Quality Indicators for Treatment Outcomes of Regional Medical Institutions*

ITO Yukiko

Professor, College of Policy Studies, Tsuda University

KASSAI Ryuki

Professor, Department of Community and Family Medicine, Fukushima Medical University

Abstract

This paper outlines what information can be utilized to compare the treatment outcomes of the acute care hospitals in regions (secondary medical-care area). Specifically, we point out existing limitations in the use of data. In addition, this paper describes leading quality indicators overseas. Some overseas public institutions publish quality indicators (QI) for each medical institution. They thus make treatment outcomes more visible to the public and improve the quality of treatment at each medical institution. One example is the Quality and Outcomes Framework (QOF) for examination and evaluation used for primary care in the UK. This paper states lessons we can learn from the QOF. In Japan, there is no evaluation of quality of care for each clinic, and the only public data are the treatment results since FY2006 of selected hospitals which adopt the payment system known as the Diagnosis Procedure Combination/Per-Diem Payment System (DPC/PDPS). Even this information is limited, as statistics for minor diseases and for small cases are dropped. In addition, the reporting quality of the personal data is diffused, as there are no uniform standards for the seriousness of the disease and complications. We conclude that the mandatory disclosure of fully unmasked set of aggregate information is vital as regional healthcare indicators. To ensure the quality of the data, we also need to impose unified reporting rules of personal treatment data.

Keywords: Quality Indicator (QI), Quality and Outcomes Framework (QOF), Diagnosis Procedure Combination/Per-Diem Payment System (DPC/PDPS), Personal Data

JEL Classification: H51, I10

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I. INTRODUCTION

In this paper, we discuss the current availability and usability of indicators (particularly published information based on individual records) in Japan to assess the extent to which improvements in patient health outcomes are realized in regional medical institutions and how they link to patient quality of life after discharge. In another paper in this journal (Ito et al., 2022), the quality of treatment at acute care facilities within a single region (a secondary health care zone) was compared using mortality rate, length of hospital stay, and the patient's ability to perform activities of daily living (ADL) at discharge. Here, we demonstrate the purpose and importance of using such quality indicators, as well as highlighting the large amount of missing information that is essential for effective quality assessment, and the resulting lack of accuracy in risk correction of outcomes.

At present, several databases provide aggregated data on the numbers of medical consultations performed and the staff and facilities in place at each medical institution, making it possible for anyone to view metrics relating to healthcare quality for specific diseases and individual hospitals. While this existing information will be important in assessing the health outcomes of medical institutions in the future, the fact that small numbers of cases within the data are currently masked presents a problem. In addition, some basic indicators, such as mortality rates and hospital readmission rates (which are routinely disclosed in the United States, United Kingdom, France, and other countries), do not form part of the data that is publicly available in Japan. Therefore, while exploring some of the mechanisms used in other countries for assessing health outcomes, such as the Quality and Outcome Framework (QOF) in the UK, we would like to present the characteristics and problems associated with each of the indicators currently used in Japan, and to discuss the disclosure and mandatory reporting of information as issues requiring further policy attention.

The purpose of comparing patient health outcomes by specific institution rather than at the regional level is to improve comparability when there are multiple institutions locally from which people can choose to receive treatment for a given condition. Increasing comparability firstly helps people in the local community to understand which of the available medical institutions is best suited to their specific needs, which not only helps to prevent mismatches between patients and hospitals, but also assists patients in choosing high-quality healthcare providers. Second, it enables medical institutions to make improvements to their own services by allowing them to check their own health outcomes. Third, it helps administrative agencies (national, prefectural, and municipal governments) to verify whether their expenditure on medical institutions (e.g., on health insurance benefits and subsidies) as a public service is commensurate with the quality of treatment provided by each institution. In Section 2, we use international examples of quality indicators and their methods of application, including in the field of primary care, to conduct a comparison with quality indicators used in Japan.

It is therefore important that local communities, medical institutions, and administrative agencies can ascertain the health outcomes of each medical institution in a way that is both

objective and relatively comparable in order to promote functional differentiation and cooperation among those institutions, from acute care to primary care. This is also important in emergency situations such as natural disasters and infectious disease outbreaks, where there tends to be a lack of reliable information available as a result of confusion on the ground, as a means of swiftly coordinating information and highlighting suitable medical care facilities available in the local area.

However, it is also necessary to avoid inefficiencies and inconsistencies when collecting and recording data, such as employees at medical institutions entering data manually via a number of different registration forms. With this in mind, we first present the issues and challenges relating to the existing databases, on the assumption that the current records collected by individual medical institutions will continue to be used. In this paper, we discuss the following existing databases that publish data on an institution-by-institution basis: (1) "DPC impact assessment survey: aggregate results"[1] (hereafter "DPC data"), Ministry of Health, Labour and Welfare (MHLW), fiscal years (FY) 2006 to FY 2019; (2) "hospital bed function reporting,"[2] MHLW, FY 2016 to FY 2020; and (3) "hospital-based cancer registry,"[3] National Cancer Center Japan, 2007-2020.

First, the DPC data in (1) are gathered from medical institutions participating in the "Diagnosis Procedure Combination/Per-Diem Payment System" (DPC/PDPS, commonly referred to as simply the "DPC system"). The DPC system is a payment methodology whereby hospitals are reimbursed for providing medical services via a fixed daily fee calculated on the basis of the number of days for which a patient is hospitalized and that patient's primary diagnosis group classification. This database provides the most detailed hospital admissions records currently available in Japan, mainly for acute care hospitals, and includes data relating to treatment outcomes by specific disease or condition.

Second, the hospital bed function reports in (2) provide data for all hospitals (20 beds or more) and clinics (19 beds or fewer) in Japan that have beds within their facilities. This database therefore currently represents the largest number of registered medical institutions. For hospitals, information on hospital wards is compiled for each functional classification of hospital bed within the respective "community health care vision,"[4] and the reports include details on what medical facilities and equipment are available in those wards, the number and type of medical professionals who work in them, and the type of treatments provided. Reporting throughout the year was made mandatory from FY 2021, meaning that a great

[1] https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/0000049343.html
[2] https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/0000055891.html
[3] https://ganjoho.jp/public/qa_links/report/hosp_c/hosp_c_registry.html
[4] There are four functional bed classifications, defined by MHLW as follows. Highly acute phase: providing particularly high-density medical care to patients in the acute phase to stabilize their condition as quickly as possible. Acute phase: providing medical care to patients in the acute phase to stabilize their condition as quickly as possible. Rehabilitative (recovery) phase: providing medical care and rehabilitation for patients who are no longer in the acute phase to facilitate their return home; in particular, this function provides intensive rehabilitation to patients with conditions such as cerebrovascular disease or femoral neck fracture who have passed the acute stage, with the aim of improving their ADL scores and returning them home. Chronic phase: providing hospital-based medical care to patients who require long-term treatment; this includes the hospitalization of patients with severe disabilities (including those with severely impaired consciousness), patients with muscular dystrophy, and patients with intractable diseases who require long-term care.

deal of useful information on health outcomes of patients can be expected.

Third, the disease registry information in (3) provides treatment outcomes by medical institution, cancer type/site, and disease stage, reported by regional core centers for cancer treatment throughout Japan. It also includes information such as 5-year and 10-year survival rates for the main types of cancer.

While these three main data sources provide useful information at the individual institution level, the key issues that we pay particular attention to in this paper in relation to these databases are the need for expanded and mandatory reporting of data on the severity of the patient's disease or condition (hereafter, severity), and the need to abolish the masking of information where the number of cases is small. As we discuss in Section 2, to successfully assess inpatient care outcomes on discharge, it is also essential to have accurate information on severity at the time of admission. In general, treatment quality is considered to be higher at medical institutions that proactively admit and treat patients whose condition is severe. However, for these institutions, it is inevitable that the health outcomes on discharge will be lower to some extent because of the correspondingly poorer condition of the patients at the time of admission. As a result, if quality of treatment is assessed solely on the basis of health outcomes at the time of discharge, institutions that provide advanced treatment will be rated lower than those that do not.

If data is disclosed in a manner that does not reward quality of treatment, not only will medical institutions be reluctant to publish information, but it may also encourage behavior whereby medical institutions avoid accepting severe cases in an attempt to improve their health outcomes assessment (leading to under-provision of health care). It is therefore necessary to employ information on severity at the time of admission, and to make greater use of information that has been risk-corrected, to compensate for differences in severity.

In Section 3, we describe the problems related to masking small numbers of cases in the data, using the three databases above as examples, and discuss the need to discontinue this practice. At present, original data records relating to small numbers of cases (less than 10 cases per reporting item) are either deleted or masked as part of the disclosure process. To minimize the possibility of individual patients being identified from small numbers of records, this information is kept confidential, in accordance with the guidelines of the Personal Information Protection Commission. However, while the social benefits of this approach are unclear, it creates significant limitations in terms of being able to make the functions of medical institutions clearer and more transparent in the future.

