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Visualization Model for Medical Care Processes by Utilizing Japanese Case-mix Classification and its Application to the Variance Analysis of Clinical Pathway

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Abstract

Under the Japanese case-mix system, so called DPC system, patient information is coded using a 14-digit code, which includes principal diagnosis and associated medical care procedures. This system can be a tool for analyzing clinical process. The clinical pathway (CP) is a management plans that provide ideal sequence of staff actions to achieve goals for patients with optimal efficiency. In this study, we collated information on medical care processes in chronological order for each patient using the DPC system, for comparative verification with the CP. The subjects included 54 laparoscopic cholecystectomy cases at Saiseikai Kumamoto Hospital between July and December 2008. We coded relevant information for medical care treatments using 20-digit DPC codes based on the original 14-digit code. The 15th digit refers to fluid administration, 16th digit antibiotic use, 17th digit blood sampling, 18th digit other examinations, 19th digit image, and 20th digit meal. We recorded information on medical care received from the date of admission to the date of discharge in chronological order using these extended DPC codes. We also created extended DPC codes for the CP and analyzed discrepancies with each patient's extended DPC codes as variance for factor analysis. Our results have indicated that the following factors are associated with occurrence of variance cases with statistical significance: age (over 65 yr old 69.2%, under 65 yr old 43.9%; p=0.024), urgency of the admission (urgent admission 76.9%, scheduled admission 41.5%, p=0.024), inflammation (inflammation 65.0%, non-inflammation 41.2%, p=0.046). Our new method enabled to compare each patient's individual situation with standard medical care processes specified in the CP, and visualize the actual medical care situation.

Key words: DPC, clinical pathway, evaluation, quality of care

❖Introduction

Because of the restrictive fiscal policy, the rapidly ageing population and the low birthrate among the child-bearing generation, it is an urgent task for the Japanese government to reform its healthcare insurance system and medical care delivery system. The Japanese case-mix classification (Diagnosis Procedure Combination; DPC) was projected and initiated under these circumstances, and is used by the Japanese Ministry of Health, Labor and Welfare (MHLW) to assess hospital payments and determine hospital performance[1)]. The intent of the DPC is to classify a patient by a combination of the diagnosis and procedures conducted within the hospitalization. The DPC was originally based on a 14-digit code that was allocated to each patient. This code is composed of eight sections, as shown in Figure 1, to concurrently encode principal diagnosis, associated procedures, comorbidities and severity[2)].

The introduction of DPC based evaluation has

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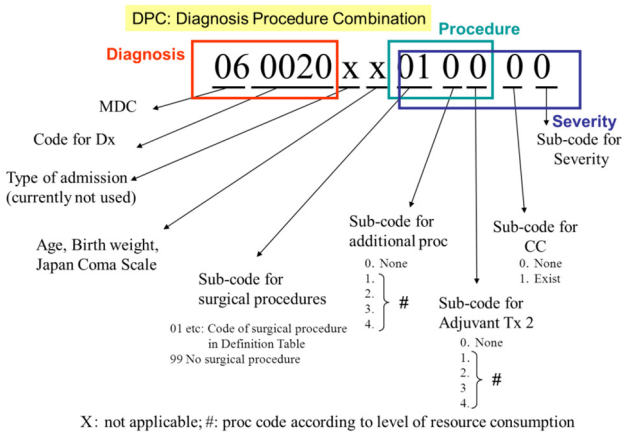

Figure 1 Structure of code of DPC version 3.4

promoted behavior changes among healthcare providers who have attempted to optimize daily care processes. This has resulted in a drastic shortening of the length of hospital stay[1, 3, 4]. In order to respond to requirement for improving efficiency of care, use of clinical pathway (CP) is gradually expanded in Japan. CP is a management plans that display goals for patients and provide the corresponding ideal sequence and timing of staff actions to achieve those goals with optimal efficiency[5]. However, it is not so common to evaluate the validity of established CP in each facility. In order to measure the quality of care and assess the scope for improvement, it will be necessary to visualize the type, order and quantity of care processes delivered on a daily basis and to identify any patient disease or provider-specific factors that are associated with any variance from intended care[6].

