Comparison of Treatment Outcomes of Acute Care Hospitals in Okitama Secondary Medical Care Zone of Yamagata Prefecture*

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Abstract

This paper compares the treatment outcomes of the three major acute care hospitals in Okitama secondary medical care zone of Yamagata prefecture. At present, each prefecture is adjusting the supply of hospital beds so that the supply plans meet the estimated demand of each region in 2025, basically reflecting changes in demography. At the national level, currently there are too many acute care beds and too few convalescence (recovery) care beds compared to the estimates. Such qualitative and quantitative shift in each region is one of the most challenging issues facing regional hospitals. To evaluate the current situation of the regional acute care, this paper compares among the three hospitals mortality rates, length of hospital stays, Barthel Index (BI) of activities of daily living (ADL) at discharge, and changes of BI per day of hospitalization. Specifically, statistical differences in hospital acute care in heart failure, myocardial infarction, stroke, pneumonia, and femoral fracture are discussed. Though there was no statistical difference in mortality rate across the three hospitalsin the region, we observed several differences in length of hospital stay and ADL at discharge. The results suggest the difficulty in consistently achieving the efficient length of

* This article is based on a study first published in the Financial Review, No. 148, pp.94-128, Ito, Y., T. Ikeda, S. Kanke, R. Kassai, and M. Murakami, 2022, Comparison of treatment outcomes of acute care hospitals in Okitama Secondary Medical-care Area of Yamagata Prefecture, written in Japanese.

We would like to thank Professor Yoko Ibuka and Professor Takashi Oshio for their valuable advice and comments. We also thank Oliver Stanyon for proofreading the body of this manuscript. The authors (Ito and Murakami) acknowledge a research grant (JPMJRX18B4) from RISTEX "Science of Science, Technology and Innovation Policy."

hospital stays on one hand and ensuring the effective functional recovery of patients on the other hand. Furthermore, we point out some inadequate reports of personal data when comparing treatment outcomes, which lead to some biased and unclear measurements for regional hospital performances.

Keywords: Barthel Index, activities of daily living (ADL), length of hospital stay
JEL Classification: H51, I10

I. INTRODUCTION

In this study, we compare the treatment outcomes for patients with one of five acute medical conditions (heart failure, myocardial infarction, stroke, pneumonia, and femoral fracture) admitted to different hospitals in the secondary medical care zone of Okitama, Yamagata Prefecture, in northern Japan.[1] For this analysis, we use hospital admission records between April 2014 and March 2020 for the three major emergency hospitals in the area: Okitama General Hospital (Kawanishi Town, 520 beds), Yonezawa City Hospital (Yonezawa City, 322 beds), and Sanyudo Hospital (Yonezawa City, 190 beds). Appendix 1 provides an overview of each facility. Okitama General Hospital, the largest hospital in the region, established in 2000, is a tertiary emergency hospital with only acute care beds, while Yonezawa City Hospital and Sanyudo Hospital are secondary emergency hospitals offering beds for both acute and non-acute (i.e., longer-term rehabilitative and chronic) care.

The three acute care hospitals that we examine in this paper have similar characteristics in terms of their geography, climate, lifestyle, demographic composition, and transportation access. We believe that conducting our comparison of treatment outcomes within a single, specific medical area, using the actual names of the medical institutions involved, increases the academic validity of the study. In addition, this approach is necessary to make the current status of the local healthcare delivery system more transparent and to enable objective, evidence-based policies to be developed for the benefit of local residents.

