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【 ORIGINAL ARTICLE 】

Quantification of Internal Medicine Resident Inpatient Care Using the Diagnosis Procedure Combination Database

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Abstract:

Objective Quantification of patient encounters during internal medicine residency training is challenging. At present, there are no established strategies for evaluating the whole inpatient experience in Japan. We hypothesized that the Diagnosis Procedure Combination (DPC) database, which is widely used in Japan, might be a useful tool for such an evaluation.

Methods We analyzed DPC-based patient encounters of five senior residents with different types of training. One of the diseases on receipt computation data, including the four main diseases and at most eight comorbidities, was matched with each category in the Online system for Standardized Log of Evaluation and Registration of specialty training system (J-OSLER), and the match ratios were assessed. The accumulation of each disease classified into J-OSLER categories was also assessed. Monthly extra working hours and total patient-days per resident were evaluated using a Pearson correlation analysis.

Results Two residents with two-year rotations in the general internal medicine department showed high numbers of patient encounters and the highest matching ratio with J-OSLER (approximately 60% with 4 major diseases, 91% with all diseases). There was a moderately positive correlation between the total patient-days and extra working hours in these residents, but no such correlation was noted in the rate of monthly patient encounters and extra working hours among residents as a whole.

Conclusion The DPC-based quantification of patient encounters during residency training appears effective in evaluating the coverage of the current J-OSLER list. Owing to its wide availability and generalization, this matching method may be useful as a universal tool for assessing internal medicine programs.

Key words: patient encounter, diagnosis procedure combination, residency training, shin-naika senmoni seido

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Introduction

Quantification of patient encounters during internal medicine residency training is challenging. In other departments, the number of procedures (such as colonoscopy or surgery) required for the achievement of a certain level of proficiency is more clearly quantifiable, as has been evaluated in previous studies (1, 2). However, the internal medicine department is diverse in nature, making it much more difficult to quantify and evaluate patient encounters, although this has been attempted in several ways. For example, one study evaluated residents' patient encounters using a web-based portfolio system called the Learning Portfolio, which is linked to electronic medical records, to compare the number of patients seen before and after a major reduction in residents' allowed working hours (3). The quantity and diversity of disease experienced during residency training was evaluated in another study using the primary diagnosis, with reference to the *International Classification of Diseases, Ninth Revision (ICD-9)* system (4). Although informative, both of these methods require specific interventions that are difficult

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Table 1. Residents and Their Type of Training.

	Type of training
Resident A	Two-year rotation in GIM department at TGH
Resident B	Two-year rotation in GIM department at TGH
Resident C	Two-year rotation in Cardiology department (One year each at TGH and AMC)
Resident D	One-year rotation in several departments (six months in GIM, two months each in cardiology, pulmonology and gastroenterology department) at AMC One-year rotation in gastroenterology department at TGH
Resident E	One-year rotation in several departments (six months in pulmonology, two months each in nephrology, endocrinology and gastroenterology department) at AMC One-year rotation in pulmonology department at TGH

GIM: general internal medicine, TGH: Takatsuki General Hospital, AMC: Akashi Medical Center

to generalize, and there are limitations in the evaluation of extracted data.

In Japan, The Society of Internal Medicine has launched a new residency program: the *shin-naika senmoni seido*, or "new internal medicine specialist system." This three-year training program requires a certain number of patient encounters for certification. At least 160 cases (ideally 200) are required, and among them, at least 70 categories of required care must be covered. Registration is by the online system for standardized log of evaluation and registration of specialty training system (J-OSLER). This new three-year program aims to provide broad knowledge of internal medicine to all trainees before they begin their specialty training programs. The residency training schedule is flexible and varies among institutions. Residents can stay in the General Internal Medicine (GIM) department for the entire three years, or they may rotate between several departments, based on their preferences, the number of specific cases they experience in each department, etc. The program stipulates the minimum required number of inpatients that must be seen in residency training, but this may not necessarily reflect the entirety of patient encounters during the training period.

