9]. As a complication, we added postoperative surgical complication (COMP) (wound infection, abcess, hematoma or hemorrhage, infection of device or implant), and deep vein thrombosis or pulmonary thromboembolism (DVT). Comorbidity or complication was identified as being present if a patient had any of the following CC coded in any of the seven secondary diagnosis columns: mild diabetes mellitus (mDM); diabetes mellitus with endorgan damages (sDM); peripheral vascular disease (PVD); dementia (DEM); chronic obstructive pulmonary disease (COPD); congestive heart disease (CHF); chronic renal failure (CRF); connective tissue disease (CTD); mild liver disease (mLD); severe liver disease (sLD); malignancy (MAL); COMP; and DVT. For DM or LD, the more sever code was selected when patients had two codes, for example, mDM and sDM, or mLD and sLD.

2.1.2. *Severity of principal diagnosis*

Principal diagnosis included clinical information about severity, location or pathology denoted by ICD 10 codes. Ischemic stroke was subdivided into four groups: vertebral artery, carotid artery, intracranial artery, and not classified elsewhere or not otherwise specified (NEC and NOS for location). In cases where consciousness level had been assessed by the Japan coma scale (JCS), we categorized assessment into four categories: alert; drowsy (JCS: 1, 2, 3); semicoma (10, 20, 30); and coma (100, 200, 300) [10]. IHD was classified by location or severity where appropriate. Angina was categorized into four groups: unstable; effort; atypical angina; angina NOS. Location of acute myocardial infarction (AMI) was categorized into five groups: anterior wall; posterior wall; other wall; subendocardium; or NOS. Where appropriate, AMI were also classified as recurrent, or old with or without complications. GVD was divided in to three groups: dissection, ruptured or unruptured. The locations of respiratory neoplasms were classified into six groups: trachea; main bronchus; upper lobe; middle lobe; lower lobe; or NOS. Respiratory neoplasms were also identified as being metastatic, or as having overlapping lesions where appropriate. The locations of gastric neoplasms were classified into four groups: fundus (including cardia); body; antrum; NEC; and NOS. The location of colonic neoplasms were classified into four groups: right (including hepatic flexure); transverse; left side (including sigmoid); or NOS.

2.1.3. *Procedures*

The database recorded a maximum of five operative procedures for each hospitalization. We also selected various kinds of procedures specific to each disease. We considered a combination of procedures valid if there were 10 or more cases coded with that combination. When ordering procedures, we counted them in order of invasiveness to physical conditions or difficulty of performing procedure in terms of labor and demanded experience. Procedures were considered valid if they had a logical, clinical association with the diagnosis. For ischemic stoke, the following procedures were considered valid: gastrostomy; tracheostomy; interventional intracranial thrombolysis; interventional angioplasty; endarterectomy; operative angioplasty (e.g. enchalo-duro synanigiosis); or extracranial–intracranial arterial bypass. For IHD, the following procedures were considered valid: percutaneous coronary artery angioplasty (PTCA); atherectomy; stenting; coronary artery bypass graft (CABG); and intra-aortic balloon pumping (IABP) as additional support for any of these procedures. Procedures considered valid for GVD included the following: stenting, excision and graft interposition for abdominal aortic aneurysm (AAA) with or without reconstruction of the intra-abdominal branch, excision and graft interposition for thoracic aortic aneurysm with or without valve replacement, and CABG as additional support for any of these procedures. Procedures considered valid for respiratory neoplasm included the following: resection under bronchoscopy, video-assisted resection, non-video assisted partial or wedge resection, lobectomy or pneumonectomy, and sleeve resection of bronchus. For gastric neoplasm, the following procedures were considered valid: certain palliative procedures (e.g. laparotomy only, bypass surgery, hemostasis under fiberscopy), endoscopic mucosal resection, total gastrectomy including laparoscopy assisted gastrectomy, partial gastrectomy including laparoscopy assisted gastrectomy with or without associated organ resection. The following procedures were considered valid for colonic neoplasm: certain palliative procedures (e.g. laparotomy only, bypass surgery, partial resection, or ostomy for decompression), infusion device implantation for hepatic intra-arterial chemotherapy, endoscopic mucosal resection, and radical colectomy. We grouped patients coded with NEC procedures along with patients who had no surgical procedures.