As shown in Table 1, Yonezawa City Hospital and Sanyudo Hospital are scheduled to undergo functional reorganization in 2023 through the establishment of a "Regional Medical Collaboration Promotion Corporation." The two hospitals, located only 2.5 km apart in a region where the population is decreasing, were seen as inefficient because of their overlapping acute care functions and unclear divisions among other medical services, leading Yone-

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[1] A secondary medical care zone is an area established by the prefectural government to provide complete general inpatient care, including emergency medical care. It is usually composed of multiple municipalities, selected on the basis of population and the flow of inpatients into and out of the prefecture. Prefectures formulate their health and medical care plans at the level of secondary medical care zones, identifying necessary numbers of physicians and quantitative requirements for hospital beds accordingly. Primary medical care refers to routine medical care, centering on outpatient care at clinics, etc., and is generally zoned at municipality level. Tertiary medical care refers to severe diseases, special medical care, and advanced medical care, with prefectures as the geographic zone for care provision. See Sato et al. (2020).

Table 1. Background of the functional reorganization of acute care hospitals in Yonezawa City

January 2017	Establishment of "Yonezawa City Medical Cooperation Review Committee" (recommendations published November 2017), which proposed the merger of Sanyudo Hospital and Yonezawa City Hospital under a Regional Medical Collaboration Promotion Corporation
February 2018	Plan submitted to the City Council to rebuild Yonezawa City Hospital on the same site and to relocate Sanyudo Hospital to an adjacent site
January 2021	Yonezawa City, Sanyudo, and Sanyudo Rehabilitation Hospitals designated as "Priority Support Area" by the Ministry of Health, Labour and Welfare
2023 (planned)	Establish a Regional Medical Collaboration Promotion Corporation • Total number of beds will decrease from 627 to 469 • Yonezawa City Hospital will be reorganized from 322 beds to approximately 270 beds (specializing in acute care) • Sanyudo Hospital (185 beds) and Sanyudo Rehabilitation Hospital (120 beds) will be combined, creating a new hospital in the city with about 199 beds (specializing in rehabilitative and chronic care)

Sources: Yonezawa City (2018) "Yonezawa City Policy on How Medical Cooperation Should Be" and Health and Welfare Department, Yamagata Prefecture (January 22, 2021) "Selection of Priority Support Areas by the Government for the Realization of the Regional Medical Care Initiative"

zawa City to establish a committee to review the hospitals' functions in 2017. In January 2021, the Okitama secondary medical care zone was designated as a "Priority Support Area" by the Japanese government, and in response to various factors, including patient competition, difficulties in physician recruitment, and management sustainability concerns, the functional reorganization and restructuring of the two hospitals was proposed. The analysis in this paper enables functional differentiation between the two hospitals to be compared before and after their planned reorganization and integration in 2023. There are few papers, both domestically and internationally, that compare the quality of clinical care in this way. We believe that this paper can serve as a foundation for such before-and-after comparisons. In addition, we believe that an analysis of treatment outcomes at both hospitals will contribute to discussions on the overall quality of medical care for local residents and the future division of functions with Okitama General Hospital (as a tertiary emergency medical institution) in the same region.

In the literature, treatment outcomes are generally measured from two broad perspectives: health status (health records) and patient satisfaction (user evaluations). Both measures have been the subject of abundant research in Japan and overseas.[2] In this paper, we

[2] Campbell et al. (2000) provide a comprehensive review of treatment outcome measures. Valdmanis et al. (2008) and Shwartz et al. (2008) discuss the association between hospital management indicators and quality indicators. Normand et al. (2008) and Geweke et al. (2003) provide a detailed discussion on how to estimate treatment quality.

specifically focus on the former, making comparisons using "diagnosis procedure combination (DPC)/per-diem payment system" hospital admissions data (hereafter, DPC data), which are anonymized records of individual admissions to hospitals that use the DPC payment methodology. These records include the primary reason for admission, other health condition-related information, and medical costs incurred during the hospitalization. Because DPC data have the same format for hospitals nationally, they can be widely applied for comparisons within and across regions.[3]

Amin et al. (2020), Shinjo and Fushimi (2017), and others used DPC data to compare treatment outcomes, such as mortality rates, after controlling for individual attributes and the severity of the main disease at the time of admission. While these studies have the advantage of identifying national trends by analyzing anonymized records from acute care hospitals across the entire country, there remains the possibility that unobservable differences in regional attributes may be overstated as differences in hospital treatment quality. In addition, because these studies are not designed to compare specific medical institutions, they do not directly link to discussions on quality comparisons between hospitals and the functional reorganization of medical institutions as a tool of local administrative policy. To overcome these issues, in this paper, we compare the differences in treatment outcomes among multiple emergency hospitals in the same secondary medical care zone, where local residents rely on nearby hospitals for rapid emergency treatment. By doing so, we aim to contribute directly to discussions on the pros and cons of functional division and reorganization in regional medical care provision.