Looking to the future of regions, and particularly regional cities, and in light of Japan's rapidly declining and aging population, it is time to review the scale and functions of medical institutions in these areas. As part of that process, it is essential to objectively evaluate the medical functions of small- and medium-sized hospitals; however, the current situation at these institutions is not clear owing to the masking of small case numbers.

Japan lags far behind the US and the UK in the disclosure of data by medical institution based on individual patient records. Masking small numbers of cases reduces the transparency of disclosable information below the required level, thus affecting the ability to review

and verify treatment outcomes. For as long as there exists a large gap in available information between Japan and other developed nations, there is a limitation on the policies that can be developed, resulting in either a medical care provision system that will forever remain inadequate or an increase in the expenditure required to achieve parity with systems in other countries. The entire healthcare system can become inefficient and ineffective in the effort to eliminate personally identifiable information.

The problems of missing data that could be used to correct for severity and masking data when the case numbers are small share the same background. While the details are beyond the scope of this paper, the legal system governing the collection and analysis of personal information in Japan is complex and decentralized, making comparisons difficult. As a result, even if it is possible to collect the relevant data, there are many patient attributes (such as information on severity) that cannot be observed. A lack of severity information for individual cases also results in inadequate severity-corrected outcome measures. As long as the outcome measures are not reliable, it is not possible to apply appropriate rewards or penalties for those outcomes as part of the overall system design. Furthermore, without appropriate rewards or penalties, there is little incentive for either medical institutions or administrative agencies to collect, analyze, and assess health outcomes data. In addition, there are limited opportunities for local residents to understand the medical functions available in their communities. This results in a vicious circle whereby existing issues in the medical care provision system are worsened rather than improved.

In order to explore the issues raised here, in Section 2, we review previous studies on healthcare quality assessment both in Japan and overseas, including in the primary care setting. In Section 3, we present the problems with the data that is available in Japan on an individual institution basis, using DPC data, hospital bed function reporting, and hospital-based cancer registry as example data sources. Finally, in Section 4, we discuss the issues relating to quality assessments that correct for severity and data disclosure when the number of cases is small.

II. ASSESSMENT OF HEALTHCARE QUALITY IN PREVIOUS STUDIES

II-1. Disclosure of information on quality of medical institutions by overseas administrative agencies

Assessment of healthcare quality is an essential policy issue for all countries and regions that invest public funds in the provision of healthcare services. In particular, we can say that assessment of the quality of each medical institution is an important means of improving efficiency in a timely manner by directly assessing the persons responsible for providing medical services.

For example, the Agency for Healthcare Research and Quality (AHRQ), a federal agency in the US, sets four areas for healthcare quality assessment (effectiveness, patient safety, timeliness, and patient-centeredness[5]) and provides corresponding quality indicators (QIs)[6].

QIs for inpatient care at each medical institution are also indexed. Length of hospital stay, excess or deficiency of medical resources, and medical errors (overuse, underuse, and misuse) for standard medical care, which is based on the diagnoses (ICD-10) and types of surgical procedures, are subject to QIs. It is interesting to note that not only misuse but also overuse and underuse are considered important in the quality of health care.

In the US, the Centers for Medicare & Medicaid Services (CMS), a federal agency for public health insurance programs (i.e., Medicare and Medicaid), publishes QIs quarterly or annually on its website, for each medical institution. There are about 100 QIs, including mortality rate, patient safety (such as nosocomial infections), readmission rate, patient satisfaction, treatment outcome, time involved in treatment, cost of standard treatment, and efficient use of imaging tests[7].

In the UK, the Care Quality Commission (CQC) website provides assessments of each healthcare facility, based on five key elements (safe, effective, caring, responsive, and well-led) of the healthcare quality assessments set by the National Health Service (NHS)[8]. The following points are of particular interest: whether staff treat patients with compassion and respect ("caring"); whether treatment is provided responsibly to meet patients' needs ("responsive"); and whether management efforts and governance by leaders provide high-quality health care, with a culture of continuous learning and improvement and a transparent and equitable environment ("well-led").

Nearly 2,000 subcategory items are targeted for the assessment, such as mortality rate, readmission rate, sanitary environment in the hospital (such as nosocomial infections), time taken for treatment, items related to costs, and other medical records for each disease classification. The scores are tallied and then services are assessed on a four-level scale: outstanding, good, requires improvement, and inadequate. Assessments for each medical institution are fully published on the CQC website[9].

In Australia, the Australian Institute of Health and Welfare, an independent statutory Australian government agency, also publishes outcome assessments of medical institutions. In addition, the data is provided through an open API (an application programming interface made publicly available to software developers), which is designed to further enhance user-friendliness[10].

In France, la Haute Autorité de Santé (HAS), an independent public authority, publishes quality assessments for all hospitals in the country, including private medical institutions[11].

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[5] Patient-centeredness can be said to be an area set by the AHRQ with family medicine in mind. The specialty care approach used by family physicians in North America, particularly in Canada, has indicators and methods to measure the extent to which the Patient-Centered Clinical Method has been achieved.

[6] In addition to these four areas, the US Institute of Medicine (IOM, 2005) proposed two further areas for assessment: efficiency (absence of waste in healthcare services) and equity (receiving equal services regardless of gender, race, region, and socioeconomic status). It also pointed out that there were very few indicators for these two areas.

[7] https://data.cms.gov/provider-data/topics/hospitals

[8] https://www.cqc.org.uk/what-we-do/how-we-do-our-job/five-key-questions-we-ask

[9] https://www.cqc.org.uk/what-we-do/services-we-regulate/find-hospital

[10] https://www.aihw.gov.au/reports-data/myhospitals

[11] https://www.has-sante.fr/jcms/c_411173/fr/comprendre-la-certification-pour-la-qualite-des-soins

QIs include detailed records on nosocomial infections, patient records, anesthesia records, team medical care for cancer, patient satisfaction, ambulatory surgery, myocardial infarction, cerebrovascular diseases, postpartum hemorrhage, dialysis, bariatric surgery, and post-hospital pulmonary embolism.

In South Korea in 2005, the Health Insurance Review and Assessment Agency (HIRA), which was established in 2000 to form a single insurer by integrating all the existing health insurance schemes in the country, began assessing medical institutions, and the results are publicly disclosed on the HIRA website. Five-level scale assessments are given on the basis of treatment outcomes for acute myocardial infarction, stroke, perinatal period, cancer, and other conditions. In addition, since 2011, it has introduced a pay-for-performance (so-called "P4P") mechanism called the "Value Incentive Program," by which assessment results are reflected in the remuneration for general hospitals[12].

As a result of these assessments in other countries, there are many medical institutions that are judged to have inadequate QIs. For example, McGlynn (2020) stated that the quality of health care in around half of the providers in the US remained inadequate throughout the 20 years following a previous study by McGlynn et al. (2003). Approximately 30% of hospitals in the UK received "requires improvement" or "inadequate" assessments from the CQC.

Even in Japan, strict penalties have been established in cases of medical malpractice, including measures such as revoking the accreditation of medical institutions authorized to accept health insurance patients or the accreditation of various specialist medical institutions, but these cases account for a very small proportion of all medical providers. In recent years, the websites of each Regional Bureau of Health and Welfare have reported no cases of medical institutions being removed from the health insurance-based treatment register alongside the other administrative punishments handed out in their respective prefectures. There are a few cases of the accreditation of designated medical institutions being revoked for specific medical practices each year, and many of these cases are not due to medical malpractice but to fraudulent billing. Compared with other countries, there seems to be a lack of recognition in Japan of differences in healthcare quality, let alone assessment of those differences.

At first glance, the fact that there are a certain number of medical institutions with low quality assessments in the US and the UK seems to be a problem. However, taking a different perspective, the publication of these outcome assessments, including inadequate ones, on websites that can be accessed from all over the world, can be considered to contribute to raising the average outcome level of medical institutions and advancing QIs for quality assessment. In the case of information disclosure in Japan, where individual names of medical institutions are not disclosed unless there is a serious case of misconduct, such effects cannot be expected.

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[12] In terms of context, Tanabe (2019) noted that medical expenses surged in the 2000s in South Korea, and that the hospital sector in particular, accounting for one-third of medical expenses, was intended for improvements. The US Medicare P4P demonstration project was used as a model for the introduction of the quality assessment. Assessment items are expanding year by year, and 34 indicators are currently in use, according to the HIRA website.

II-2. Over- and under-provision of healthcare services

In the quality assessment of healthcare services, clarifying over- and under-provision is necessary to optimize health outcomes and necessary medical expenses. However, unlike accounting fraud (e.g., improper billing), judging treatment as medically inappropriate is extremely difficult in terms of both data collection and statistical verification.