Table 1
Characteristics of patients by explanatory factors, region and ownership

	Ischemic stroke	Ischemic heart disease	Great vessel disease	Respiratory neoplasm	Gastric neoplasm	Colonic neoplasm
Total number of hospitals	79 {2}	78 {0}	77 {5}	82 {3}	81 {0}	82 {6}
Cases	3801 ⟨25⟩	10218 ⟨71⟩	1955 ⟨20⟩	7301 ⟨34⟩	4651 ⟨19⟩	2356 ⟨12⟩
Outcome at discharge dead	114 (3.00)	137 (1.40)	110 (5.70)	600 (8.30)	283 (6.10)	104 (4.40)
Age mean [S.E]	66.57 [0.21]	65.10 [0.19]	68.82 [0.26]	64.88 [0.14]	65.40 [0.17]	66.06 [0.24]
Alive	66.38 [0.21]	65.01 [0.11]	68.64 [0.11]	64.70 [0.15]	65.41 [0.18]	65.99 [0.25]
Dead	72.75 [1.12]	71.47 [0.93]	71.81 [0.98]	66.88 [0.46]	65.31 [0.76]	67.45 [1.22]
Gender						
Male	2467 (65.33)	7509 (74.00)	1437 (74.26)	5030 (69.22)	3269 (70.57)	1344 (57.34)
Age (years)						
<65	1403 (37.16)	4383 (43.20)	528 (27.29)	3046 (41.92)	1978 (42.7)	939 (40.06)
≧65	2373 (62.84)	5764 (56.80)	1407 (72.71)	4221 (58.08)	2654 (57.3)	1405 (59.94)
Transfer						
Ambulance car used	1103 (29.21)	1651 (16.27)	405 (20.93)	195 (2.68)	103 (2.22)	54 (2.30)
Absent	2667 (70.63)	6832 (67.30)	1523 (78.70)	6122 (84.24)	3428 (74.01)	1945 (82.98)
mDM	498 (13.19)	1669 (16.45)	106 (5.48)	356 (4.9)	261 (5.63)	146 (6.23)
sDM	197 (5.22)	735 (7.24)	23 (1.19)	74 (1.02)	58 (1.25)	39 (1.66)
PVD	**	**	**	74 (1.02)	34 (0.73)	16 (0.68)
DEM	47 (1.24)	17 (0.17)	9 (0.47)	15 (0.21)	13 (0.28)	7 (0.30)
COPD	55 (1.46)	156 (1.54)	71 (3.67)	398 (5.48)	78 (1.68)	38 (1.62)
CHF	87 (2.30)	311 (3.06)	42 (2.17)	42 (0.58)	23 (0.5)	30 (1.28)
CRF	49 (1.30)	377 (3.72)	86 (4.44)	51 (0.70)	42 (0.91)	26 (1.11)
CTD	24 (0.64)	62 (0.61)	11 (0.57)	25 (0.34)	8 (0.17)	9 (0.38)
mLD	39 (1.03)	90 (0.89)	18 (0.93)	59 (0.81)	53 (1.14)	26 (1.11)
sLD	15 (0.40)	30 (0.30)	3 (0.16)	33 (0.45)	61 (1.32)	26 (1.11)
MAL	86 (2.28)	166 (1.64)	45 (2.33)	**	**	**
COMP	4 (0.11)	48 (0.47)	34 (1.76)	37 (0.51)	101 (2.18)	63 (2.69)
DVT	8 (0.21)	6 (0.06)	3 (0.16)	4 (0.06)	12 (0.26)	2 (0.09)
Region†						
Hokkaido	86 (2.28)	137 (1.35)	74 (3.82)	182 (2.50)	94 (2.03)	48 (2.05)
Tohoku	228 (6.04)	466 (4.59)	113 (5.84)	481 (6.62)	262 (5.66)	107 (4.56)
Kanto	1582 (41.90)	4516 (44.51)	721 (37.26)	3218 (44.28)	2235 (48.25)	1113 (47.48)
Chubu	508 (13.45)	1358 (13.38)	236 (12.20)	817 (11.24)	507 (10.95)	272 (11.60)
Kinki	775 (20.52)	1881 (18.54)	411 (21.24)	1114 (15.33)	705 (15.22)	352 (15.02)
Chugoku	185 (4.90)	405 (3.99)	103 (5.32)	394 (5.42)	255 (5.51)	134 (5.72)
Sikoku	128 (3.39)	173 (1.70)	50 (2.58)	229 (3.15)	110 (2.37)	55 (2.35)
Kyushu	284 (7.52)	1211 (11.93)	227 (11.73)	832 (11.45)	464 (10.02)	263 (11.22)
Ownership†						
National	1439 (38.11)	3968 (39.11)	982 (50.75)	3573 (49.17)	2141 (46.22)	963 (41.08)
Public	294 (7.79)	721 (7.11)	147 (7.60)	574 (7.90)	317 (6.84)	166 (7.08)
Private	2043 (54.10)	5458 (53.79)	806 (41.65)	3120 (42.93)	2174 (46.93)	1215 (51.83)

(**) Comorbidity not considered since it could be strongly associated with the disease indicated above. { }, number of hospitals with less than 10 cases; ⟨ ⟩, cases of death within 24 h after admission, excluded in analysis; S.E., standard error; ( ), proportion of each indicated factor for analyzed cases. (†) $p < 0.001$, chi-square test.

Table 2
Characteristics of patient by severity, pathology or location of disease involved

Disease severity or pathology	n (%)
Ichemic stroke	
Conciousness level	
Alert	3215 (85.14)
Drowsiness	303 (8.02)
Semicoma	156 (4.13)
Coma	102 (2.70)
Diseased vessel	
Vertebral artery involved	124 (3.28)
Carotid artery involved	717 (18.99)
Intracranial artery involved	1122 (29.71)
NEC and NOS for location	1813 (48.01)
Ischemic heart disease	
Angina	
Unstable angina	2024 (19.95)
Atypical angina	537 (5.29)
Effort angina	2735 (26.95)
Angina NOS	1870 (18.43)
Myocardial infarction	
AMI anterior wall	466 (4.59)
AMI posterior wall	303 (2.99)
AMI elsewhere wall	111 (1.09)
AMI subendocardium	92 (0.91)
AMI NOS	534 (5.26)
Recurrent AMI	17 (0.17)
OMI	1416 (13.95)
Complicated OMI	42 (0.41)
Great vessel disease	
Aneurysm	
Dissecting	456 (23.57)
Ruptured	128 (6.61)
Unruptured	1351 (69.82)
Respiratory neoplasm	
Location	
Trachea	26 (0.36)
Main bronchus	168 (2.31)
Upper lobe	2123 (29.21)
Middle lobe	471 (6.48)
Lower lobe	1531 (21.07)
More than two lobes involved	252 (3.47)
Metastatic	996 (13.71)
NOS for location	1700 (23.39)
Gastric neoplasm	
Location	
Fundus	418 (9.02)
Body	1539 (33.23)
Antrum	1065 (22.99)
NEC and NOS for location	1610 (34.76)
Colonic neoplasm	
Location	
Right	674 (28.75)
Transverse	296 (12.63)
Left and sigmoid	1022 (43.60)
NEC and NOS for location	352 (15.02)

Conciousness level: drowsiness means Japan coma scale 1, 2, 3; semicoma 10, 20, 30; coma 100, 200, 300, respectively; ( ) proportion of indicated factor; NOS, not otherwise specified; NEC, no elsewhere classified.

Supportive therapy included total parenteral nutrition, artifical ventilation, hemodialysis, and rehabilitation. We noted the presence of chemotherapy or radiotherapy or both, for neoadjuvant therapy to malignant neoplasm.

2.1.4. Location and ownership of hospitals

To determine the location of hospitals, we divided Japan into eight regions (Hokkaido, Tohoku, Kanto, Chubu, Kinki, Chugoku, Shikoku, Kyushu). Hospital ownership was divided into national, public (prefectural or municipal), and private.

2.2. Statistical analysis

Descriptive statistics of LOS and TC of six principal diagnoses were demonstrated by the presence of the variables mentioned above. Differences in the frequencies of the six diseases by region and ownership were examined by chi-square test. To examine how much variance in LOS and TC was explained by each set of variables of interest, we used six-step forward linear regression models. Model 1 included age and gender; model 2, emergency and severity added to model 1; model 3, comorbidity and complication added to model 2; model 4, surgical procedure added to model 3; model 5, supportive +/− neoadjuvant therapy added to model 5; model 6, hospitals of over 10 cases added to model 5. Hospitals with less than 10 cases were merged into one hospital for the purpose of modeling. Other variable with less than 10 cases were not included in the regression models. All study variables were put into each regression model not nested, but independently.