Because the analysis is limited to a single area, the number of observations of statistically comparable medical conditions is limited. However, because the background regional characteristics are the same, the possibility of omitted variable bias is reduced. We therefore believe that we can show differences in treatment outcomes between hospitals for major acute conditions with minimal statistical bias.

As indices for individual treatment outcomes, we use mortality rate, length of hospital stay, and activities of daily living (ADL) at discharge (as measured by the Barthel Index (BI)), extracted from DPC data. Where individual records are available, we also check the difference in ADL between hospital admission and discharge, and evaluate the change in ADL per day (the difference in BI between the time of admission and discharge, divided by the total number of days of hospitalization). As a treatment outcome index, a lower mortality rate implies that the treatment is more effective. Similarly, a shorter length of hospital stay implies a more efficient treatment, owing to the inpatient treatment taking a shorter period of time to reach the set recovery level for that clinical pathway. However, a reduced length of hospital stay may also be motivated by management efficiency rather than treatment efficiency; this is due to the DPC reimbursement methodology, whereby per-day hospital fees decline as the number of days of hospitalization increases. ADL (as measured by

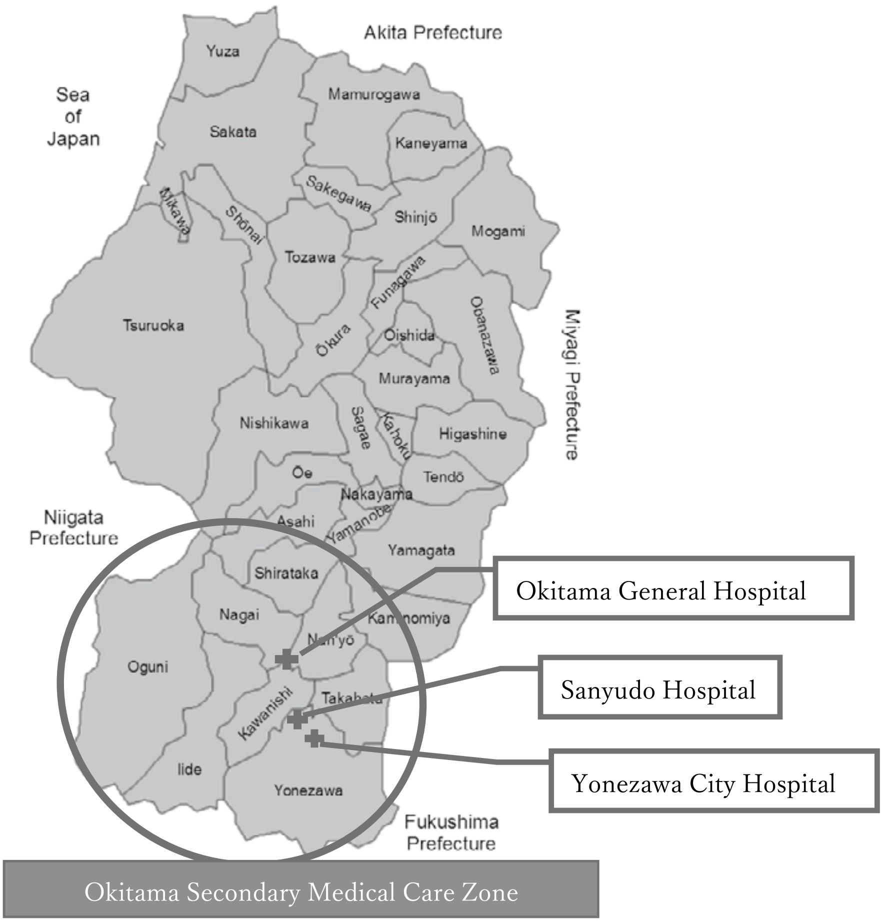
[3] Our focus on health status records is not intended to downgrade the value of patient satisfaction surveys. Mizuno et al. (2020), Issac et al. (2010), and O'Hara et al. (2018) argue that patient surveys are appropriate as a measure of safety management and quality of care in medical institutions.