Therefore, when looking at previous studies from a quantitative perspective, there are many examples of pharmacoepidemiological research into over- and under-provision of healthcare, such as adverse reactions due to under- or over-administration of drugs. As a pioneering example, Soumerai et al. (1997) pointed out the under-prescription of β-blockers in clinical practice, which are efficacious in preventing the recurrence of acute myocardial infarction. In addition, Gonzales, Steiner, and Sande (1997) investigated the overuse of antibiotics in adults and pointed out that this led to the emergence of multidrug-resistant bacteria as an adverse reaction, which has had a major impact on subsequent clinical therapy.

It has been suggested that medical and pharmaceutical regulations, information asymmetry between doctors and patients, and internal resistance from providers such as medical institutions are the underlying causes of under-provision of health care. For example, in the case of β-blockers, Skinner and Staiger (2015) pointed out the problem of search costs (the time and cost of research to identify problems) and the resulting lack of sufficient knowledge of drug efficacy among doctors. Bloom et al. (2014) and McConnell et al. (2013) used data from medical institutions in the UK and the US to emphasize differences in the quality of business management. It has also been pointed out that field leaders may avoid the risk of using new treatments (Bradley et al., 2001) and that there may be differences in training environments for doctors (Chan, 2021).

On the other hand, regarding over-provision, there are many examples of research pointing out the possibility of cases of supplier-induced demand under the fee-for-service system, or insufficient evaluation by doctors regarding the marginal utility (or marginal productivity) of treatment (Cutler et al., 2019). However, as pointed out by Burke et al. (2018), there is also an unavoidable over-provision from the perspective of critical care, such as investing more medical resources than necessary for patients with high severity (e.g., with heart failure), and such factors make the discussion more complex. (For example, in the case of critical care, it is considered appropriate from an ethical point of view to invest as much medical resource as possible, even if the patient dies as a result.)

Despite these limitations, in previous studies, particularly in the field of economics, even if misallocation between the severity of individual diseases and medical resources was observed in some cases, overall, it is considered possible to demonstrate statistical "over-" and "under-provision." Therefore, in many facility-specific verifications, the hypothesis is tested that an appropriate relationship should be observed between the amount of input of medical resources and the productivity (total factor productivity; TFP) of each medical institution if coordination is performed appropriately throughout the medical institution (Doyle et al., 2015, 2017; Doyle, 2011; Fisher et al., 2003a,b). In addition, the relationship between input

and TFP and the variation in medical institutions within the region are regarded as QIs of regional health care. However, in the medical field, it is known that it is very difficult to calculate TFP appropriately both from the point of view of methodology and level of detail in the data.

Density of medical care by region and by medical institution and differences in health outcomes are important concerns. There are many studies centered on diseases such as acute myocardial infarction, which have little selection bias (room for selecting medical institutions and patients, and errors caused by it) for both patients and medical institutions (e.g., Finkelstein et al., 2016; Fisher et al., 2003a,b; Skinner, 2012; Baicker and Chandra, 2004a; Doyle et al., 2015, 2017; Yasaitis et al., 2014; Romley et al., 2011). Of particular interest in the context of economics is the relationship between medical costs and health outcomes, and the regression coefficient is thought to indicate, to some extent, the productivity of medical institutions and the underlying efficiency of resource allocation (Garber and Skinner, 2008).

II-3. Incentive design for payment considering healthcare quality

In the US and the UK, attempts are being made not only to assess quality, but also to make quality assessment correspond to the payment of medical expenses. Both countries are trying to improve outcomes by providing economic incentives (i.e., P4P).

One of the authors (RK) has published a study comparing indicators for assessing primary care (PC) with overseas academic family doctors (Olde Hartman et al., 2021). The authors examined the QOF, the world's largest health care-related P4P scheme, which was implemented in 2004 in the UK PC settings (not usually including inpatient care).

There are four advantages of the QOF: (1) it promotes the systematic management of chronic diseases by multidisciplinary health teams, which had been the trend up to that point, and spread of electronic medical records; (2) it led to modest improvements in quality of health care (possibly partly due to various quality-improvement programs running nationwide already); (3) care delivery in socioeconomically disadvantaged areas has caught up with the level of care delivery in wealthy areas (reduced inequality) in the provision of care for major chronic diseases; and (4) there are fewer emergency hospital admissions for diseases incentivized by the QOF (improved quality of care at the PC level may have had an effect, but further research is needed).

There are two disadvantages: (1) government incentives focused on prompt access to PCs have reduced users' opportunities to see their preferred general practitioner (GP).; and (2) because incentives are set for each single disease by its clinical practice guidelines and indicators, it has been pointed out that this has led to overtreatment in the elderly, inappropriate treatment of multiple comorbidities, and disregard for diseases without incentives.

Around the same time, Ahmed et al. (2021) published a systematic review of P4P schemes including the QOF in UK general practice to compare the advantages and disadvantages in four categories: patient experience, organizational effect, clinical outcome, and GP experience. Although increased patient satisfaction has been shown to be a benefit of the

QOF, many studies have shown equivocal results. They concluded that further research is needed to include non-economic incentives to improvement of healthcare quality.

Concerning the implications of the QOF for the Japanese healthcare system, Hori (2010) closely examined previous studies up to six years after the introduction of the QOF, and Tsugawa (2020) published a book to clearly explain the significance of P4P in inpatient and outpatient care in the US and the UK. However, there is concern that these discussions may be oversimplified and interpreted to mean that QOF will not improve the quality of health care or that QOF will not work well if it is introduced to Japan. Dozens of studies have already been published on the effects of introducing the QOF in the UK alone. These studies have produced a broad range of evidence from a diverse set of contexts, and warrant careful reading.

For example, Mendelson et al. (2017) examined the effects of introducing the QOF in 24 studies as part of a systematic review. There is the potential for that review to invite the misunderstanding that there is evidence that the introduction of the QOF did not improve patient health outcomes; however, this is based on the fact that the evidence shown in one study - that the prevalence of chronic obstructive pulmonary disease (COPD) increased from 1.27% before to 1.45% after the introduction of the QOF - was regarded as a negative finding. The original study (Smith et al., 2008) showed at the same time that the use of pulmonary function tests to make a positive diagnosis for people at risk of COPD increased from 12%-22% to 48%-67%, and that the recommended combination of long-acting bronchodilators and inhaled corticosteroids for treatment increased from 22%-28% to 40%-49% as a result of the introduction of QOF to the UK, where large-scale care improvement had not been systematically implemented for COPD. In other words, the increase in the prevalence of COPD can be seen as an effect of correcting the underdiagnosis and undertreatment before the introduction of the QOF, and can rather be said to be an advantage of the introduction of the QOF.

There is a danger that evidence will take on a life of its own, and care must be taken when conducting health care and implementing health policy based on it. Whether it is evidence or guidelines, it is necessary to take a view that seeks to understand the background and intention of the studies that produced it. We need to understand that what evidence means is not absolute, but relative, and subject to change according to its background and intended purpose.

This aspect is particularly strong in the PC evidence. If we ignore the background of the community and focus only on individual disease-specific outcomes such as mortality, morbidity, and test results, we cannot fully appreciate the fundamental roles of PC, such as cost-effectiveness, equity, and population health. This is called “the paradox of primary care” (Stange and Ferrer, 2009).

In this way, there are always difficult aspects in assessing healthcare quality. However, quality assessment is not only for the purpose of discussing payment methods. Independent of the discussion of whether or not to change the payment system, assessment of healthcare quality is absolutely necessary to realize safe, effective, and timely health care for local

communities. In the next section, we explore the databases of medical institutions in Japan, which serve as a starting point for quality assessment, and discuss their specific problems.

III. VIZUALIZING HEALTHCARE QUALITY USING DATA FROM JAPANESE MEDICAL INSTITUTIONS

III-1. DPC data and making healthcare quality more visible

III-1-1. DPC data (MHLW)

DPC data are compiled for each medical institution participating in the DPC system, providing the most detailed disease-specific medical information and results available in Japan at present, primarily for acute care hospitals.

Matsuda and Fushimi (2012) used DPC classifications to estimate the quantity of medical resources needed in each region per medical condition. First, they attempted to quantify the demand for and supply of health care by linking individual records from patient surveys and medical facility surveys, and then estimated the quantity of medical resources required in the region after taking patient inflow and outflow rates into account. These base data were also reflected in the tool (known as the "data book") that prefectures used to estimate the total demand for health care and the number of hospital beds (for each functional bed classification) needed by 2025 when formulating their strategy as part of their 2015 community health care vision. However, this data book presents comparative information by region, not by individual medical institution.