From our six models, we calculated the proportion (R^2) of variance explained by the models relative to the total variance observed in LOS and TC. We also calculated and tested the 'incremental R^2', the

Table 3
Characteristics of surgical, adjuvant or supportive procedure specific for each disease

	n (%)
Ichemic stroke	
Surgical procedure	
Gastrostomy only	26 (0.69)
Tracheostomy only	30 (0.79)
Interventional intracranial thrombolysis	10 (0.26)
Interventional angioplasty	67 (1.77)
Endarterectomy	72 (1.91)
Operative revascularization	54 (1.43)
NEC	3517 (93.14)
Supportive procedure	
None	2205 (58.40)
Total parenteral nutrition	276 (7.31)
Ventilation	138 (3.65)
Hemodialysis	21 (0.56)
Rehabilitation	1410 (37.34)
Ischemic heart disease	
Surgical procedure	
PTCA only	1442 (14.21)
Atherectomy only	13 (0.13)
PTCA + atherectomy	19 (0.19)
Stenting only	670 (6.60)
Stenting + PTCA	757 (7.46)
Stenting + atherectomy	59 (0.58)
Stenting + PTCA + atherectomy	31 (0.31)
CABG (one vessel)	101 (1.00)
CABG (one vessel) + intervention	15 (0.15)
CABG (more than two vessels)	988 (9.74)
CABG (more than two vessels) + PTCA	32 (0.32)
CABG (more than two vessels) + atherectomy or stenting	19 (0.19)
NEC	5883 (57.98)
Additional support device of IABP	
Absent	9916 (97.72)
Present	231 (2.28)
Supportive procedure	
None	8022 (79.06)
Total parenteral nutrition	848 (8.36)
Ventilation	1002 (9.87)
Hemodialysis	441 (4.35)
Rehabilitation	976 (9.62)
Great vessel disease	
Surgical procedure	
Stenting only	103 (5.32)
AAA replacement	242 (12.51)
AAA replacement + branch reconstruction	340 (17.57)
Distal TAA replacement	76 (3.93)
TAA+AAA replacement	50 (2.58)
Ascending TAA replacement only	52 (2.69)
Ascending TAA replacement + valve replacement	29 (1.50)
Arch replacement	209 (10.80)
Arch + ascending TAA replacement	12 (0.62)
NEC	822 (42.48)
Additional procedure of CABG	
Absent	1885 (97.42)
Present	50 (2.58)
Supportive procedure	
None	929 (48.01)
Total parenteral nutrition	778 (40.21)
Ventilation	592 (30.59)
Hemodialysis	110 (5.68)
Rehabilitation	229 (11.83)

NEC, no elsewhere classified, including cases without any procedures; AAA, abdominal aortic aneurysm; TAA, thoracic aortic aneurysm beyond left subclavian artery.

difference of R^2, between adjacent steps in the above models, which means the variance explained by the specific variables set added to each model. Statistical analysis was performed using SPSS ver. 11.0. All reported P-values were two-tailed, and the level of significance was less than 0.05.

3. Results

We identified 3801 patients with ischemic stroke across 79 hospitals; 10,218 patients with IHD across 78 hospitals; 1955 patients with GVD across 77 hospitals; 7301 patients with respiratory malignant neoplasm across 82 hospitals; 4651 patients with gastric malignant neoplasm across 81 hospitals; and 2356 patients with colonic malignant neoplasm across 82 hospitals. In-hospital mortality ranged from 1.40 to 8.30%. Male patients and patients older than 65 years were more common with every disease.

The proportion of emergent cases ranged from 16.27 to 29.21% in cerebral and cardiovascular disease, as opposed to a range of 2.22–2.68% in malignant neoplasm. DVT was the less frequent CC, and the proportions of six diseases differed significantly by region and by hospital ownership ($p < 0.001$) (Table 1).

Effort angina was most common for patients admitted for treatment of ischemic heart stroke, and unruptured anerysm was most frequent for patients with

Table 4
Characteristics of surgical, adjuvant or supportive procedure specific for each disease

	n (%)
Respiratory neoplasm	
Surgical procedure	
Resection under bronchospy	33 (0.45)
Video-assisted resection	705 (9.70)
Partial or wedge resection	45 (0.62)
Lobectomy or pneumonectomy	1044 (14.37)
Sleeve resection	28 (0.39)
NEC	5412 (74.47)
Neoadjuvant therapy	
None	3840 (52.84)
Chemotherapy	2311 (31.80)
Radiation therapy	468 (6.44)
Combined therapy	648 (8.92)
Supportive procedure	
None	6131 (84.37)
Total parenteral nutrition	650 (8.94)
Ventilation	213 (2.93)
Hemodialysis	33 (0.45)
Rehabilitation	425 (5.85)
Gastric neoplasm	
Surgical procedure	
Total gastrectomy (including laparoscopic gastrectomy)	416 (8.98)
Partial gastrectomy (including laparoscopic gastrectomy)	1339 (28.91)
Palliative	88 (1.90)
Endoscopic mucosal resection	759 (16.39)
Gastrectomy + pancreactomy	25 (0.54)
Total gastrectomy + splenectomy	150 (3.24)
Partial gastrectomy + splenectomy	18 (0.39)
Total gastrectomy + cholecystectomy	141 (3.04)
Partial gastrectomy + cholecystectomy	184 (3.97)
Gastrectomy + liver resection	18 (0.39)
NEC	1494 (32.25)
Neoadjuvant therapy	
None	3536 (76.34)
Chemotherapy	1047 (22.60)
Radiation therapy	18 (0.39)
Combined therapy	31 (0.67)
Supportive procedure	
None	2928 (63.21)
Total parenteral nutrition	1590 (34.33)
Ventilation	186 (4.02)
Hemodialysis	20 (0.43)
Rehabilitation	134 (2.89)
Colonic neoplasm	
Surgical procedure	
Palliative surgery	26 (1.11)
Infusion device implantation only	20 (0.85)
Endoscopic mucosal resection	249 (10.62)
Laparoscopy-assisted colectomy	125 (5.33)
Radical colectomy	1168 (49.83)
NEC	756 (32.25)
Neoadjuvant therapy	
None	1788 (76.28)
Chemotherapy	521 (22.23)
Radiation therapy	22 (0.94)
Combined therapy	13 (0.55)
Supportive procedure	
None	1391 (59.34)
Total parenteral nutrition	898 (38.31)
Ventilation	111 (4.74)
Hemodialysis	20 (0.85)
Rehabilitation	66 (2.82)

NEC, no elsewhere classified, including cases without any procedures.