BI) is commonly used in academic studies as a highly objective and consistent index to measure the degree of recovery of patients' physical functions. In this paper, by additionally evaluating changes in ADL (BI) per day, we also aim to represent the clinical efficiency and effectiveness per day of hospitalization.

Figure 1 shows the area of the Okitama secondary medical care zone that forms the subject of our analysis. Its total population is 202,000 (as of 2020). It contains multiple hospitals with acute care designation, but the top three hospitals, comprising 90% of all DPC hospital admissions in the Okitama zone in 2019, are those we focus on in this study: Okitama General Hospital, Yonezawa City Hospital, and Sanyudo Hospital, representing 51.4%, 28.2%, and 10.2% of DPC admissions, respectively. Okitama General Hospital mainly serves the patient population in eastern and western Okitama, while Yonezawa City Hospital and Sanyudo Hospital mainly serve patients in Yonezawa City.

In Japan, owing in part to the dispersed, low-density provision of medical care, it is difficult for all local hospitals to stay open to provide stable levels of emergency care to pa-

Figure 1. Yamagata Prefecture and Okitama secondary medical care zone



tients at all times. For this reason, emergency rotation (hospital group rotation) systems are often used as a means of guaranteeing local residents access to out-of-hours emergency medical care (i.e., at night, at weekends, and on public holidays) while reducing the operational strain on individual medical institutions. Many regions employ such a system, with a total of 2,851 hospitals (corresponding to 73% of emergency hospitals) participating nationally, according to the Ministry of Health, Labour and Welfare's (MHLW; 2019) "Survey of Medical Facilities."[4] In 1987, Yonezawa City introduced its own hospital group rotation system. Currently, Yonezawa City Hospital carries out this role for 18 days per month, and the private Sanyudo Hospital for 10 days per month.[5]

Rotation systems do not necessarily aim for homogeneity in the quality of medical care among participating hospitals. However, if the quality of care among those hospitals in an emergency rotation system differs greatly, residents may perceive this difference as a problem and demand improvements.[6] Even if the quality of care is comparable among a certain group of participating hospitals, residents may still be in favor of a consolidation of services and personnel to achieve more stability in local medical care provision. Given the fact that mortality rates and prognoses differ significantly among hospitals in many rotation systems, despite similar patient characteristics and levels of severity, the rotation system is considered to lack fairness for some urgent conditions and diseases that fall under national medical care policy.[7]

In discussing the pros and cons of continuing the hospital group rotation system, it is also important to consider whether certain levels of treatment process and treatment outcome can be statistically guaranteed, regardless of which emergency rotation hospital is used. However, there has been very limited real-world data analysis of the differences between hospitals in a specific region or within a group rotation system, partly because of the risk of reputational damage to hospitals. For example, Fudo et al. (2016) assumed a hypothetical secondary medical care zone when conducting their simulation of the differences in the operational burden on medical institutions and the differences in the time required for transport between hospitals with and without hospital group rotation.

When using real-world data, it is inappropriate to compare medical institutions solely on the basis of their aggregate mortality rate or average length of hospital stay. This is because selection bias arises as a result of treatment outcomes being naturally lower in hospitals with a higher proportion of critically ill or older patients at the time of admission. Therefore, in this study, we consider differences in patient condition from the time of admission to time of

[4] Based on data from the MHLW "18th Study Group on the Emergency and Disaster Medical Care Provision System" (November 20, 2019).