Quantification of patient encounters may vary among institutions or departments, which may affect the efficacy of the training experience. Notably, the GIM department has only recently been added in Japan, meaning there is some uncertainty as to whether or not this new department provides sufficient patient encounters to trainees. There are no known Japan-based evaluations of the quantification of patient encounters during internal medicine residency training, and such a quantification system may be useful for developing domestic internal medicine programs.

In this context, the present study explored the utility of the Diagnosis Procedure Combination (DPC) inpatient database as a means of filling this gap (5). In contrast to the Learning Portfolio, the DPC is widely available and may thus have wide applicability in the quantification of the residency program in Japan.

Materials and Methods

This retrospective analysis evaluated the patient encounters of each resident. Inclusion criteria were being a post-graduate year 3 or 4 senior resident during the study period (2018-2019) working at either Takatsuki General Hospital (TGH) or Akashi Medical Center (AMC). Exclusion criteria were residents who were unable to manage patients independently for any reason. Five residents were included in our study, and the details of the training they underwent are shown in Table 1.

We utilized DPC coding of each admission to count the diseases that each resident encountered as a primary physician. Emergency department and outpatient clinic encounters were not included, as they were not searchable by our DPC coding method. DPC categorization involves up to 12 entries per encounter: 4 entries on the 'main diseases' (principal diagnosis, the disease as a reason for admission, the disease requiring the greatest number of medical resources, and the disease requiring the second-greatest number of medical resources) and 8 entries on 'comorbidities' (4 on admission and 4 after admission). Each category is registered using receipt computation data, and there can be overlap between the categories. In each encounter, the patient has at most 12 diseases registered but can have as few as 3 entries depending on the reason for admission and presence of comorbidities.

J-OSLER lists 549 diseases in total, including 70 categories within 15 fields: gastroenterology [9], cardiology [10], endocrinology [4], metabolism [5], nephrology [7], pulmonology [8], hematology [3], neurolog [9], allergy [2], rheumatology [2], infectious disease [4], emergency medicine [4] and general internal medicine I-III [3]. Thirty-one diseases and three categories included in GIM I-III were not included in our study because they were non-specific (e.g. death, smoking) and were not considered to be suitable for matching (6).

We performed two matching methods for evaluation. The first is designed to match a patient encounter with one disease in J-OSLER. Each disease in J-OSLER is classified by category, and the computer-based matching method is de-

Table 2. Data of Patient Encounters.

Resident	Number of patients	Number of diseases (total/categorized/ non-categorized)	Proportion of non-categorized disease	Match rate with 4 major diseases	Match rate with all diseases
A	479	3,526/2,057/1,469	41.7%	59.7% (40/67)	91% (61/67)
B	476	3,574/2,013/1,561	43.7%	65.7% (44/67)	91% (61/67)
C	427	3,240/2,347/893	27.6%	37.3% (25/67)	80.6% (54/67)
D	222	2,239/1,613/626	28.0%	47.8% (32/67)	82.1% (55/67)
E	289	1,596/1,134/462	28.9%	64.2% (43/67)	83.6% (56/67)

signed to fulfill each category as closely as possible from registered receipt computation data. The matching ratio of 67 categories was evaluated in two different ways: firstly, using only the four main disease entries mentioned above, and secondly all diseases including four main diseases and up to 8 comorbidities. The second matching method was designed to evaluate the accumulation of each disease in J-OSLER. All diseases registered as receipt computation data in each patient were attempted to be matched with diseases. If receipt computation data included several diseases in J-OSLER to be matched, the more specific diseases were prioritized. For example, if gout was registered, this would be matched with gout (metabolism) rather than crystal-induced arthritis (rheumatology). If exactly the same diseases from different fields were nominated, specialty departments were prioritized over infectious disease and emergency medicine departments. To evaluate the relative adequacy the number of diseases matched with each field in J-OSLER was divided by the number of each category. Diseases that did not match were counted, and the 10 most-common diseases were then evaluated.