Table 1 presents an extract of the data available by disease and by medical institution on the MHLW website. By way of example, if we compare the number of cases of acute myocardial infarction at Fukushima Medical University Hospital and Kyoto University Hospital, the number of cases involving surgery is nearly identical, which in itself is not enough information on which to base a comparison of treatment quality at the two hospitals. In this table, if the number of cases is between zero and nine for a particular item, this is entered as a blank (represented by a dash [-]). As we can see, many of the entries in the table for other university hospitals are blank, making it impossible to compare whether the number of cases at that hospital is zero (i.e., no performance history) or between one and nine (i.e., some performance history)[13]. For example, the number of cases of "coronary artery bypass grafting (etc.)" is unknown for many of the medical institutions listed. As a result, there is little reference information available to patients faced with this type of surgery or details on suitable medical institutions from which they can seek a second opinion.

In Table 1, the performance results for "coronary artery bypass grafting (etc.)" at Nippon Medical School Hospital and Iwate Medical University Hospital are shown because they include over ten cases; however, with information only available for these two hospitals, it is difficult, for example, to determine how the lengths of hospital stay (38 days and 28 days, respectively) compare with those at other hospitals for which the figures are not disclosed. This kind of partial disclosure may actually lead to patient confusion.

Table 1. Excerpt of DPC performance data for acute myocardial infarction at selected university hospitals

DPC impact assessment survey: aggregate results (8) By disease and by surgery MDC 05 cardiovascular diseases			050030									
			Acute myocardial infarction (including secondary complications); recurrent myocardial infarction									
			Number of cases					Length of hospital stay (days)				
Report number	Serial number	Name of facility	99	97	97 (excluding	02	01	99	97	97 (excluding	02	01
			Without surgery	With surgery	With surgery (excluding blood transfusion)	Coronary artery bypass grafting (etc.)	Ventricular aneurysm resection (including infarctectomy)	Without surgery	With surgery	With surgery (excluding blood transfusion)	Coronary artery bypass grafting (etc.)	Ventricular aneurysm resection (including infarctectomy)
10010	10010	Fukushima Medical Univeristy Hospital	-	69	69	-	-	-	13.55	13.55	-	-
10052	10052	Kyoto University Hospital	-	67	67	-	-	-	14.93	14.93	-	-
10013	10013	Dokkyo Medical University Hospital	27	180	179	-	-	12.67	16.37	16.40	-	-
10060	10060	Nara Medical Univeristy Hospital	-	164	164	-	-	-	14.66	14.66	-	-
10012	10012	Jichi Medical University Hospital	-	147	147	-	-	-	15.74	15.74	-	-
10046	10046	Fujita Health University Hospital	30	147	146	-	-	9.90	13.67	13.63	-	-
10004	10004	Hirosaki University Hospital	-	137	137	-	-	-	15.65	15.65	-	-
10034	10034	Tokai University Hospital	15	135	135	-	-	8.27	10.07	10.07	-	-
10029	10029	Kyorin University Hospital	24	131	128	-	-	12.92	15.55	15.02	-	-
10023	10023	Nippon Medical School Hospital	28	130	129	16	-	7.14	18.72	18.43	38.00	-
10005	10005	Iwate Medical University Hospital	20	128	126	15	-	6.45	12.41	12.18	28.47	-
10061	10061	Wakayama Medical University Hospital	11	116	115	-	-	8.09	14.15	14.24	-	-
10025	10025	Showa University Hospital	-	113	112	-	-	-	20.27	20.29	-	-
10027	10027	Nihon University Itabashi Hospital	20	111	109	-	-	9.20	17.68	17.61	-	-

While the example of acute myocardial infarction presented in Table 1 is a relatively common medical condition within the six-digit DPC classification, the data in many cells are still masked. When it comes to rare and intractable diseases and conditions, nearly all medical institutions have fewer than ten cases, making it very difficult to ascertain the number of cases in Japan. Although it is possible to aggregate the number of cases at the national level without any risk of identifying individual patients, the result is that the valuable individual-level data collected on hospital admissions cannot be used at all.

III-1-2. Individual admissions data for DPC hospitals (provided by Zao Conference, Yamagata Prefecture)

Problems with data reporting and disclosure exist not only for rare diseases and conditions but also for those that are commonly treated in many medical institutions. As described in another paper in this journal (Ito et al., 2022) in which the authors analyze admission data from acute care hospitals participating in the DPC system, conditions such as heart failure,

[13] Regarding the records for which the number of cases is zero, the fact that zero is not specified in the published data is unreasonable, given that disclosing this figure would provide absolutely no personally identifiable information, and thus the personal information protection guidelines for masking of data do not apply. The MHLW's December 2015 "Study into Publication Standards for Results" states that the standard aggregated unit size for patients must not be below ten, which is based on an interpretation of the Cell Size Suppression Policy produced by the US CMS (https://www.hhs.gov/guidance/document/cms-cell-suppression-policy). However, the original wording of the policy is clear in stating that a value of zero can be directly reported: "The policy stipulates that no cell (e.g., admissions, discharges, patients, services, etc.) containing a value of 1 to 10 can be reported directly. A value of zero does not violate the minimum cell size policy." In addition, the support site that provides CMS data for research purposes (https://resdac.org/ articles/cms-cell-size-suppression-policy) proposes methods for aggregating data that do not violate personal information protection principles, such as combining adjacent categories (e.g., combining "aged 95 or above" into "aged 90 or above," or combining disease stages) when small numbers of cases appear in relation to age group or severity.

myocardial infarction, stroke, pneumonia, and femoral fracture have high hospitalization rates and have been the subject of numerous international studies that aim to compare quality of care by individual hospital and specific medical condition. Therefore, it is important to be able to correct for severity at the time of admission. Conducting an assessment of treatment outcomes at the point of discharge alone is not sufficiently accurate to evaluate the quality of care at medical institutions; this is because high-quality medical institutions that accept patients in a severe condition and provide difficult and complex treatment end up with a lower outcome score.

In order to account for such biases, it is mandatory to record information on severity at admission and treatment outcomes on individual DPC records ("Form 1"). However, in reality, there is almost always a certain number of missing values in these records, and there are large differences in the degree of reporting by each medical institution.

Table 2 shows the percentages of missing values relating to severity and treatment outcomes among the individual DPC hospital admission forms collected by Zao Conference, Yamagata Prefecture, and provided to us for analysis. Specifically, for five representative conditions (heart failure, myocardial infarction, stroke, pneumonia, and femoral fracture), the following data were collected: severity (as measured by New York Heart Association [NYHA] classification for heart failure, Killip classification for myocardial infarction, Japan Coma Scale [JCS] for stroke, and A-DROP score for pneumonia); BMI, which is necessary when considering patient attributes for all diseases and conditions; and the "criteria for determining the level of independence in daily living for older people with dementia" classification and ADL score (as measured by the Barthel Index [BI], at both admission and at discharge), which is important information when making discharge decisions and determining functional prognosis.

One example of a serious deficiency in reporting is NYHA classification for patients admitted to hospital with heart failure, for which 60% of values were missing. This essential

Table 2. Severity and treatment outcomes information extracted from DPC individual admissions records in Yamagata Prefecture (April 2014-March 2020)

Heart failure										
Number of cases	NYHA classification		ADL (BI) at admission		ADL (BI) at discharge		Classification for		BMI	
Total	Missing values	(%)	Missing values	(%)	Missing values	(%)	Missing values	(%)	Missing values	(%)
16,415	9,874	**60%**	3,197	**19%**	4,317	**26%**	685	**4%**	2,638	**16%**
Myocardial infarction										
Number of cases	Killip classification		ADL (BI) at admission		ADL (BI) at discharge		Classification for		BMI	
Total	Missing values	(%)	Missing values	(%)	Missing values	(%)	Missing values	(%)	Missing values	(%)
2,459	No missing values (excluding deaths)		265	**10.8%**	284	**11.5%**	478	**19.4%**	284	**11.5%**
Stroke										
Number of cases	JCS score		ADL (BI) at admission		ADL (BI) at discharge		Classification for		BMI	
Total	Missing values	(%)	Missing values	(%)	Missing values	(%)	Missing values	(%)	Missing values	(%)
24,140	No missing values (excluding deaths)		4,724	**19.6%**	4,995	**20.7%**	1,918	**7.9%**	4,357	**18.0%**
Pneumonia										
Number of cases	A-DROP score		ADL (BI) at admission		ADL (BI) at discharge		Classification for		BMI	
Total	Missing values	(%)	Missing values	(%)	Missing values	(%)	Missing values	(%)	Missing values	(%)
19,545	419	**2.1%**	3,498	**17.9%**	4,854	**24.8%**	1,048	**5.4%**	1,223	**6.3%**
Femoral fracture										
Number of cases			ADL (BI) at admission		ADL (BI) at discharge		Classification for		BMI	
Total			Missing values	(%)	Missing values	(%)	Missing values	(%)	Missing values	(%)
8,529			1,937	**22.7%**	1,538	**18.0%**	231	**2.7%**	1,223	**14.3%**

information therefore cannot be used when comparing treatment quality by individual institution or region, despite NYHA classification being a mandatory item on the DPC reporting form for this disease category.