GVD. The location of ischemic stroke was most commonly coded as NEC or NOS. Respiratory neoplasms were most commonly located in the upper lobe. Colonic neoplasms were most commonly located in the left or sigmoid colon. The location of gastric neoplasm was most commonly coded as NEC or NOS (Table 2).

Among the surgical procedures, endarectomy was frequently performed for ischemic stroke, PTCA was performed exclusively for IHD, and AAA replacement was commonly performed for GVD. Lobectomy or pneumonectomy was more common for treatment of respiratory neoplasm, partial gastrectomy was commonly performed for gastric neoplasm, and radical colectomy was performed to treat colonic neoplasm (Tables 3 and 4). Average LOS ranged from 16.53 to 33.63 days. TC for patients with bad outcomes or with transfer by ambulance were higher. Patients over 65 years of age with GVD, respiratory neoplasm, or gastric neoplasm had lower TC (Table 5).

For patients with ischemic stroke, TC increased in proportion to deterioration in the consciousness level. For patients with IHD, AMI was more costly than angina. Ruptured or dissecting aneurysm was associated with higher TC compared to unruptured aneurysm (Table 6).

TC for patients receiving some surgical procedure except endoscopic mucosal resection were higher compared to patients with NEC. With the exception of palliative procedures such as gastrostomy or tracheostomy

Table 5
Total charge (US$) by explanatory factors, region and hospitals

	Ichemic stroke	Ischemic heart disease	Great vessel disease	Respiratory neoplasm	Gastric neoplasm	Colonic neoplasm
LOS (days)						
Mean (S.E.)	25.41 (0.42)	16.53 (0.19)	33.03 (0.75)	33.63 (0.38)	30.01 (0.37)	28.78 (0.50)
TC						
Mean (S.E.)	9115.97 (140.65)	14257.56 (159.34)	28115.53 (673.82)	12277.56 (138.27)	12890.59 (152.59)	12019.07 (184.97)
TC by outcome						
Alive	8967.39 (135.05)	13763.10 (147.99)	26292.79 (624.38)	11768.40 (127.94)	12528.14 (144.78)	11735.51 (176.64)
Dead	13888.79 (1643.29)	50385.71 (3576.37)	58356.47 (4958.02)	17935.11 (852.34)	18460.62 (1083.72)	18126.58 (1598.06)
Gender						
Male	8961.18 (165.38)	14588.35 (188.79)	26722.13 (738.16)	12937.81 (178.74)	12977.07 (186.16)	11991.61 (256.06)
Female	9407.67 (259.64)	13315.97 (294.00)	32136.24 (1509.43)	10792.94 (197.07)	12683.19 (263.76)	12055.99 (263.86)
Age (year)						
<65	8061.26 (215.46)	13272.81 (219.76)	29377.18 (1377.69)	12565.91 (249.24)	12979.30 (227.47)	11909.57 (300.94)
≥65	9739.55 (182.85)	15006.37 (224.81)	27642.07 (769.00)	12069.47 (155.89)	12824.48 (205.41)	12092.26 (234.11)
Transfer by ambulance car						
Not used	8071.49 (145.28)	12400.80 (158.50)	25450.90 (700.30)	12236.42 (139.70)	12819.40 (149.10)	11943.70 (184.37)
Used	11647.14 (315.84)	23812.41 (477.33)	38181.90 (1748.07)	13769.27 (934.92)	16020.79 (2012.67)	15215.33 (1789.27)
Complication and comorbidity						
Absent	8535.01 (157.71)	12720.96 (174.08)	26815.29 (758.95)	11787.46 (151.34)	12093.26 (159.43)	11384.91 (194.78)
mDM	10208.49 (393.04)	15933.00 (405.88)	34618.35 (2551.66)	15047.34 (593.40)	16203.30 (740.88)	14249.89 (772.84)
sDM	9705.35 (489.81)	19364.03 (754.88)	36323.66 (4516.04)	16230.36 (1316.94)	17614.13 (1550.29)	16387.94 (1380.25)
PVD	**	**	**	14903.68 (1474.05)	16467.88 (2014.4)	12484.93 (1694.32)
DEM	9786.87 (1709.17)	27720.96 (5367.88)	15906.03 (2906.82)	11752.97 (2869.03)	17072.23 (4160.64)	9740.04 (1578.51)
COPD	10194.84 (1079.48)	17470.65 (1483.23)	32237.69 (3876.96)	14557.81 (558.62)	17628.02 (2405.52)	14399.41 (2099.23)
CHF	13670.90 (1022.58)	24337.18 (1394.90)	43541.41 (6028.06)	11536.02 (1245.58)	16484.37 (2791.85)	15577.17 (1125.12)
CRF	13283.64 (1768.80)	21342.02 (1251.62)	31890.49 (2843.24)	16681.54 (1457.49)	15396.47 (2213.61)	15470.90 (1916.34)
CTD	14181.27 (2545.81)	11673.13 (1384.46)	29263.00 (9291.70)	20012.59 (2367.28)	13411.58 (3419.99)	12402.78 (4966.94)
mLD	12535.58 (3469.13)	15702.19 (1467.03)	22055.40 (5431.91)	10798.45 (1057.25)	12033.92 (1051.59)	11342.87 (1364.99)
sLD	6487.57 (950.64)	19569.14 (4326.42)	8689.94 (5248.96)	13700.42 (1530.54)	12983.90 (1278.35)	14730.33 (1968.13)
MAL	9504.42 (856.25)	14920.13 (1190.76)	30077.45 (3847.81)	**	**	**
COMP	15072.29 (613.65)	32850.73 (3112.96)	46888.79 (5689.01)	19743.90 (1716.44)	24212.07 (1056.71)	19910.39 (1398.38)
DVT	12216.57 (2782.55)	26096.89 (8347.11)	71744.86 (47429.14)	21183.74 (7212.05)	20400.40 (2639.96)	21438.05 (5798.52)
Region						
Hokkaido	8861.86 (894.49)	17916.49 (2271.39)	37446.02 (3866.12)	17587.42 (989.80)	16570.47 (1373.16)	13540.10 (1387.49)
Tohoku	10545.02 (521.01)	13396.56 (731.20)	28714.28 (3011.96)	12062.19 (649.92)	11863.91 (885.69)	12437.64 (723.92)
Kanto	9542.21 (236.66)	12723.98 (219.21)	24471.65 (992.13)	11207.80 (167.44)	11599.05 (197.41)	11034.13 (254.55)
Chubu	8683.16 (346.44)	14813.08 (459.74)	29692.30 (2053.12)	14954.24 (625.61)	15162.42 (560.37)	14335.53 (551.91)
Kinki	8425.72 (268.96)	14950.09 (353.66)	30266.98 (1524.65)	11960.20 (316.88)	14354.38 (360.50)	13096.33 (471.85)
Chugoku	8136.27 (520.58)	17745.66 (1051.17)	31770.68 (2837.70)	11699.71 (487.26)	12263.01 (554.68)	11413.78 (869.18)
Sikoku	7350.55 (1052.09)	14539.57 (1227.31)	24585.39 (3387.90)	12033.99 (616.34)	16465.79 (953.22)	15849.50 (1580.15)
Kyushu	9762.90 (480.65)	16988.44 (479.31)	29933.94 (2131.58)	13515.30 (435.67)	13736.80 (470.88)	11409.26 (572.14)
Ownership						
National	8412.13 (216.87)	15269.62 (275.01)	30295.43 (964.86)	12294.39 (208.44)	12546.64 (214.87)	12112.54 (284.71)
Public	9422.13 (550.17)	15357.86 (575.42)	33137.68 (2630.10)	14283.12 (509.12)	15834.20 (636.18)	13471.06 (663.15)
Private	9567.66 (194.26)	13376.44 (204.23)	24543.67 (989.44)	11889.30 (194.18)	12800.10 (227.44)	11746.62 (260.79)