The monthly extra working hours of each resident during the study period were obtained from time card data. Extra working hours were defined as time used for working besides scheduled daily work hours (weekdays between 08:00 and 17:00). The monthly number of admissions (new patient encounters per month) and monthly total patients/day during the study period were also obtained via electronic medical charts. The association between monthly working extra hours and monthly total patient-days was analyzed using a Pearson correlation analysis. The analysis was performed for each resident to assess the character of each rotation. Analyses were performed using EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan). This study was approved by the ethics boards of both TGH and AMC in accordance with the Declaration of Helsinki.

Results

Data on patient encounters are shown in Table 2. Each of the 3 residents who had training in just 1 department (GIM or cardiology) had more than 400 patient encounters (479, 476 and 427 respectively), while the 2 residents who rotated between several departments had fewer than 300 patient encounters each (222 and 289 respectively). The match ratio with 4 major diseases was approximately 60% in Residents A and B (GIM training only) and Resident E (rotation training without GIM training) at 59.7%, 65.7% and 64.2% respectively. Resident C (cardiology rotation only) had the lowest match rate (37.3%), followed by Resident D (rotation training including GIM, 47.8%). The differences in the match ratios among residents were ameliorated using all diseases, but the highest rate continued to be from residents who had GIM training only (91%).

The number of experienced diseases was highest in Residents A and B, reflecting the number of patient encounters, and the number of diseases that could not be categorized into J-OSLER was also highest in these residents (41.7% and 43.7%, respectively, vs. 27.6%, 28.0% and 28.9% in the other residents). The 10 most-common uncategorized diseases for each resident are shown in Table 3.

Figure shows the number of diseases matched with each field in J-OSLER divided by the number of each category. Using the cut-off point of 10, Residents A and B failed to meet two or fewer fields (Resident A had 1, Resident B had 2) while the other residents failed to meet four or more fields (Resident C had 7, Resident D had 4, and Resident E had 7).

The average numbers of monthly extra working hours and inpatient encounters are shown in Table 4. The limit on extra working hours, which is currently set as 60 hours per month, was not violated by any residents. The most daily inpatients were seen by Residents A and B, while the number of daily inpatients seen by Resident C was similar to that seen by Residents D and E, despite the high number of new inpatient encounters. The Pearson analysis revealed a moderately positive correlation between monthly extra working hours and monthly total patient-days in Residents A ($r=0.485$, p value=0.016) and B ($r=0.528$, p value=0.008), while there was no correlation among the other residents (Resident C; $r=0.311$, p value=0.139, Resident D; $r=-0.372$, p value=0.074, Resident E; $r=0.022$, p value=0.917). New inpatient encounters had no correlation with extra working hours in any residents.

Discussion

This is the first known Japan-based observational study to evaluate the quantity of patient encounters among internal medicine residents. Registration to J-OSLER is currently

Table 3. Top 10 of Uncategorized Diseases.