Appendices 1-5 present the numbers and percentages of missing entries for the key severity- and patient attribute-related data items listed above, at the individual medical institution level, for the five representative medical conditions. For some medical institutions, more than half of their case records are excluded from the analysis because of missing values in their reporting. This means that there is insufficient information both in terms of evaluating the treatment outcomes of those institutions and comparing them with other institutions.

III-2. Hospital bed function reporting (MHLW)

Under the hospital bed function reporting system, hospitals and clinics with general and long-term care beds are required to submit reports about the current status and future direction of the medical functions they are performing to the relevant prefectural government. These reports include the functional categories (highly acute, acute, recovery, or chronic phase) of each ward and the number of beds they contain, along with specific reporting items such as performance results and staffing levels.

The contents of these reports are published on the MHLW website. In the early stages of the functional reporting system, from FY 2016, hospitals self-reported their functions without any quantitative basis, creating the issue that the objectivity of the information could not be guaranteed. From FY 2019, however, hospitals participating in the DPC system have been required to report this bed function information in a manner that is consistent with their reported DPC data. In addition, from FY 2021, the reporting requirement was changed from data for the previous month to data for the entire year. These improvements are expected to increase the availability of DPC data and hospital bed function reporting by individual institution and the ability to make use of the National Database (NDB) of medical claims data at the secondary medical care zone level.

However, the hospital bed function reports are also subject to data masking restrictions. Table 3 shows an excerpt of records for emergency care on an institution-by-institution basis. Let us consider the proportion of patients whose condition required urgent attention, which can be measured by taking the ratio of the "total number of patients hospitalized immediately after examination" among the "total number of patients seen." For example, at Fukushima Medical University Hospital, 8.1% of patients were urgently admitted on Sundays or public holidays and 13.9% at night, while at Kyoto University Hospital, 20.4% were urgently admitted on Sundays or public holidays and 23.3% at night. The proportion of patients receiving such emergency care is a variable that is influenced by the location of the specific medical institution and other characteristics of the surrounding area, such as the composition of the local population and the size and function of other nearby institutions. Therefore, although it is not a direct indicator of quality of care, it does make clear the fact

Table 3. FY 2020 hospital bed function reporting data (facilities report) for emergency care

Source: FY 2020 hospital bed function reporting data (facilities report)	Status of emergency care				
	Total number of patients seen on Sundays and public holidays	Of these, the total number of patients who were hospitalized immediately after examination	Total number of patients seen out-of-hours and at night	Of these, the total number of patients who were hospitalized immediately after examination	Number of patients received by ambulance
Fukushima Medical Univeristy Hospital	5,317	432	2,446	340	2,099
Kyoto University Hospital	3,331	681	5,855	1,365	5,827
The University of Tokyo Hospital	3,907	886	6,904	1,738	5,573
St. Luke's International Hospital	20,367	991	81,345	2,592	10,356
Fujita Health University Nanakuri Memorial Hospital	11	*	14	*	29
Showa University Fujigaoka Rehabilitation Hospital	12	0	11	0	0
Kurume University Medical Center	155	*	418	27	117
Showa University East Hospital	206	*	189	*	60
Kansai Medical University Kori Hospital	40	14	37	*	162
IMSUT Hospital, The Institute of Medical Science, The University of Tokyo	58	*	38	*	46
Tokai University Tokyo Hospital	62	24	77	55	70
Meiji University of Integrative Medicine Hospital	74	*	121	19	167
Showa University Karasuyama Hospital	99	19	321	72	55
Kyushu University Beppu Hospital	113	32	20	12	47

that, even among emergency departments, emergency care functions are not always the same. This provides an opportunity to consider how personnel should be allocated to match the specific functions needed at the point of care.

However, in Table 3, if the number of cases in a cell is between one and nine, this is masked by an asterisk (*). As a result, it is not possible, for example, to carry out a functional assessment of whether it is necessary to provide face-to-face treatment on Sundays, public holidays, out-of-hours, and at night in hospitals where the number of ambulance arrivals is small and the number of patients hospitalized immediately after being examined is below ten (and thus masked). It also becomes impossible to discuss whether the emergency room at such a medical institution could be replaced by online-based medical care, or consolidated into another hospital. To make the process of accepting patients who require hospitalization as smooth as possible, it is important to separate the functions of inpatient care and primary care. If the assessment of one is unclear, the assessment of the other also becomes extremely difficult. Therefore, as Sekimoto (2016) states, the role currently played by small-scale emergency care needs to be made clearer if the function of primary care is also to be improved.

III-3. Hospital-based cancer registry (National Cancer Center Japan)

On the National Cancer Center website, the key purposes of the hospital-based cancer registry system, employed at all regional core centers for cancer treatment in Japan, are listed as follows: (1) to ascertain the distribution of cancer types, progression rates, and treatments used at medical institutions that provide specialized cancer care, and to use this information for cancer prevention and control measures at the national and prefectural level; (2) to allow individual institutions to determine the status of cancer care at their facilities compared with that of the country as a whole, to inform their own planning processes and direction of care provision; and (3) to contribute to the decision-making process of patients and their families when selecting medical institutions, by disclosing appropriate hospital-based cancer registry information. For cases from 2011 onwards, data were collected from prefecture-endorsed medical institutions, and from 2017 onwards, have additionally been collected from those institutions that wish to participate voluntarily in the process. Since 2016, following revision of the "Cancer Registry Promotion Act," data on people diagnosed with cancer have been managed centrally via prefectures in a national database, known as the "population-based cancer registry system."

Table 4 presents the total number of cases of pancreatic cancer seen at individual institutions, broken down by disease stage. The data are based on the stage of cancer at the time of initial treatment (i.e., the as-yet untreated cancer stage after the initial diagnosis), and do not provide a full picture of the institutions themselves, such as how many cases they are treating and which treatment methods they are using. However, data on the severity of the disease at the time of initial diagnosis plays an extremely important risk-correction role in evaluating 5-year and 10-year survival rates by medical institution and cancer type/site.

For example, at Fukushima Medical University Hospital, 33% of patients are Stage I and 32% are Stage IV, while at Kyoto University Hospital, 23% are Stage I and 42% are Stage IV. Pancreatic cancer is a disease that has a poor prognosis, with a low 5-year survival rate, and the stage at which the disease is detected has a major impact on survival time. Therefore, comparing the proportions of patients with advanced-stage pancreatic cancer at the two hospitals, Kyoto University Hospital, where the percentage is higher, can be expected to inevitably have a lower 5-year survival rate.

The ability to correct treatment outcomes (such as 5-year survival rate) for individual

Table 4. Total number of pancreatic cancer cases by disease stage

Prefecture	Facility	Classification	Total years of data	Total number of cases (including disease stage unknown)	Stage 0	Stage I	Stage II	Stage III	Stage IV
Fukushima	Fukushima Medical University Hospital	Core hospital	4	212	4–6	69	47	19	68
Kyoto	Kyoto Univeristy Hospital	Core hospital	4	452	7–9	106	83	58	190
Wakayama	Wakayama Medical University Hospital	Core hospital	4	461	7–9	128	88	94	129
Wakayama	Japanese Red Cross Wakayama Medical Center	Core hospital	4	194	1–3	34	29	27	87
Wakayama	Shingu Municipal Medical Center	Prefecture-endorsed hospital	4	63	0	4–6	4–6	4–6	48
Wakayama	Wakayama Rosai Hospital	Prefecture-endorsed hospital	4	62	1–3	7–9	11	7–9	31
Wakayama	Minami Wakayama Medical Center	Core hospital	4	61	0	4–6	7–9	7–9	37
Wakayama	Naga Hospital	Core hospital	4	55	0	4–6	7–9	7–9	32
Wakayama	Hashimoto Municipal Hospital	Core hospital	4	54	1–3	4–6	4–6	7–9	30
Wakayama	Kinan Hospital (Wakayama)	Core hospital	4	53	0	4–6	7–9	4–6	33
Wakayama	Kainan Iryou Center	Voluntary facility	3	25	0	1–3	1–3	0	19
Wakayama	Hidaka General Hospital	Prefecture-endorsed hospital	4	20	0	1–3	1–3	1–3	7–9

medical institutions in this way, using the proportion of patients whose condition is severe at the time of initial treatment, is extremely important. However, let us take the list of core hospitals, prefecture-endorsed hospitals, and voluntarily participating facilities in Wakayama Prefecture as an example (Table 4) of why this is not always possible. Cancer stages with nine or fewer cases are tabulated as 1-3, 4-6, and 7-9, meaning that the exact figures are not identifiable. From the table, it is clear that Wakayama Medical University Hospital and the Japanese Red Cross Wakayama Medical Center are the two facilities that provide the real hub for pancreatic cancer treatment in Wakayama Prefecture, but it is not easy to compare the treatment outcomes of the six core and prefecture-endorsed hospitals that follow in the list. At these hospitals, there were between 53 and 63 cases recorded, but the distribution of disease stages is not clear.