TC, total charge; S.E., standard error. (**) Comorbidity not considered since it could be the cause of analyzed disease.

Table 6
Total charge (US$) by severity, pathology or location involved

Disease severity or pathology	Mean (S.E.)
Ichemic stroke	
Conciousness level	
Alert	8372.69 (139.32)
Drowsiness	11682.28 (594.01)
Semicoma	15162.79 (876.73)
Coma	15672.30 (1273.19)
Diseased vessel	
Vertebral artery involved	5149.05 (399.57)
Carotid artery involved	9801.33 (336.52)
Intracranial artery involved	9542.57 (242.09)
NOS for location	8852.23 (210.15)
Ischemic heart disease	
Angina	
Unstable angina	18050.43 (406.66)
Atypical angina	6923.61 (370.57)
Effort angina	12260.81 (260.94)
Angina NOS	11299.06 (328.93)
Myocardial infarction	
AMI anterior wall	25342.37 (832.22)
AMI posterior wall	24722.69 (832.51)
AMI elsewhere wall	26302.06 (2409.18)
AMI subendocardium	18603.22 (1260.86)
AMI NOS	25077.34 (825.00)
Recurrent AMI	28677.25 (4492.39)
OMI	7947.93 (293.78)
Complicated OMI	16481.94 (3730.06)
Great vessel disease	
Aneurysm	
Dissecting	31487.16 (1557.12)
Ruptured	46170.00 (3230.53)
Unruptured	25266.94 (728.73)
Respiratory neoplasm	
Location	
Trachea	9026.15 (1185.41)
Main bronchus	13768.80 (853.78)
Upper lobe	12305.15 (221.79)
Middle lobe	11305.78 (460.68)
Lower lobe	12271.74 (263.39)
More than two lobes involved	12633.78 (647.23)
Metastatic	10991.23 (551.31)
NOS for location	13120.76 (279.33)
Gastric neoplasm	
Location	
Fundus	15612.41 (588.58)
Body	11629.71 (220.35)
Antrum	12985.75 (332.29)
NEC and NOS for location	13326.27 (273.07)

Table 6 (*Continued*)

Disease severity or pathology	Mean (S.E.)
Colonic neoplasm	
Location	
Right	12014.38 (325.61)
Transverse	12817.21 (554.92)
Left and sigmoid	12405.25 (256.91)
NEC and NOS for location	10235.68 (587.14)

Conciousness level: drowsiness means Japan coma scale 1, 2, 3; semicoma 10, 20, 30; coma 100, 200, 300, respectively; NOS, not otherwise specified; NEC, no elsewhere classified; S.E., standard error.

Table 7
Total charge (US$) of surgical, neoadjuvant or supportive procedure specific for each disease

Cerebro- and cardo-vascular disease	Mean (S.E.)
Ichemic stroke	
Surgical procedure	
Gastrostomy only	20209.51 (1977.95)
Tracheostomy only	34981.13 (4013.12)
Interventional intracranial thrombolysis	18890.79 (2725.06)
Interventional angioplasty	18242.54 (1246.24)
Endarterectomy	16201.08 (1271.44)
Operative revascularization	20491.00 (1279.78)
NEC	8291.97 (127.86)
Supportive procedure	
None	5987.37 (112)
Total parenteral nutrition	21472.14 (886.23)
Ventilation	20420.59 (1605.78)
Hemodialysis	15891.62 (3396.08)
Rehabilitation	13396.10 (262.02)
Ischemic heart disease	
Surgical procedure	
PTCA only	18185.31 (310.92)
Atherectomy only	22073.30 (1399.50)
PTCA + atherectomy	27464.20 (2678.92)
Stenting only	21502.60 (430.04)
Stenting + PTCA	22992.46 (423.38)
Stenting + atherectomy	26807.94 (1580.49)
Stenting + PTCA + atherectomy	29294.80 (2512.04)
CABG (one vessel)	34569.45 (1761.71)
CABG (one vessel) + intervetion	49995.24 (3979.34)
CABG (more than two vessels)	39736.82 (631.46)
CABG (more than two vessels) + PTCA	62581.46 (4510.86)
CABG (more than two vessels) + intervetion	62943.48 (6926.35)
NEC	5784.98 (97.68)
IABP additional	
Absent	13506.69 (150.39)
Present	46489.80 (1650.63)

Table 7 (*Continued*)