A		B		C		D		E	
Disuse syndrome	258 (17.6%)	Disuse syndrome (legs)	284 (18.2%)	Hypertension	216 (24.2%)	Hypertension	77 (12.3%)	Hypertension	64 (13.9%)
Dysphagia	118 (8.0%)	Dysphagia	154 (9.9%)	Dyslipidemia	58 (6.5%)	Disuse syndrome (legs)	63 (10.1%)	Left pleural effusion	34 (7.4%)
Right femoral neck fracture	90 (6.1%)	Left femoral neck fracture	91 (5.8%)	Suspicion of angina pectoris	50 (5.6%)	Constipation	34 (5.4%)	Constipation	27 (5.8%)
Hypertension	82 (5.6%)	Hypertension	84 (5.4%)	Nausea	49 (5.5%)	Insomnia	27 (4.3%)	Interstitial pneumonia	26 (5.6%)
Constipation	77 (5.2%)	Right trochanteric fracture	78 (5.0%)	Pacemaker batter depletion	46 (5.2%)	Right pleural effusion	18 (2.9%)	Insomnia	18 (3.9%)
Insomnia	55 (3.7%)	Constipation	65 (4.2%)	Constipation	40 (4.5%)	Upper gastrointestinal bleeding	15 (2.4%)	Carcinomatous pain	16 (3.5%)
Right trochanteric fracture	55 (3.7%)	Insomnia	52 (3.3%)	Status post coronary stent placement	28 (3.1%)	Dysphagia	15 (2.4%)	Respiratory distress	15 (3.2%)
Altered mental status	23 (1.6%)	Vertebral compression fracture	36 (2.3%)	Insomnia	27 (3.0%)	Altered mental status	12 (1.9%)	Disuse syndrome	14 (3.0%)
Lumbar spine compression fracture	22 (1.5%)	Leg cellulitis	25 (1.6%)	Left pleural effusion	25 (2.8%)	Liver dysfunction	11 (1.8%)	Dyslipidemia	12 (2.6%)
Respiratory distress	21 (1.4%)	Dementia	20 (1.3%)	ICD battery depletion	23 (3.1%)	Dyslipidemia	10 (1.6%)	Suspicion of carcinomatous pleurisy	11 (2.4%)

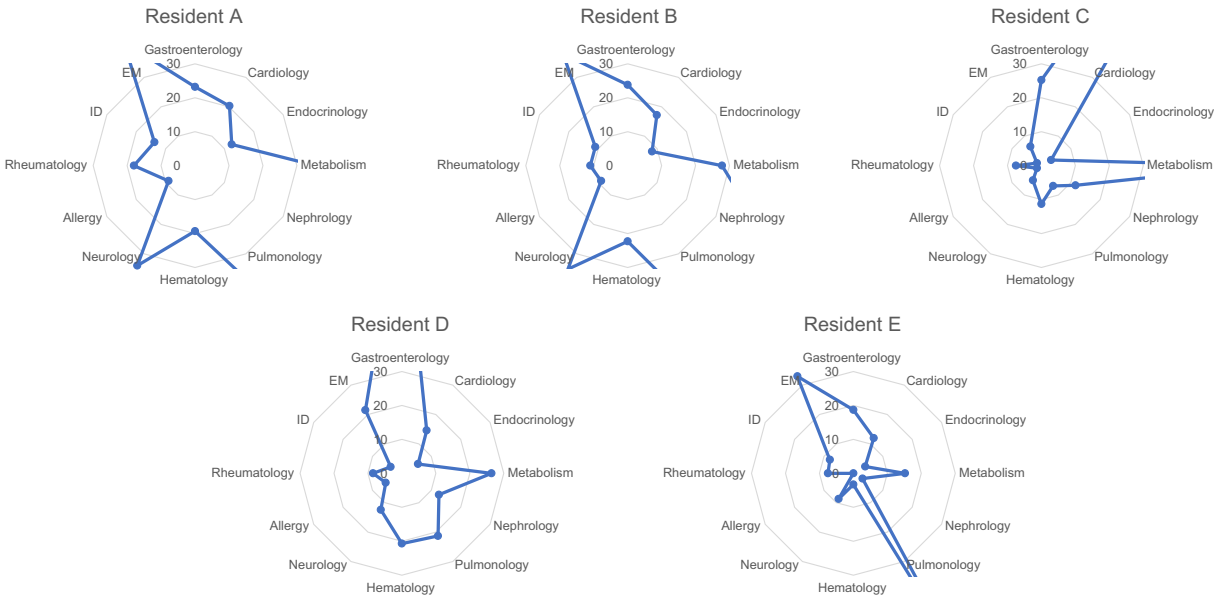

Figure. Achievement rate of diseases in each field. The number of diseases matched with each field in J-OSLER were divided by the number of each category in respective field. ID: infectious disease, EM: emergency medicine