In order to develop a methodology for evaluation of CP by DPC database, we tried to assess the care processes delivered daily and observed any deviations from the CP in patients who underwent laparoscopic cholecystectomy (LC) for benign gall-bladder disease.

❖Material and Methods

Methodology of visualizing care process

We used the three main types of information recorded in the DPC project. File Form 1 is a clinical summary that contains information on diagnosis and severity. File E contains information pertaining to the bundled charge and the date of procedures. File F records the detail of the bundled procedures and charge, as summarised in file E. Both files are database for claim. File Form 1, and files E and F are matched by the patient identifier, which is unique for each discharged case. These relational databases enabled us to describe the detailed care process received by all treated in-patients on a daily basis during hospitalization (Figure 2).

The DPC is a 14-digit defined code based on a table published by the MHLW. For LC, the first six digits represent the principal diagnosis (060330, benign gallbladder disease without inflammation; 060335, with inflammation)[7]. Digit 7 indicates the type of admission, digit 8 codes age and birth weight, digits 9 and 10 represent the use and types of surgical procedures performed (LC: 01; open cholecystectomy: 02), digit 11 represents dilatation or sphyncterotomy of the duodenal vater or percutaneous common bile duct drainage, digit 12 indicates the use of ventilation or total parenteral nutrition, digit 13 indicates the existence of co-morbidities or complications (CC) and the last digit (14) codes severity. For cases undergoing LC, digits 7, 9 and 14 are not required for grouping in the DPC definition table. These study diagnosis (060330 and 060335) needs other four kinds of care information for DPC 14 digits coding (Figure 1).

To apply this logic for the care processes involved in LC, we added six more digits representing study care process (fluid administration, antibiotics, laboratory test, diagnosis images, other relevant procedures and diet) to code factors not included in the original 14-digit DPC code. We constructed a total of 20-digit codes to document daily patient care and predetermined task for LC based on the CP. To mine these study care process out of E-/F-file, we also constructed master tables to document fluid administration and antibiotics, laboratory tests (blood cell counts, blood chemistry), diagnostic images (abdominal sonography) or other relevant procedures (urinary analysis or electrocardiography), and diet served, in cooperation with surgeons and nurses. We coded these items in 15th through 20th digit (0, if not provided; 1, if provided) and constructed a relational database. Pivoting this database on the date of pre-/postoperative day (from day –1 to the predetermined day), we visualized the chronological occurrence of services provided and calculated the proportion of every study care among all LC patients (Figure 3).

Study patients and statistical analysis

We selected patients who underwent LC between

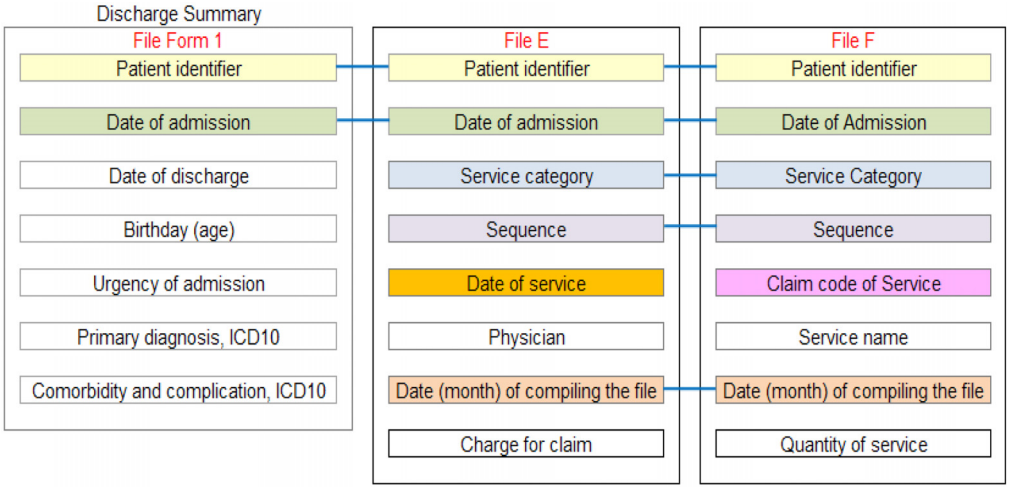

Figure 2 Summary of the three components of the DPC database and key variables included in the relational database