Cerebro- and cardo-vascular disease	Mean (S.E.)
Supportive procedure	
None	9618.04 (108.75)
Total parenteral nutrition	43001.81 (868.58)
Ventilation	41210.47 (720.97)
Hemodialysis	30666.91 (1517.04)
Rehabilitation	30384.36 (684.53)
Great vessel disease	
Surgical procedure	
Stenting only	23247.39 (1112.66)
AAA replacement	27982.62 (1331.58)
AAA replacement + branch reconstruction	26200.50 (849.29)
Distal TAA replacement	55027.16 (3232.77)
TAA + AAA replacement	65180.96 (3989.06)
Ascending TAA replacement only	61330.57 (4170.80)
Ascending TAA replacement + valve replacement	71675.21 (8593.12)
Arch replacement	68857.59 (1786.46)
Arch + ascending TAA replacement	108907.87 (15559.36)
NEC	9637.58 (514.32)
CABG additional to procedure above	
Absent	26994.69 (667.54)
Present	70371.03 (3194.83)
Supportive procedure	
None	12081.97 (478.96)
Total parenteral nutrition	44219.99 (1151.22)
Ventilation	55615.5 (1418.11)
Hemodialysis	61509.86 (4471.26)
Rehabilitation	52109.43 (2428.17)

AAA, abdominal aortic aneurysm; TAA, thoracic aortic aneurysm; S.E., standard error.

for ischemic stroke, TC increased with increasing invasiveness of the procedure (Tables 7 and 8).

R^2 of LOS was larger in IHD ($R^2 = 0.432$) and colonic neoplasm ($R^2 = 0.413$) than in other diseases. R^2 of TC was larger in IHD ($R^2 = 0.673$) and GVD ($R^2 = 0.702$). As for the cerebro or cardiovascular disease, incremental R^2 of LOS or TC was largest in the surgical procedure for IHD (20.51%) and GVD (16.69%), or for IHD (44.44%) and GVD (52.94%), respectively (model 4). Incremental R^2 of LOS or TC was largest in the supportive therapy for ischemic stroke (18.27 and 18.48%) (model 5). As for the malignant neoplasm, incremental R^2 of LOS was largest in the supportive +/− neoadjuvant therapy for respiratory neoplasm (27.78%) and colonic neoplasm (18.72%)

Table 8
Total charge of surgical, neoadjuvant or supportive procedure specific for each disease

Malignant neoplasm	Mean (S.E.)
Respiratory neoplasm	
Surgical procedure	
Resection under bronchospy	16249.00 (2294.07)
Video-assisted resection	17028.58 (419.38)
Partial or wedge resection	16563.61 (1203.70)
Lobectomy or pneumonectomy	17550.12 (294.10)
Sleeve resection	21312.81 (2119.74)
NEC	10534.96 (160.16)
Neoadjuvant therapy	
None	10099.33 (145.63)
Chemotherapy	12395.12 (292.49)
Radiation therapy	13954.74 (465.24)
Combined therapy	23554.97 (465.54)
Supportive procedure	
None	10724.49 (126.08)
Total parenteral nutrition	22722.00 (793.30)
Ventilation	25331.03 (2017.03)
Hemodialysis	28273.49 (10687.42)
Rehabilitation	20391.45 (624.66)
Gastric neoplasm	
Surgical procedure	
Total gastrectomy (including laparoscopic gastrectomy)	22060.84 (588.57)
Partial gastrectomy (including laparoscopic gastrectomy)	15965.76 (207.68)
Palliative	16610.40 (1048.00)
Endoscopic mucosal resection	5182.27 (164.50)
Gastrectomy + pancreactomy	26613.12 (1915.52)
Total gastrectomy + splenectomy	22838.42 (652.21)
Partial gastrectomy + splenectomy	20178.79 (1287.44)
Total gastrectomy + cholecystectomy	24352.40 (847.71)
Partial gastrectomy + cholecystectomy	17766.47 (480.29)
Gastrectomy + liver resection	19770.06 (1073.8)
NEC	8196.66 (243.96)
Neoadjuvant therapy	
None	12359.17 (153.98)
Chemotherapy	14484.59 (408.95)
Radiation therapy	6929.01 (1076.86)
Combined therapy	23132.53 (3599.40)
Supportive procedure	
None	9021.63 (121.73)
Total parenteral nutrition	19839.62 (304.49)
Ventilation	22784.01 (1181.28)
Hemodialysis	21616.37 (5607.04)
Rehabilitation	26988.63 (1667.97)
Colonic neoplasm	
Surgical procedure	
Palliative surgery	16679.30 (1470.16)

Table 8 (*Continued*)

Malignant neoplasm	Mean (S.E.)
Infusion device implantation only	17076.18 (2292.81)
Endoscopic mucosal resection	3593.19 (241.66)
Laparoscopy-assisted colectomy	11738.17 (381.92)
Radical colectomy	15793.56 (198.69)
NEC	8715.17 (377.10)
Neoadjuvant therapy	
None	11382.50 (199.66)
Chemotherapy	13885.97 (439.55)
Radiation therapy	14828.47 (2632.69)
Combined therapy	19998.49 (3041.31)
Supportive procedure	
None	8002.10 (173.93)
Total parenteral nutrition	18127.05 (297.71)
Ventilation	19058.65 (1097.36)
Hemodialysis	23474.19 (2404.47)
Rehabilitation	23287.96 (1669.87)

S.E., standard error.

(model 5), while in the surgical procedure for gastric neoplasm (14.30%) (model 4). But incremental R^2 of TC was largest in the surgical procedure for gastric neoplasm (31.55%) and colonic neoplasm (21.42%) (model 4), while in the supportive +/− neoadjuvant therapy for respiratory neoplasm (24.49%) (model 5) (Table 9).

4. Discussion

This study presents descriptive characteristics and identifies factors explaining the variance of LOS or TC for six diseases across 82 special functioning hospitals in Japan through the analysis of administrative data. It is unique enough to show that the variation can be compared among several kinds of diseases based upon the same administrative database and the common model. It should be noted that the data used for this study was relatively free of bias because it was gathered before the new payment system was established.