The need for comparisons of medical institution quality is not limited to large-scale facilities. Instead, the key to reorganizing and restructuring medical functions within a declining population lies with small- and medium-sized medical institutions. Compared with DPC data and hospital bed function reporting, the issue with the hospital-based cancer registry system is more related to making statistical use of small numbers of cases. However, it can also be said that, at the very least, disclosure of the numbers of medical examinations undertaken at smaller medical institutions should be considered. This would provide an evidence base for consolidating services at hubs to ensure greater medical effectiveness, management efficiency, and fairness as a public service.

IV. DISCUSSION AND FUTURE ISSUES

In Japan, outcomes and performance records for individual medical institutions are currently disclosed via multiple databases. The DPC database provides information on the number of medical examinations undertaken, by disease category, at each individual medical institution that subscribes to the DPC payment system, while the hospital bed function reporting system contains information such as an overview of the number of beds, facilities, and personnel in each ward by function and the functional role each institution plays in regional medical care. Both databases contain an ever-growing wealth of information. Furthermore, the hospital-based cancer registry is an example of a specific disease registry that contains records relating to treatment undertaken at regional core hospitals and other institutions offering specialist care. The fact that an increasing amount of information is being disclosed in this way is extremely important in improving the comparability of medical institutions and the transparency of their track record in providing treatment, and has also brought about some results in terms of formulating healthcare policy and evaluating progress.

Although these existing information sources are important for the future evaluation of health outcomes of medical institutions, in this paper we raise various issues that are currently of concern and propose several suggestions for improvements in relation to data disclosure. One is removing the need to mask records where the number of cases is small. Another is making it mandatory to enter risk-correction and outcome indicators in individual

data records. These constitute simple changes that would apply to data input manuals and operational rules and regulations rather than relying on revisions to laws such as governmental and ministerial ordinances. Masking small numbers of cases conceals valuable information on treatment outcomes for rare diseases and performance records for advanced surgical procedures. In addition, a significant proportion of information for small-scale medical institutions is masked, which has become a hindrance in discussions about future restructuring and consolidating the functions of those institutions. The fact that so much aggregate information is not available, even though it is reported by medical institutions on the assumption that it will be, is a meaningless and unnecessary constraint in the information disclosure system. A move toward full disclosure of data warrants serious discussion.

The most important health outcomes - basic information such as mortality rates and hospital readmission rates - are rarely shown in Japanese databases, despite being widely disclosed in the US, the UK, France, South Korea, and other countries. Furthermore, presenting this data without any risk correction for hospitalized patients leads to underassessment of healthcare quality at medical institutions that offer highly advanced medical services and accept patients whose condition is particularly severe. It is therefore important to present risk-corrected information and treatment outcomes together. However, there is currently a significant amount of missing information (owing to lack of input) for indicators relating to risk correction (i.e., records of condition severity at the time the patient was admitted to hospital). There are also inconsistencies, including differences between the standards of academic societies and the standards for mandatory DPC reporting. Even when there is the opportunity to analyze the data gained from individual hospital admission records, the inadequacy of the information those records contain means it is not possible to make full use of the data in academic debate.

The entry of patient attribute information requires time to evaluate patients and the judgment of medical professionals at the point of care. This information is recorded for the purpose of improving healthcare quality and is extremely valuable; it should therefore be put to the maximum practical use possible, while paying due consideration to the protection of personal information. However, the mere fact that there are differences in the degree of data input at each medical institution makes it difficult to use the recorded information as quality indicators by region and by individual institution. A suitable ICT system should be developed to ensure that all required records are entered and that there are no missing inputs, before payment is made.

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Appendix 1. Percentage of missing values for mandatory inputs relating to risk correction for severity and patient attributes, for patients admitted with heart failure (number of patients seen between April 2014 and March 2020; excludes in-hospital deaths)

				Heart failure											
				Number of cases	NYHA classification		ADL (BI) at admission		ADL (BI) at discharge		Classification for		BMI		
Attributes of medical institution				Total	Missing values	(%)	Missing values	(%)	Missing values	(%)	Missing values	(%)	Missing values	(%)	
Medical zone	Municipality	Founding body	DPC group	16,415	9,874	60%	3,197	19%	4,317	26%	685	4%	2,638	16%	
Murayama	Yamagata City	Prefecture	Special DPC hospital	1,950	1,356	70%	131	7%	322	17%	192	10%	180	9%	
Shonai	Sakata City	Local Incorporated Administrative Agency	Special DPC hospital	1,864	1,287	69%	468	25%	310	17%	183	10%	492	26%	
Shonai	Tsuruoka City	Municipality	Standard DPC hospital	1,533	1,021	67%	362	24%	421	27%	53	3%	794	52%	
Murayama	Yamagata City	Municipality	Standard DPC hospital	1,307	529	40%	224	17%	283	22%	27	2%	126	10%	
Mogami	Shinjo City	Prefecture	Standard DPC hospital	1,156	507	44%	431	37%	464	40%	41	4%	288	25%	
Okitama	Kawanishi Town	Prefecture	Standard DPC hospital	1,082	613	57%	215	20%	326	30%	57	5%	42	4%	
Murayama	Yamagata City	National University Corporation	University hospital	867	275	32%	118	14%	150	17%	28	3%	109	13%	
Murayama	Yamagata City	Social Welfare Organization (Saiseikai)	Standard DPC hospital	843	559	66%	285	34%	222	26%	0	0%	29	3%	
Murayama	Higashine City	Other corporation	Not DPC	746	554	74%	71	10%	206	28%	60	8%	43	6%	
Okitama	Yonezawa City	Other corporation	Standard DPC hospital	723	451	62%	0	0%	118	16%	4	1%	61	8%	
Okitama	Yonezawa City	Municipality	Standard DPC hospital	707	95	13%	80	11%	130	18%	6	1%	138	20%	
Shonai	Shonai Town	Medical Corporation	Standard DPC hospital	592	387	65%	11	2%	143	24%	14	2%	17	3%	
Murayama	Kahoku Town	Prefecture	Standard DPC hospital	496	369	74%	181	36%	226	46%	17	3%	211	43%	
Okitama	Takahata Town	Municipality	Standard DPC hospital	392	20	5%	252	64%	110	28%	0	0%	0	0%	
Murayama	Yamagata City	Mutual Aid Association/Federation	Standard DPC hospital	325	170	52%	103	32%	118	36%	0	0%	12	4%	
Shonai	Tsuruoka City	Medical Cooperative	Not DPC	278	277	100%	0	0%	83	30%	0	0%	18	6%	
Shonai	Sakata City	Medical Corporation	Not DPC	271	268	99%	53	20%	127	47%	0	0%	19	7%	
Mogami	Shinjo City	Medical Corporation	Not DPC	203	200	99%	82	40%	130	64%	0	0%	15	7%	
Murayama	Kaminoyama City	Medical Corporation	Not DPC	155	155	100%	1	1%	51	33%	0	0%	4	3%	
Murayama	Yamagata City	Medical Corporation	Not DPC	129	82	64%	0	0%	34	26%	0	0%	0	0%	
Murayama	Sagae City	Municipality	Not DPC	115	113	98%	11	10%	44	38%	0	0%	0	0%	
Okitama	Yonezawa City	Medical Corporation	Not DPC	106	49	46%	2	2%	39	37%	0	0%	0	0%	
Murayama	Yamagata City	Medical Corporation	Not DPC	98	95	97%	1	1%	48	49%	0	0%	22	22%	
Murayama	Tendo City	Municipality	Not DPC	94	91	97%	2	2%	31	33%	2	2%	5	5%	
Okitama	Oguni Town	Municipality	Not DPC	93	93	100%	8	9%	21	23%	0	0%	0	0%	
Murayama	Yamagata City	Medical Corporation	Not DPC	59	45	76%	0	0%	16	27%	0	0%	2	3%	
Okitama	Nanyo City	Other corporation	Not DPC	58	57	98%	2	3%	18	31%	0	0%	1	2%	
Okitama	Nagai City	Other corporation	Not DPC	53	53	100%	41	77%	45	85%	0	0%	0	0%	
Murayama	Tendo City	Medical Corporation	Not DPC	44	44	100%	28	64%	32	73%	0	0%	1	2%	
Murayama	Higashine City	Medical Corporation	Not DPC	34	34	100%	13	38%	28	82%	0	0%	0	0%	
Murayama	Asahi Town	Municipality	Not DPC	28	13	46%	18	64%	16	57%	0	0%	6	21%	
Murayama	Yamagata City	Medical Corporation	Not DPC	12	10	83%	2	17%	5	42%	1	8%	3	25%	
Shonai	Sakata City	Local Incorporated Administrative Agency	Not DPC	1	1	100%	1	100%	0	0%	0	0%	0	0%	
Shonai	Tsuruoka City	Municipality	Not DPC	1	1	100%	0	0%	0	0%	0	0%	0	0%	