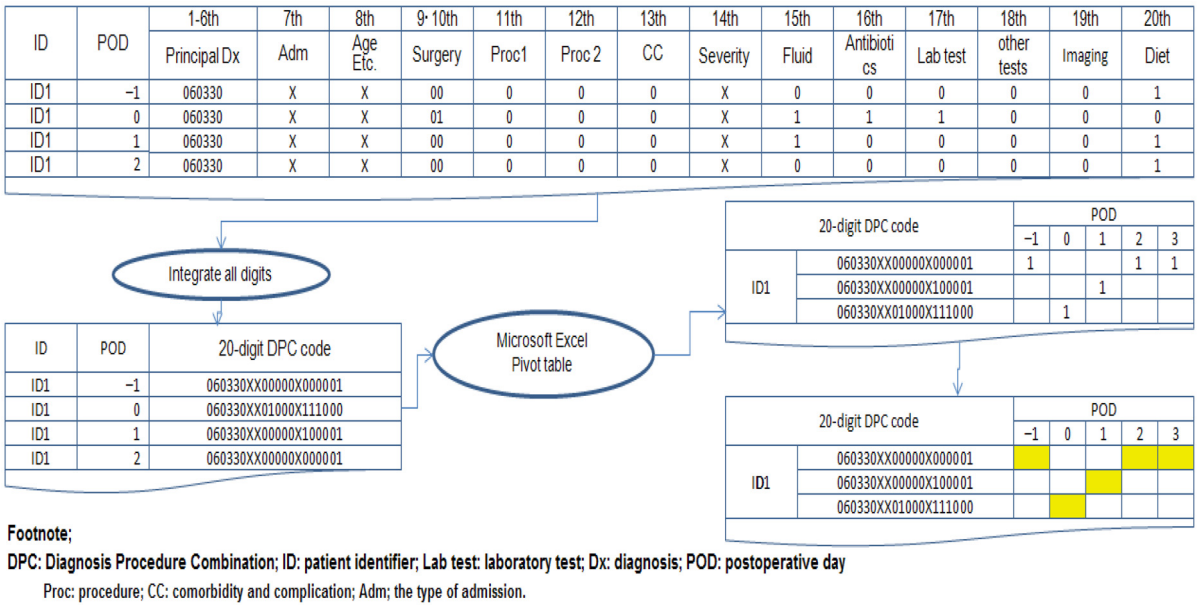

Figure 3 Allocation of 20-digit DPC codes for visualization of the care provided

July and December 2008. Study variables included patient demographic factors (age, sex and urgency of admission), disease severity (the presence of gallbladder inflammation), calendar day of admission and physician's experience. Next, we visualized the care map of LC patients as seen in 'Tetris' game, in which the integrated yellow-colored block indicated care process code and the date after the preoperative day – 1, as the operative day.

Next, we used Fisher's exact test to identify differences in care processes according to age (≥65 versus <65 yr), sex, elective or urgent admission, the presence of comorbidities defined using Charlson Index, the presence of gallbladder inflammation, calendar day of LC (Monday and Tuesday versus other days)[Note] and the surgeons' experience year (≥20 versus <20 yr). The significance level was set at a level of p=0.05[8].

Note: As the lengths of hospitalization set in the CP are different between the Monday and Tuesday admission cases and other days' case, we have examined this factor as covariate.