Before proceeding with the discussion, we must consider some limitations of this study. Firstly, we gathered information from patients who were discharged during only a 4 months period in 2002. Secondly, only the main effect of explanatory variables was examined, though in some cases, interaction between variables may have been able to explain a larger portion of observed variation. Claims data including the variables mentioned above are now being collected exhaustively all through the year, so it will eventually be possible to answer these questions with the use of a larger database. Thirdly, clinical severity like tumor stage or acuity of presentation (bleeding versus obstruction versus asymptomatic) were not included in the dataset

Table 9
R^2 and incremental R^2 (%) calculated with multiple linear regression model

Disease category	Stroke	Ischemic heart disease	Great vessel disease	Respiratory neoplasm	Gastric neoplasm	Colonic neoplasm
LOS						
Model 1	0.012†	0.011†	0.003	0.007†	0.001	0.001
Model 2	0.049 (3.70%)†	0.085 (7.43%)†	0.011 (0.80%)†	0.02 (1.24%)†	0.012 (1.17%)†	0.003 (0.21%)†
Model 3	0.062 (1.30%)†	0.114 (2.87%)†	0.026 (1.57%)†	0.032 (1.25%)†	0.044 (3.23%)†	0.036 (3.31%)†
Model 4	0.121 (5.88%)†	0.319 (20.51%)†	0.193 (16.69%)†	0.033 (0.08%)†	0.164 (11.99%)†	0.159 (12.26%)†
Model 5	0.304 (18.27%)†	0.368 (4.88%)†	0.28 (8.64%)†	0.311 (27.78%)†	0.307 (14.3%)†	0.346 (18.72%)†
Model 6	0.354 (5.09%)†	0.432 (6.41%)†	0.357 (7.76%)†	0.389 (7.83%)†	0.374 (6.71%)†	0.413 (6.76%)†
Total charge						
Model 1	0.009†	0.005†	0.007†	0.008†	0.001	0.001
Model 2	0.074 (6.49%)†	0.136 (13.13%)†	0.048 (4.09%)†	0.011 (0.35%)†	0.014 (1.37%)†	0.011 (1.09%)†
Model 3	0.088 (1.38%)†	0.161 (2.49%)†	0.065 (1.65%)†	0.022 (1.06%)†	0.054 (4.02%)†	0.045 (3.36%)†
Model 4	0.226 (13.79%)†	0.605 (44.44%)†	0.594 (52.94%)†	0.089 (6.72%)†	0.37 (31.55%)†	0.259 (21.42%)†
Model 5	0.411 (18.48%)†	0.651 (4.54%)†	0.676 (8.21%)†	0.334 (24.49%)†	0.481 (11.12%)†	0.442 (18.32%)†
Model 6	0.446 (3.52%)†	0.673 (2.22%)†	0.702 (2.57%)†	0.383 (4.88%)†	0.513 (3.26%)†	0.488 (4.57%)†

Model 1, age and gender; model 2, emergency and seveirty added to model 1; model 3, comorbidity and complication added to model 2; model 4, surgical procedure added to model 3; model 5, supportive +/− neoadjuvant therapy added to model 4; model 6, hospitals added to model 5. (†) P-value <0.05.

used of this study. Through the linkage with DPC database and the clinical-data oriented one of some academic society, we could demonstrate how well clinical severity would correspond to the resource use.

From an administrative and clinical point of view, it is meaningful to demonstrate the frequency, LOS and TC for these six diseases in Japan. Overall, LOS in Japan may be longer. In general, Japanese hospitals have accommodated patients with both acute and subacute or chronic illness—functions that are typically performed by different facilities in Western countries [11]. Neoplasms of the stomach were more common than of the colon in Japan, while cancer of the colon and rectum occurred nearly six times more frequently than stomach neoplasms in U.S.A. [12]. This study showed that the postoperative complication rate was between 1.1 and 26.9 per 1000 discharges across all six diseases, while Zhan and Miller reported rates ranging from 2.05 for wound dehiscence, to 9.34 for postoperative thromboembolism in their Healthcare Cost and Utilization Project Nationalwide Inpatient Sample 2000 [13]. By standardizing the definitions of complications, we will be able to engage in more meaningful discussion about the quality and cost of medical practice.

In this study, it was the IHD where the largest amount of variance in LOS was explained by the full model (model 6 in Table 9) (0.432). And it was the GVD where that in TC was explained by the full model (0.702). When examining the magnitude of variance in LOS and TC between variables of every six disease, the greatest variation was observed in the surgical procedure for IHD and GVD (20.51 and 16.69% in LOS, 44.44 and 52.94% in TC, respectively), and in the supportive +/− neoadjuvant therapy for malignant respiratory neoplasm and malignant colonic neoplasm (27.78 and 18.72% in LOS, respectively), for ischemic stroke and malignant respiratory neoplasm (18.48 and 24.49% in TC, respectively).

In Japan, Chino et al. analyzed TC for PTCA cases [14]. In their study, R^2 of full model was 0.55 for non-AMI and 0.52 for AMI for TC of PTCA cases alone, and incremental R^2 of hospital factor was 12% for AMI. By contrast, our model deals with all IHD cases including CABG and non-procedure cases, where R^2 of full model was 0.673 for IHD and incremental R^2 of hospital factor was only 2.22%. The reason our model generated a higher R^2 of full model is that we were able to include variables such as surgical procedures that can explain more variation in resource use.

The methodology of this study gives us useful chart to exhibit the magnitude of variance explained by each set of variables of interest in targeted diseases, based upon the large standardized database of Japanese leading institutions. If some surgical procedure is explaining largest variance of resource use, we will be able to examine in detail whether in Japan it is axiomatic that the severity of disease or the invasiveness of surgical procedure affect TC or LOS, and if so, to select the cases receiving such a procedure and investigate the inter-hospital difference.

Although only special functioning hospitals were selected and analyzed in this paper, the project of DPC system are now being adopted voluntarily by community hospitals. It is possible and expected to present the profiling of disease and to compare the resource use or practice performance of targeted diseases among highly selected academic hospitals and other leading community hospitals. In addition, we could take it into consideration to examine and demonstrate how well the analysis of the resource use in special functioning hospitals could correspond to the community hospitals.

As key elements, DPC system necessitates ICD10-coded principal and secondary diagnosis, and surgical procedure labeled in Japanese claims system which can be converted to ICD9-CM. Therefore, it is also possible to compare the casemix grouping system of other relevant nations and our DPC, for example, to examine the coverage of disease or the discriminative validity in resource use. Through these investigations and the enhancement or publicization of potential of DPC, health policy maker might make an access in the survey of practice variation and the profiling of diseases or hospital performance, and might make a novel comparison among healthcare systems of countries concerned.