[5] Yonezawa Medical Association's website shows the rotation table per month. (http://www.omn.ne.jp/~isikai/cgi/kanri/rinban.cgi?md=2&type=2). In the hospital group rotation system, Funayama Hospital in Yonezawa City is also in charge of two days per month.

[6] While the rotation system is intended to reduce the operational burden on local medical institutions rather than guarantee the same quality of medical care among them, there is legitimate concern as to whether it is appropriate that the system distributes this responsibility to small- and medium-sized medical institutions in this way.

[7] Treatment is not necessarily completed only at the single hospital on duty under the the rotation system, and patients may be transferred to other emergency hospitals. Therefore, differences in treatment between medical institutions are unlikely to become a major problem unless the disease requires rapid treatment following onset.

discharge to enable the change in outcomes over the course of the entire hospitalization to be assessed. Furthermore, we examine data for urgent conditions for which the number of cases is large and the timeliness of treatment is important: heart failure, myocardial infarction, stroke, pneumonia, and femoral fracture.

By comparing health records for individual patients, we show statistical differences (fixed effects) between hospitals after controlling for the severity of the individual's primary reason for admission, the degree of complications, and patient attributes, such as age and presence of nursing care prior to hospitalization. This approach also corrects for the possibility of differences in the respective characteristics of the patient populations of Okitama General Hospital, which specializes in acute care, and Yonezawa City Hospital and Sanyudo Hospital, which have comprehensive community care units (CCCU) and offer a mix of acute and non-acute care.

Sustaining emergency care has become a major nationwide challenge, particularly against a background of declining populations, the changing nature of diseases, aging hospital facilities, physician shortages, and a lack of financial resources to support national policy-based medical care. Furthermore, the spread of COVID-19 since February 2020 has forced a reassessment of local emergency medical care provision and the fragile systems of individual medical institutions, making it a higher priority to encourage reorganization and integration. However, the debate has become muddled in some regions, where reorganization and integration have halted rather than hastened, partly as a result of the pandemic.[8]

It is important to objectively present the condition-specific treatment outcomes of medical institutions and to increase the transparency of such information. In an environment where differences in treatment quality are not transparent, discussions on reorganization and consolidation are influenced solely by connections with local councils and the emotionally led views of local residents. This is a major problem from the perspective of providing sustainable local healthcare services in the long term.

This paper is organized as follows. Section 2 presents the data and basic statistics used for the treatment outcome measures in our analysis. Section 3 presents our analytical methodology and results. Section 4 discusses our findings, and Section 5 presents our conclusions.

II. DATA

The DPC data that we use in this analysis comprises individual (anonymized) patient hospitalization records for admissions to the three subject hospitals between April 2014 and March 2020 (fiscal year [FY] 2014-2019). We do not analyze hospitalizations in previous years because of a change in the data items included in DPC records from FY 2014 onwards. The data for the six-year period from April 2014 to March 2020 for admissions to Okitama General Hospital, Yonezawa City Hospital, and Sanyudo Hospital are shown in Table 1.

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[8] Although there are many empirical results on the effects of hospital reorganization both in Japan and overseas, the regional and institutional backgrounds are diverse, making it difficult to determine the overall effects of hospital reorganization on quality of care in Japan. The results also vary widely (Beaulieu et al., 2020; Gaynor and Town, 2011; Short and Ho, 2020). Other studies have discussed the effects of hospital alliances as opposed to consolidation (Hasnain-Wynia et al., 2007).