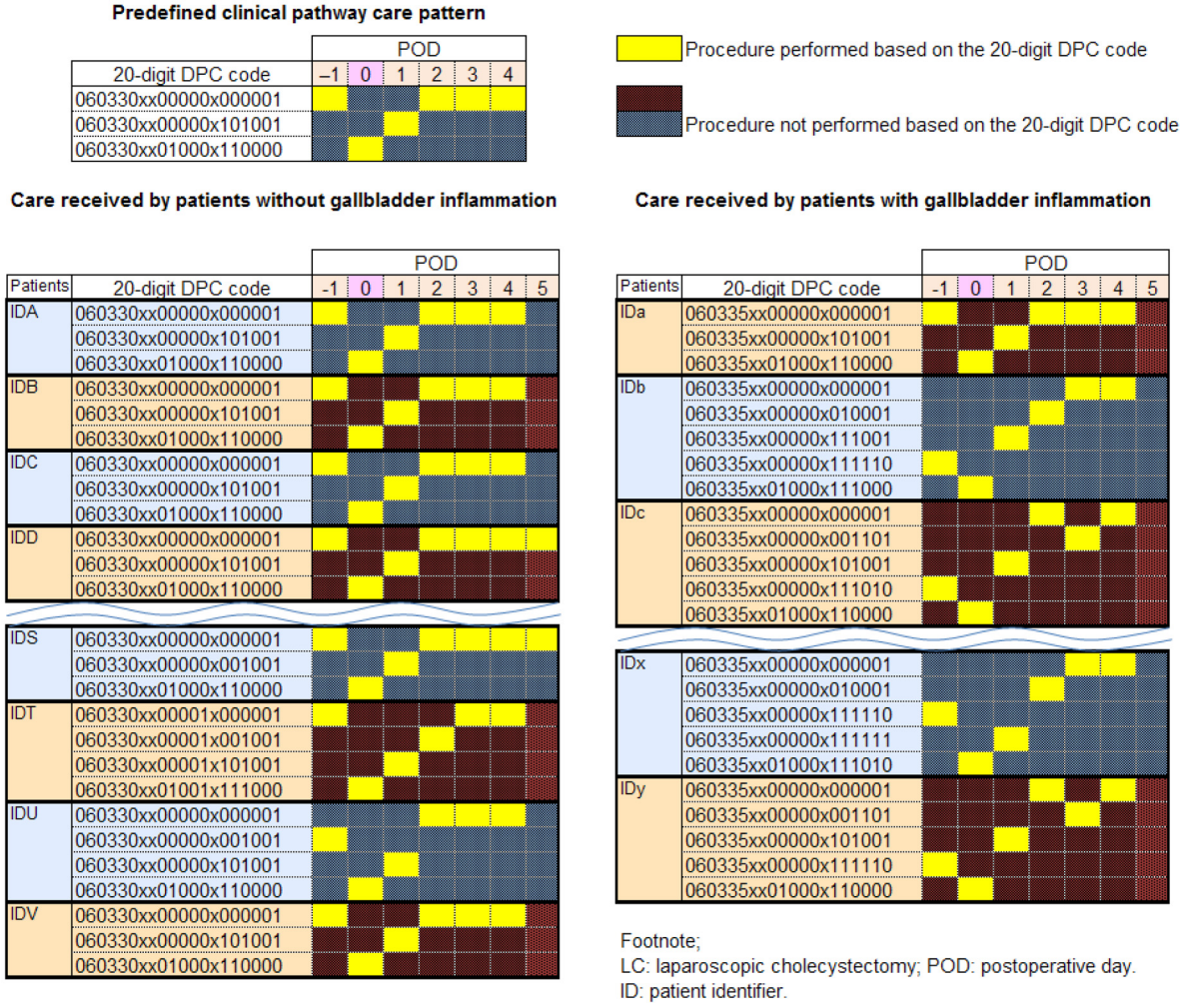

Figure 4 Predefined care pattern for the clinical pathway and care received by patients undergoing LC (with or without gallbladder inflammation)

❖Results

Among 6,146 patients discharged during the study periods, 54 patients underwent LC. The mean age was 54.4 yr old, 13 cases (24.1%) were aged ≥65 yr old, 25 cases (46.3%) were male. Emergency hospital admission was required for 13 cases (24.7%) and gallbladder inflammation was present in 20 cases (37.3%).