manually performed by residents themselves, and only specific numbers and the variety of patient encounters are required, making it relatively simple to use. Of note, it may not necessarily reflect the entire training experience in inpatient care, and the specific number of cases required from J-OSLER has not yet been sufficiently validated to carry out adequate training. We utilized the DPC because this system can be used to manage data on all patient encounters, including not only the number of patients but also all of the diseases, including comorbidities, that residents have encountered. In addition, because of its wide availability in Japan, the DPC may be able to be used as a universal evalu-

Table 4. Extra Working Hours and Inpatient Encounters.

Resident	Average monthly extra working hours	Average monthly new inpatient encounters	Average daily number of inpatients
A	19.5	19.9	9.9
B	30.5	19.8	10.0
C	31.3	17.8	5.6
D	36.7	9.3	4.1
E	25.9	12.0	5.40

ation tool for each institution or each department for resident training. Although it is clear that the number of residents in our study was very limited, we have experimentally developed a hypothesis to explain the results in our institutions.

Each internal medicine resident had characteristic patterns of training (Table 1). Two residents (A and B) had GIM training, and one resident (C) had cardiology training for the entire two years. Another two residents (D and E) had one-year rotation training, with Resident D having two months of training at the GIM department, while Resident E underwent traditional specialty department rotation. The number of patient encounters was highest among those who participated in the two-year GIM/cardiology department training, while those residents who received rotation training had far fewer patient encounters. This is due to the character of the GIM/cardiology department and can be considered a negative effect of rotation training. Residents may have difficulty getting used to each rotated department, resulting in their encountering fewer inpatients than residents who stay in the same department. The definitive adequate number of inpatient encounters during the training period is uncertain. In the United States, the Accreditation Council for Graduate Medical Education (ACGME) places a strict restriction on the number of new patient encounters (≤5 per day) and patients receiving ongoing care (≤10 per day) for interns, but there is no specific mention concerning the total number of patient encounters during training (7). Owing to the high turnover rate of inpatient care, residents in the United States are exposed to a high number of new inpatient encounters and are actively engaged in ongoing inpatient care (8). This may explain why the ACGME does not need to set any requirements on the total number of inpatients in addition to the current requirements. In contrast, Japan has no specific regulation concerning the numbers of new admissions or admitted patients encountered during residency training. In addition, the length of hospital stay is significantly longer than that in the United States. Owing to significant differences in the medical systems between Japan and the United States, the quantification of patient encounters may be useful for assessing the efficacy of training program.

The highest match rate with J-OSLER was 91%, which means that even Residents A and B, who were seeing the highest number of patients, could not achieve a full match. Receipt computation data may not cover all of the experienced diseases. Data were registered by both residents and a certified health information manager, and although the data were carefully registered based on medical charts and medication, there is still a possibility that not all data were registered for several reasons, such as the limited number of registrations. Data from residents did not fully match the J-OSLER requirements, despite all residents manually submitting the required cases. This may be due to a non-registry issue or simply because the residents were able to use cases that they had previously experienced during their junior resident training period.

There were high numbers of diseases that were not classified into any of the categories in J-OSLER (Table 3). These diseases were either not included or were insufficiently specific to fit the current J-OSLER disease list. Fractures were frequently registered by Residents A and B, perhaps because the GIM department in TGH has a unique practice called orthopedic co-management (9). Care of fractures by the internal medicine department is widely considered to be effective practice, and J-OSLER also registered this disease in GIM II. There is difficulty in translating all diseases in these fields into specific diseases, however, so GIM I-III were not used in our research. Skin and soft tissue infections, some of the most common infections in elderly patients, are also not specifically listed in J-OSLER. Cellulitis was highlighted as the ninth-most-common disease in Resident A's encountered uncategorized disease. Vertigo was also ranked highly among uncategorized diseases, and it too is not listed in J-OSLER. Given the nature of the super-aged society of Japan, care for common diseases encountered in elderly patients is a core practice, so adding these diseases, which currently straddle vertically segmented departments, to the disease list of J-OSLER should be considered.