We include patients aged 18 years or older whose main reason for hospital admission was heart failure, myocardial infarction, stroke, pneumonia, or femoral fracture. These conditions were selected owing to their emergency nature (i.e., the urgent need for acute care at a nearby hospital, usually in the patient's local area) and because they represent a large number of cases in the dataset.[9] Specifically, in terms of the International Classification of Diseases, 10th Revision (ICD-10) classifications, the following records were included in the analysis: patients with heart failure coded as I110, I500, I501, or I509; patients with myocardial infarction coded as I21 or I22; patients hospitalized within 3 days of stroke coded as I60, I61, or I62; patients with pneumonia coded as J12-J18; and patients who underwent surgery for one-sided femoral fracture coded as S720 or S721.[10]

The outcome measures include in-hospital mortality, length of hospital stay, ADL at discharge (as measured by BI), difference in ADL at admission and discharge (difference in BI), and change in ADL per day of hospital stay (change in BI per day).[11]

First, we note the differences in the level of aggregate information among the three hospitals. Appendix 2 presents a group comparison of the mean values of treatment outcomes by one-way ANOVA for the differences in length of hospital stay, BI at admission, BI at discharge, and change in BI between admission and discharge for each of the five acute conditions analyzed. Statistically significant differences at the 1% level were found for all conditions and all items, although it is necessary to bear in mind that the results are not risk-adjusted for individual severity of condition.

The average medical costs per admission (unit cost per hospitalization) for all five conditions were higher at Yonezawa City Hospital and Sanyudo Hospital, which are secondary emergency hospitals, than at Okitama General Hospital, which is a tertiary emergency hospital. The unit costs per hospitalization were ¥106,000-¥212,000 for heart failure, ¥23,000-¥113,000 for stroke, ¥169,000-¥390,000 for pneumonia, and ¥302,000 to ¥571,000 for femoral fracture.[12] These differences are largely due to variations in the length of stay among the hospitals. After appropriately correcting for individual risk, the average length of hospital stay was estimated to be 1.5 to 2.5 times higher at the secondary emergency hospitals than at the tertiary emergency hospital. If these differences in unit cost do not come with a guaranteed commensurate increase in quality of treatment, these hospitalization costs can be considered excessive.

[9] According to the MHLW's definition of medical functions, medical facilities are primarily classified into highly acute phase, acute phase, rehabilitative (recovery) phase, and chronic phase, in accordance with the density of medical treatment provided, or specifically, the amount of medical resource investment per day.

[10] The pneumonia category in this paper does not include aspiration pneumonia (ICD-10 classification J690), which is a common subacute disease in older people. J12 (viral pneumonia), J13 (pneumonia caused by Streptococcus pneumoniae), J14 (pneumonia caused by Haemophilus influenzae), and J15-18 (pneumonia caused by bacteria or other infectious agents) are included.

[11] This paper uses BI as a measurement of ADL. BI consists of 10 items: eating, transferring, dressing, toileting, bathing, walking (transferring), climbing stairs, changing clothes, defecating, and urinating. Each of these items is scored on a scale of 10 (independent), 5 (partial assistance), and 0 (full assistance), respectively, to give an overall score of 0-100.

[12] The unit cost per hospitalization here is calculated as the sum of DPC fixed fees, DPC variable (per-service) fees during the defined hospitalization period, DPC variable (per-service) fees outside the defined hospitalization period, and functional/adjustment coefficients for the specific medical institution, for each fiscal year.

II-1. Heart Failure

II-1-1. Heart Failure

Table 2 presents a comparison of the attributes of patients with heart failure, including age, sex, independence in daily living classification for older people with dementia, and whether nursing care was being provided prior to hospitalization.[13] Furthermore, as indicators of severity at the time of hospitalization, we compare BI, Charlson Comorbidity Index (CCI; a weighted score that predicts the risk of death for hospitalized patients with multiple comorbidities, with each specific comorbid condition being scored from 1 to 6 at the time of hospitalization), and whether the patient was brought to hospital by emergency transport. In addition, four New York Heart Association (NYHA) classifications from I (mild) to IV (severe) are shown as indicators of the severity of the heart failure on admission.[14]