Figure 4 compares the 20-digit DPC codes for CP and the codes of care processes provided to the study patients.

Analysis of practice variation showed that 27 cases (50%) diverged from the CP. Univariate analysis revealed that the following factors were significantly associated with variance: age (≥65 yr old 69.2%, <65 yr old 43.9%, p=0.024), urgency of the admission (urgent admission 76.9%, scheduled admission 41.5%, p=0.024) and the presence of inflammation (inflammation 65.0%, no inflammation 41.2%, p=0.046) (Table 1).

Figure 5 shows the care processes used for the LC patients; there was variation in antibiotic injections, blood sampling and imaging tests.

❖Discussion

In this study, we successfully integrated a summary of the complete daily medical care provided for LC patients in a 20-digit DPC code. By comparing the daily codes for each patient with the predetermined CP, we were able to quantify variations in practice. Age, urgency of admission and the presence of gallbladder inflammation explained the differences in postoperative care processes from the CP. To deter-

Table 1 Patient characteristics according to divergence from the predefined clinical pathway (n, %)

		Variance (–)	Variance (+)	p
N		27	27	
Age	Mean (SD)	51 (13.0)	58 (14.3)	0.096†
	≥ 65 years old	4 (14.8)	9 (33.3)	0.024
Sex	Male	12 (44.4)	13 (48.1)	0.592
Urgency at admission	Urgent	3 (11.1)	10 (37.0)	0.024
Severity of principal diagnosis	Inflammation	7 (25.9)	13 (48.1)	0.046
Comorbidities	Present	1 (3.7)	7 (25.9)	0.063
Calendar day of LC	Monday or Tuesday	7 (25.9)	12 (44.4)	0.252
Surgeons' experience	≥ 20 years	8 (29.6)	8 (29.6)	0.765

LC: laparoscopic cholecystectomy; †: tested by *t*-test; others by Fisher's exact test.