The numbers of diseases classified in J-OSLER were highest in Residents A, B, and C (2,057, 2,013 and 2,347, respectively), but there was a significant difference in the disease distribution between GIM training and cardiology training. Figure shows the proportion of diseases in each field. To ameliorate the discordance in the number of diseases in each field, the number of diseases was divided by the number of categories in each field. Residents A and B had a balanced proportion in each field, while data for other residents showed significantly different proportions between their specialty and others. In addition to the high number of patient encounters in GIM training, this difference may also have been due to patient characteristics. The GIM department basically has no scheduled admissions or elective pro-

cedures, and most patients are admitted for acute illness. Furthermore, the majority of patients are elderly, meaning that there is a high number of comorbidities. The broad coverage in each field of internal medicine as well as the high number of other diseases not included in our study suggest that the GIM department is active in care of a high number of patients with multiple comorbidities.

The relationship between patient encounters and extra working hours was also evaluated, and a correlation was noted between total patient-days and extra working hours in Residents A and B. Work in the GIM department is mainly occupied by inpatient service, which may explain this correlation. The balance between the intensity of training and working hours should be carefully regulated (10). In the United States, the ACGME has regulated working hours to a maximum of 80 hours per week during residency training (11). Japan also has plans to launch this work style reform, but how to achieve the ideal number of working hours while maintaining the quality of training remains unclear. There is a risk of the quality of internal medicine training being impaired if there is too great a focus on the regulation of working hours. The accompanying training load should also be evaluated, and we suggest that utilizing the quantity of patient encounters will be effective for this.

Developing a universal method of assessing the quantity of patient encounters is essential for evaluating residency training in Japan. Obtaining objective data will aid in the establishment of a training program and help residents themselves understand the intensity of training, which can be useful for future planning. If the data over the two years of GIM training are considered to be sufficient based on these data, then the resident may thus be considered to be ready to move into specialty training without hesitancy.

Limitations

Several limitations associated with the present study warrant mention. First, the current J-OSLER information cannot be fit smoothly to our DPC matching system. A certain number of diseases were unable to be classified into a particular category of J-OSLER. As discussed above, there may be diseases that will be included as necessary experience in the next revision of J-OSLER, such as skin and soft tissue infections. Many data were classified by symptoms or pathology. We had difficulty matching receipt computation data with the list of GIM I-III, so it would be better if the same classification was available for both groups. Nevertheless, we still suggest that this quantification is useful, despite the unclassified data, for the evaluating the quantification of training. Second, our study involved only five residents from two institutions, so the data may not reflect the situations in other institutions. Our assessment of our data may only be applied to our institutions at present, but if these data can be collected from other institutions, the respective trends and features of educational programs at each institution would be able to be assessed, facilitating future improvements. Furthermore, if DPC data can be widely used for most institutions in Japan, the data may reflect the current situation of the internal medicine training program as a whole. We believe that these data will aid in the establishment of an even better residency program in Japan. Our study focused on introducing a method of quantitating inpatient encounters, not for assessing the current Japanese residency educational program. Finally, this study only evaluated the quantification of patient encounters. The optimal number or variation of inpatient encounters is unknown. This system must act as a counterpart to the assessment of the quality of training and the methods used therein. The number of patient encounters is related to the internal medicine in-training examination score, so future studies should investigate these issues (12).

Conclusion

DPC-based quantification of patient encounters during residency training is effective in evaluating the coverage of current J-OSLER list. Owing to its wide availability and generalization, this database may be useful as a universal tool for assessing internal medicine programs.

The authors state that they have no Conflict of Interest (COI).

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