Appendix 2. Percentage of missing values for mandatory inputs relating to risk correction for severity and patient attributes, for patients admitted with myocardial infarction (number of patients seen between April 2014 and March 2020; excludes in-hospital deaths)

				Myocardial infarction									
				Number of cases	ADL (BI) at admission		ADL (BI) at discharge		Number of cases	Classification for		BMI	
Attributes of medical institution				Total	Missing values	(%)	Missing values	(%)	Total	Missing values	(%)	Missing values	(%)
Medical zone	Municipality	Founding body	DPC group	2,459	265	10.8%	284	11.5%	2,461	478	19.4%	284	11.5%
Murayama	Yamagata City	Prefecture	Special DPC hospital	637	25	3.9%	62	9.7%	632	203	32.1%	38	6.0%
Okitama	Kawanishi Town	Prefecture	Standard DPC hospital	310	40	12.9%	52	16.8%	305	70	23.0%	4	1.3%
Shonai	Sakata City	Local Incorporated Administrative Agency	Special DPC hospital	306	19	6.2%	26	8.5%	306	98	32.0%	70	22.9%
Murayama	Yamagata City	National University Corporation	University hospital	274	43	15.7%	35	12.8%	276	2	0.7%	62	22.5%
Shonai	Tsuruoka City	Municipality	Standard DPC hospital	221	27	12.2%	23	10.4%	221	32	14.5%	39	17.6%
Mogami	Shinjo City	Prefecture	Standard DPC hospital	170	66	38.8%	28	16.5%	174	23	13.2%	22	12.6%
Murayama	Yamagata City	Municipality	Standard DPC hospital	153	16	10.5%	20	13.1%	149	19	12.8%	13	8.7%
Okitama	Yonezawa City	Municipality	Standard DPC hospital	123	11	8.9%	9	7.3%	129	3	2.3%	25	19.4%
Okitama	Yonezawa City	Other corporation	Standard DPC hospital	88	0	0.0%	8	9.1%	93	3	3.2%	6	6.5%
Murayama	Higashine City	Other corporation	Not DPC	67	4	6.0%	8	11.9%	70	21	30.0%	1	1.4%
Shonai	Shonai Town	Medical Corporation	Standard DPC hospital	47	0	0.0%	5	10.6%	44	4	9.1%	3	6.8%
Murayama	Yamagata City	Social Welfare Organization (Saiseikai)	Standard DPC hospital	46	14	30.4%	5	10.9%	45	0	0.0%	0	0.0%
Shonai	Tsuruoka City	Medical Cooperative	Not DPC	9	0	0.0%	2	22.2%	9	0	0.0%	1	11.1%
Murayama	Yamagata City	Mutual Aid Association/ Federation	Standard DPC hospital	8	0	0.0%	1	12.5%	8	0	0.0%	0	0.0%

Appendix 3. Percentage of missing values for mandatory inputs relating to risk correction for severity and patient attributes, for patients admitted with stroke (number of patients seen between April 2014 and March 2020; excludes in-hospital deaths)

				Stroke								
				Number of cases	ADL (BI) at admission		ADL (BI) at discharge		Classification for		BMI	
Attributes of medical institution				Total	Missing values	(%)	Missing values	(%)	Missing values	(%)	Missing values	(%)
Medical zone	Municipality	Founding body	DPC group	24,140	4,724	19.6%	4,995	20.7%	1,918	7.9%	4,357	18.0%
Murayama	Yamagata City	Municipality	Standard DPC hospital	4,129	636	15.4%	545	13.2%	290	7.0%	781	18.9%
Shonai	Sakata City	Local Incorporated Administrative Agency	Special DPC hospital	3,067	963	31.4%	466	15.2%	477	15.6%	1,254	40.9%
Shonai	Tsuruoka City	Municipality	Standard DPC hospital	2,982	654	21.9%	728	24.4%	191	6.4%	678	22.7%
Murayama	Yamagata City	Prefecture	Special DPC hospital	2,379	192	8.1%	334	14.0%	453	19.0%	253	10.6%
Okitama	Kawanishi Town	Prefecture	Standard DPC hospital	2,176	367	16.9%	686	31.5%	87	4.0%	20	0.9%
Mogami	Shinjo City	Prefecture	Standard DPC hospital	1,765	590	33.4%	544	30.8%	135	7.6%	633	35.9%
Murayama	Higashine City	Other corporation	Not DPC	1,662	197	11.9%	447	26.9%	175	10.5%	34	2.0%
Murayama	Yamagata City	Social Welfare Organization (Saiseikai)	Standard DPC hospital	1,223	469	38.3%	302	24.7%	20	1.6%	41	3.4%
Okitama	Yonezawa City	Other corporation	Standard DPC hospital	980	1	0.1%	112	11.4%	11	1.1%	129	13.2%
Okitama	Yonezawa City	Municipality	Standard DPC hospital	966	198	20.5%	169	17.5%	3	0.3%	165	17.1%
Shonai	Shonai Town	Medical Corporation	Standard DPC hospital	808	5	0.6%	137	17.0%	37	4.6%	40	5.0%
Murayama	Yamagata City	National University Corporation	University hospital	749	128	17.1%	185	24.7%	19	2.5%	159	21.2%
Murayama	Kahoku Town	Prefecture	Standard DPC hospital	289	108	37.4%	96	33.2%	11	3.8%	122	42.2%
Murayama	Yamagata City	Medical Corporation	Not DPC	256	0	0.0%	43	16.8%	1	0.4%	0	0.0%
Okitama	Takahata Town	Municipality	Standard DPC hospital	210	127	60.5%	43	20.5%	0	0.0%	0	0.0%
Mogami	Shinjo City	Medical Corporation	Not DPC	110	35	31.8%	44	40.0%	0	0.0%	8	7.3%
Murayama	Yamagata City	Medical Corporation	Not DPC	83	21	25.3%	14	16.9%	2	2.4%	13	15.7%
Shonai	Sakata City	Medical Corporation	Not DPC	72	17	23.6%	26	36.1%	2	2.8%	8	11.1%
Shonai	Tsuruoka City	Medical Cooperative	Not DPC	69	0	0.0%	19	27.5%	0	0.0%	1	1.4%
Murayama	Yamagata City	Medical Corporation	Not DPC	36	0	0.0%	9	25.0%	1	2.8%	5	13.9%
Okitama	Oguni Town	Municipality	Not DPC	35	3	8.6%	12	34.3%	0	0.0%	0	0.0%
Murayama	Yamagata City	Mutual Aid Association/Federation	Standard DPC hospital	28	6	21.4%	7	25.0%	0	0.0%	3	10.7%
Murayama	Kaminoyama City	Medical Corporation	Not DPC	19	0	0.0%	9	47.4%	0	0.0%	5	26.3%
Okitama	Yonezawa City	Medical Corporation	Not DPC	14	1	7.1%	5	35.7%	0	0.0%	0	0.0%
Murayama	Tendo City	Municipality	Not DPC	12	2	16.7%	5	41.7%	3	25.0%	3	25.0%
Murayama	Yamagata City	Medical Corporation	Not DPC	8	0	0.0%	1	12.5%	0	0.0%	0	0.0%
Murayama	Sagae City	Municipality	Not DPC	5	1	20.0%	3	60.0%	0	0.0%	1	20.0%
Murayama	Asahi Town	Municipality	Not DPC	5	3	60.0%	3	60.0%	0	0.0%	1	20.0%
Murayama	Tendo City	Medical Corporation	Not DPC	2	0	0.0%	1	50.0%	0	0.0%	0	0.0%
Shonai	Tsuruoka City	Medical Cooperative	Not DPC	1	0	0.0%	0	0.0%	0	0.0%	0	0.0%

Appendix 4. Percentage of missing values for mandatory inputs relating to risk correction for severity and patient attributes, for patients admitted with pneumonia (number of patients seen between April 2014 and March 2020; excludes in-hospital deaths)