5. Conclusion

Following analysis of a large set of administrative data, we presented descriptive characteristics and resource use of six common diseases in Japan, and analyzed the degree to which procedure or hospital factors can explain observed variation. There was significant variation by region and by ownership among the diseases studied. Total charges increased with increasing severity of illness and procedure invasiveness. In this study, we presented the magnitude of variance that was explained by each variable of concern, and it was procedure variables that explained the largest variance of LOS and TC. DPC promises to be a standardizing tool for profiling frequency of disease, variation of resource use and hospital performance in Japanese healthcare, empowering providers to demonstrate accountability to a wide audience of stakeholders.

Appendix A

See Table A.1.

Table A.1
Comorbidity and complication considered in this study and their ICD 10 codes

Abbreviation	Description	ICD 10 definition
mDM	Mild diabetes mellitus	E100-1, E109, E110-1, E119, E120-1, E129, E130-1, E139, E140-1, E149
sDM	Diabetes mellitus with endorgan damages	E102-8, E112-8, E132-8, E142-8
PVD	Peripheral vascular disease	I70$, I71$, I72$, I73$, I771, R02, Z958-9
DEM	Dementia	F00$, F01$, F020-1, F03$, G30$, G310-1
COPD	Chronic obstructive pulmonary disease	I278-9, J41$, J42$, J43$, J44$, J45$, J46$, J47$
CHF	Congestive heart disease	I110, I42$, I43$, I50$, I517
CRF	Chronic renal failure	N18$, N19, Z49$, Z940, Z992
CTD	Connective tissue disease	M05$, M06$, M08$, M09$, M32$, M33$, M34$, M350, M358-9
mLD	Mild liver disease	K70-1, K709, K710, K713-9, K721, K729, K73$, K760-1, K768-9
sLD	Severe liver disease	I850, I859, K702-4, K711-2, K717, K720, K740-6, K762-7
MAL	Malignancy	C00$–C41$, C45$–C96$, D890, Z85$
COMP	Postoperative surgical complication	T81$, T82$, T83$, T84$, T85$, T86$, T87$
DVT	Deep vein thrombosis or pulmonary thromboembolis	I260, I269, I80$

References

[1] 3M Health Information Systems. All Patient Diagnosis Related Groups (AP-DRGs), ver. 12.0. Definition Manual. Wallingford, Connecticut: 3M Health Information Systems; 1994.

[2] Urbach DR, Baxter NN. Does it matter what a hospital is 'high volume' for? Specificity of hospital volume-outcome associations for surgical procedures: analysis of administrative data. Quality in Safety and Health Care 2004;13:379–83.

[3] Heuschmann PU, Kolominsky-Rabas PL, Misselwitz B, et al. German Stroke Registers Study Group. Predictor of in-hospital mortality and attributable risks of death after ischemic stroke. Archives of Internal Medicine 2004;164:1761–8.

[4] Wu C, Hannan EL, Ryan TJ, et al. In the impact of hospital and surgeon volumes on the in-hospital mortality rate for coronary artery bypass graft surgery limited to patients at high risk? Circulation 2004;110:784–9.

[5] Chiappini B, Tan ME, Morshuis W, et al. Surgery for acute type A aortic dissection: Is advanced age a contraindication? Annals in Thoracic Surgery 2004;78:585–90.

[6] McCulloch P, Ward J, Tekkis PP. ASCOT group of surgeons; British Oesophageal-Gastric Cancer Group. Mortality and morbidity in gastro-oesophageal cancer surgery: initial results of ASCOT multicenter prospective cohort study. British Medical Journal 2003;22;327(7425):1192–7.

[7] Wainess RM, Dimick JB, Upchurch Jr GR, et al. Epidemiology of surgically treated gastric cancer in the United States, 1988–2000. Journal of Gastrointestinal Surgery 2003; 7:879–83.

[8] Deborah S, Katherine SP, Elyn R, et al. Surgeon volume compared to hospital volume as a predictor of outcome following primary colon cancer resection. Journal of Surgery Oncology 2003;83:68–79.

[9] Romano PS, Roos LL, Jollis JG. Adapting a clinical comorbidity index for use with ICD-9-CM administrative data: differing perspective. Journal of Clinical Epidemiology 1993;46: 1075–9.

[10] Takagi T, Aoki M, Ishii T, et al. Japan coma scale as a grading scale of sub-arachnoid hemorrhage: a way to determine the scale. No Shinkei Geka 1998;26:509–15 [in Japanese].

[11] 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. International Journal of Quality of Health Care 2002;5:411–8.

[12] Ross CB, John SR. Cancer. In: Ross CB, Patrick LR, James RD, editors. Chronic disease epidemiology and control. 2nd ed. Washington, NW: American Public Health Association; 1998. p. 335–73.

[13] Zhan C, Miller MR. Adiministrative data based patient safety research: a critical review. Quality of Safety and Health Care 2003;12:58–63.

[14] Chino M, Nakanishi S, Isshiki T, Hashimoto H. The JSIC national database for cost analysis of PTCAin Japan. Part2: Multivarate analysis of initial in-hospital charge and inter-hospital difference. Japanese Journal in Interventional Cardiology 2001;16:401–7 [in Japanese].

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Impact of age and procedure on resource use for patients with ischemic heart disease

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Abstract

Objectives: Impact of age on healthcare expenditures should be assessed by targeting on specific diseases and controlling for procedures and severity of illness. Relationship between age and resource use in patients receiving acute care medicine for ischemic heart disease (IHD) was examined.
Methods: We analyzed 19,874 IHD patients treated in 82 academic and 92 community hospitals. Length of stay (LOS), total charges (TC), and high outliers of LOS and TC were analyzed for every age group (under 65 years, 65–74 years, 75 years or older). Independent effects of age on LOS, TC, and high outliers of LOS and TC were determined using multivariate analysis.
Results: 7863 (39.6%) patients were under 65 years, 7181 (36.1%) between 65 years and 74 years, and 4830 (24.3%) aged 75 years or older. Proportion of angina or non-medical treatment was significantly different among three age categories (angina 72%, 75%, 71.4%; non-medical 37.3%, 40.9%, 38.9%, respectively). Significant association with LOS or TC was identified in patients receiving coronary artery bypass graft surgery with percutaneous intracoronary intervention, who were most associated with TC high outlier.
Conclusions: Age had a modest impact on resource use, as compared with procedures. Policy makers need to acknowledge the impact of procedures on healthcare spending.

Keywords: Age; Technology; Resource use; Ischemic heart disease; Case-mix classification

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