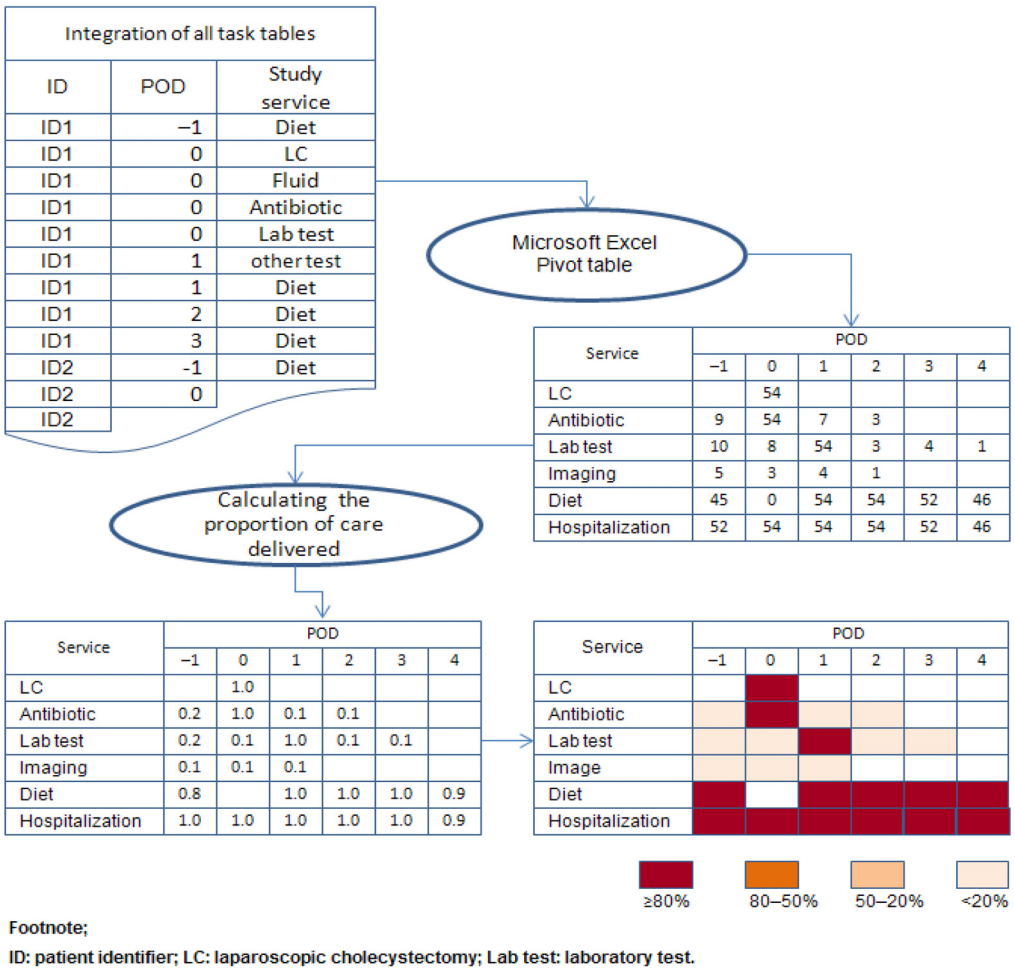

Figure 5 Visualization of the chronological services delivered for 54 LC patients

mine the individual variables responsible for deviating from CP, we examined the medical services provided and found that provision of antibiotics, laboratory tests, and imaging were significant factors.

This study provides valuable information in revealing targets to aim for to improve the quality of care because it is possible to easily identify unexpected medical practices and measure deviations from standardized care for various case-mixes. A collective review of CPs by Hunter *et al.* revealed numerous pro-

cesses for developing CPs. However, many reports have addressed not the contribution of the case-mix and accompanying databases on elaborating the CPs but have rather reasoned the raison d'être of CP as being the results of managed care[9]. We believe this study and the methodology used are novel because we have confirmed the generalizability, feasibility and reproducibility of CPs.

In terms of the generalizability of CPs, the coding scheme used in this study is likely to be available for other case-mixes. Validation to develop CPs can be investigated in terms of real-life care delivered in daily practice. The question of whether CPs can be applied in some case-mixes can be answered by observing the daily practice patterns shown in Figure 5. The reason this observation is possible is that the DPC database contains extensive claims data for every case-mix classification, and includes information such as diagnosis, procedures conducted and drugs prescribed.

In terms of reproducing CPs, we need data summarizing the care processes used in every day clinical practice. Here we successfully visualized the care processes used. Stakeholders will be able to access key factors such as variance and audit, which have until now been poorly defined[9]. Complex CPs can be developed to minimize differentiation from conventional CPs.

Unless the claim format has been fully standardized or computerized, these valuable data have not been fully used for quality improvement initiatives. Here, the DPC definition table was used to standardize and code all procedures and treatments applied for each case-mix classification, which suggests that the DPC offers a common language for health service sectors. We also applied this system to label valid care processes defined for LC in the CP. This methodology can also be used to monitor adherence to clinical guidelines and to revise or redevelop them, which will be a target of future research.

There are some limitations that should be mentioned. First, we expressed only the use of care processes, not the specific type of process used. This is because visualization of the care processes in this study would be degraded by exhaustively recording each specific process and treatment. Second, patient outcomes or satisfaction were not considered in this study.

In conclusion, we successfully recorded the daily care processes and examined factors that deviated from the CP. Age, urgency of admission and the presence of gallbladder inflammation explained the deviation from CP. The originality of this study is that it enables stakeholders in the Japanese health service sector to visualize CPs; quantify any variance in delivered care; and enhance the feasibility of including all case-mixes simultaneously. Using this DPC case-mix classification, it was possible to evaluate the adherence to clinical guidelines and develop quality improvement initiatives for CPs. Because stakeholders commonly evaluated the individual hospital's or physician's accountability to established clinical practice and the quality of medical care, case-mixes such as that used in our DPC will foster innovation in health service delivery.

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