				Pneumonia											
				Number of cases	A-DROP score		ADL (BI) at admission		ADL (BI) at discharge		Classification for		BMI	
Attributes of medical institution				Total	Missing values	(%)	Missing values	(%)	Missing values	(%)	Missing values	(%)	Missing values	(%)
Medical zone	Municipality	Founding body	DPC group	19,545	419	2.1%	3,498	17.9%	4,854	24.8%	1,048	5.4%	3,773	19.3%
Shonai	Tsuruoka City	Municipality	Standard DPC hospital	2,444	38	1.6%	419	17.1%	569	23.3%	130	5.3%	1,168	47.8%
Shonai	Sakata City	Local Incorporated Administrative Agency	Special DPC hospital	1,636	81	5.0%	299	18.3%	280	17.1%	243	14.9%	797	48.7%
Murayama	Yamagata City	Municipality	Standard DPC hospital	1,629	41	2.5%	274	16.8%	354	21.7%	126	7.7%	139	8.5%
Murayama	Yamagata City	Prefecture	Special DPC hospital	1,310	19	1.5%	100	7.6%	238	18.2%	164	12.5%	237	18.1%
Okitama	Kawanishi Town	Prefecture	Standard DPC hospital	1,290	8	0.6%	320	24.8%	409	31.7%	96	7.4%	68	5.3%
Mogami	Shinjo City	Prefecture	Standard DPC hospital	1,175	31	2.6%	360	30.6%	428	36.4%	80	6.8%	277	23.6%
Murayama	Higashine City	Other corporation	Not DPC	1,144	68	5.9%	107	9.4%	332	29.0%	67	5.9%	33	2.9%
Murayama	Kahoku Town	Prefecture	Standard DPC hospital	992	7	0.7%	332	33.5%	376	37.9%	39	3.9%	463	46.7%
Okitama	Yonezawa City	Municipality	Standard DPC hospital	829	37	4.5%	111	13.4%	162	19.5%	10	1.2%	215	25.9%
Okitama	Yonezawa City	Other corporation	Standard DPC hospital	747	5	0.7%	0	0.0%	78	10.4%	13	1.7%	108	14.5%
Shonai	Sakata City	Medical Corporation	Not DPC	724	29	4.0%	142	19.6%	265	36.6%	4	0.6%	63	8.7%
Murayama	Yamagata City	National University Corporation	University hospital	690	15	2.2%	135	19.6%	129	18.7%	19	2.8%	50	7.2%
Murayama	Yamagata City	Mutual Aid Association/ Federation	Standard DPC hospital	640	3	0.5%	172	26.9%	170	26.6%	1	0.2%	20	3.1%
Okitama	Takahata Town	Municipality	Standard DPC hospital	612	3	0.5%	328	53.6%	89	14.5%	1	0.2%	0	0.0%
Shonai	Tsuruoka City	Medical Cooperative	Not DPC	541	4	0.7%	0	0.0%	90	16.6%	0	0.0%	7	1.3%
Shonai	Shonai Town	Medical Corporation	Standard DPC hospital	538	9	1.7%	25	4.6%	117	21.7%	2	0.4%	30	5.6%
Murayama	Yamagata City	Social Welfare Organization (Saiseikai)	Standard DPC hospital	524	4	0.8%	163	31.1%	86	16.4%	1	0.2%	18	3.4%
Okitama	Yonezawa City	Medical Corporation	Not DPC	439	2	0.5%	1	0.2%	129	29.4%	0	0.0%	0	0.0%
Murayama	Yamagata City	Medical Corporation	Not DPC	281	5	1.8%	0	0.0%	128	45.6%	2	0.7%	4	1.4%
Murayama	Sagae City	Municipality	Not DPC	249	3	1.2%	22	8.8%	81	32.5%	2	0.8%	2	0.8%
Mogami	Shinjo City	Medical Corporation	Not DPC	205	0	0.0%	80	39.0%	116	56.6%	0	0.0%	22	10.7%
Okitama	Oguni Town	Municipality	Not DPC	148	0	0.0%	5	3.4%	17	11.5%	1	0.7%	1	0.7%
Murayama	Tendo City	Medical Corporation	Not DPC	139	0	0.0%	60	43.2%	84	60.4%	0	0.0%	0	0.0%
Murayama	Tendo City	Municipality	Not DPC	135	2	1.5%	0	0.0%	12	8.9%	34	25.2%	0	0.0%
Murayama	Yamagata City	Medical Corporation	Not DPC	110	1	0.9%	0	0.0%	23	20.9%	0	0.0%	0	0.0%
Murayama	Yamagata City	Medical Corporation	Not DPC	107	2	1.9%	0	0.0%	27	25.2%	8	7.5%	19	17.8%
Murayama	Yamagata City	Medical Corporation	Not DPC	84	0	0.0%	9	10.7%	26	31.0%	1	1.2%	20	23.8%
Murayama	Kaminoyama City	Medical Corporation	Not DPC	78	1	1.3%	0	0.0%	9	11.5%	3	3.8%	2	2.6%
Okitama	Nanyo City	Other corporation	Not DPC	56	0	0.0%	1	1.8%	12	21.4%	0	0.0%	2	3.6%
Murayama	Asahi Town	Municipality	Not DPC	42	1	2.4%	27	64.3%	12	28.6%	1	2.4%	8	19.0%
Murayama	Higashine City	Medical Corporation	Not DPC	4	0	0.0%	3	75.0%	4	100.0%	0	0.0%	0	0.0%
Okitama	Nagai City	Other corporation	Not DPC	3	0	0.0%	3	100.0%	2	66.7%	0	0.0%	0	0.0%

Appendix 5. Percentage of missing values for mandatory inputs relating to risk correction for severity and patient attributes, for patients admitted with femoral fracture (number of patients seen between April 2014 and March 2020; excludes in-hospital deaths)

				Femoral fracture									
				Number of cases	Classification for		ADL (BI) at admission		ADL (BI) at discharge		BMI		
Attributes of medical institution				Total	Missing values	(%)	Missing values	(%)	Missing values	(%)	Missing values	(%)	
Medical zone	Municipality	Founding body	DPC group	8,529	231	2.7%	1,937	22.7%	1,538	18.0%	1223	14.3%	
Shonai	Tsuruoka City	Municipality	Standard DPC hospital	1,297	21	1.6%	417	32.2%	230	17.7%	587	45.3%	
Shonai	Sakata City	Local Incorporated Administrative Agency	Special DPC hospital	1,288	60	4.7%	231	17.9%	73	5.7%	219	17.0%	
Okitama	Kawanishi Town	Prefecture	Standard DPC hospital	1,079	47	4.4%	246	22.8%	325	30.1%	4	0.4%	
Murayama	Yamagata City	Municipality	Standard DPC hospital	790	20	2.5%	111	14.1%	91	11.5%	70	8.9%	
Murayama	Higashine City	Other corporation	Not DPC	653	23	3.5%	124	19.0%	188	28.8%	2	0.3%	
Mogami	Shinjo City	Prefecture	Standard DPC hospital	560	10	1.8%	280	50.0%	239	42.7%	115	20.5%	
Murayama	Yamagata City	Social Welfare Organization (Saiseikai)	Standard DPC hospital	520	4	0.8%	204	39.2%	104	20.0%	6	1.2%	
Okitama	Yonezawa City	Other corporation	Standard DPC hospital	364	1	0.3%	1	0.3%	6	1.6%	83	22.8%	
Murayama	Kahoku Town	Prefecture	Standard DPC hospital	308	7	2.3%	95	30.8%	86	27.9%	42	13.6%	
Murayama	Yamagata City	Prefecture	Special DPC hospital	305	25	8.2%	71	23.3%	33	10.8%	22	7.2%	
Shonai	Shonai Town	Medical Corporation	Standard DPC hospital	255	0	0.0%	2	0.8%	7	2.7%	0	0.0%	
Okitama	Yonezawa City	Municipality	Standard DPC hospital	252	0	0.0%	34	13.5%	39	15.5%	47	18.7%	
Murayama	Kaminoyama City	Medical Corporation	Not DPC	165	0	0.0%	0	0.0%	2	1.2%	0	0.0%	
Murayama	Yamagata City	Medical Corporation	Not DPC	147	5	3.4%	0	0.0%	12	8.2%	0	0.0%	
Murayama	Sagae City	Municipality	Not DPC	140	0	0.0%	19	13.6%	17	12.1%	0	0.0%	
Murayama	Yamagata City	National University Corporation	University hospital	107	1	0.9%	12	11.2%	28	26.2%	7	6.5%	
Murayama	Yamagata City	Mutual Aid Association/Federation	Standard DPC hospital	90	0	0.0%	23	25.6%	21	23.3%	5	5.6%	
Murayama	Yamagata City	Medical Corporation	Not DPC	87	3	3.4%	18	20.7%	25	28.7%	14	16.1%	
Murayama	Tendo City	Medical Corporation	Not DPC	61	4	6.6%	46	75.4%	10	16.4%	0	0.0%	
Okitama	Yonezawa City	Medical Corporation	Not DPC	51	0	0.0%	3	5.9%	2	3.9%	0	0.0%	
Shonai	Tsuruoka City	Medical Cooperative	Not DPC	10	0	0.0%	0	0.0%	0	0.0%	0	0.0%	