These attributes are required to be reported in DPC Form 1 (the reporting form for each discharged case), and are useful in verifying treatment outcomes that take into account the severity of the patient's condition on admission. However, in reality, as seen in Table 2, there are missing values. For example, in Okitama General Hospital, 20% of the BI scores at admission and 56% of all NYHA classifications are missing. When the urgency of the condition is particularly high, providing rapid treatment is generally prioritized over measuring and recording the various severity scores. This creates a possibility of selection bias, whereby severe cases are biased toward samples with missing information. Another problem is that missing scores not only suggest that a patient's condition was particularly severe, but can also vary from institution to institution and department to department. For example, at Sanyudo Hospital, there are no missing reported values for BI at admission or discharge (excluding deaths at discharge). At Yonezawa City Hospital, only 13% of all cases are missing the NYHA classification, which is lower than the other two hospitals and suggests more consistent reporting. In Appendix 3, we examine the association between missing information and severity of condition (described in more detail in Section III-5).

Overall, the average length of hospital stay is 18 days at Okitama General Hospital, but 27 to 28 days at the other two hospitals, indicating a trend toward longer hospital stays. However, while there are limitations in the comparison, there is no statistically significant difference in severity at the time of admission among the institutions in terms of patients who were receiving nursing care prior to hospitalization, CCI, and being brought to hospital

[13] In the criteria for determining the level of independence in daily living for older people with dementia, an index of "Degree III" or higher indicates that the person requires nursing care, and "M" indicates that the person exhibits significant psychiatric symptoms. In the long-term care insurance system, this index is used as a reference point for an initial computerized determination and for the long-term care certification examination board's decision, as well as in the certification survey and the main physician's written opinion.

[14] The New York Heart Association has developed a chart to show subjective symptoms caused by physical activity, available from the Japan Cardiovascular Society / Japan Heart Failure Society (Guidelines for the Treatment of Acute and Chronic Heart Failure, 2017 revised edition, p. 13): https://www.j-circ.or.jp/guideline/pdf/JCS2017_tsutsui_h.pdf. The heart failure stages indicated by MHLW correspond to the NYHA classification, but in the DPC system, data entry of these classifications is only required for patients with heart disease corresponding to codes I110, I130, I132, I270, I272, and I279 (not I500 and others).

by ambulance.

II-1-2. Myocardial Infarction

Patients with myocardial infarction (with surgery) have been representative subjects in previous studies in Japan and overseas to validate indicators of treatment outcomes in acute care.[15] In this study, although the data include only approximately 500 cases in total, we determined that certain comparisons can be made have therefore analyzed the data.

Table 3 presents a comparison of the attributes of patients undergoing surgery related to myocardial infarction, for which the Killip classification is used as an index of severity. Unlike the NYHA classification, which is based on subjective symptoms, the Killip classification is classified into groups I (mild) to IV (severe) according to the presence or absence of rales, venous stasis, pulmonary edema, cyanosis, and other heart failure symptoms, on the basis of clinical findings in the chest.

All but two patients underwent percutaneous coronary angioplasty (PTCA). In terms of differences between the institutions, patients at Sanyudo Hospital had relatively high severity of condition on admission, which may have led to a lower BI at the time of discharge.

II-2. Stroke

Table 4 presents a comparison of patients admitted to the three institutions within three days of having a stroke. The type of stroke (subarachnoid hemorrhage, cerebral hemorrhage, or cerebral infarction) and the Japan Coma Scale (JCS) classification are used as indicators of severity. The JCS classifies the level of consciousness of patients with impaired consciousness, such as in the acute phase of cerebrovascular disease or head injury, into 0 (clear), and 1 digit (mild) to 3 digits (severe).

For each hospital, 5%-7% of patients had subarachnoid hemorrhage, 17%-24% had cerebral hemorrhage, and 73%-78% had cerebral infarction. Thrombolysis using intravenous alteplase (tPA), which is supposed to be administered within 4.5 hours of onset, was applied in 7%-12% of cases.

Regarding differences by institution, the higher average JCS score for patients at Sanyudo Hospital indicates a higher average degree of severity. Because there are no missing values for JCS or type of stroke, these can be used as a correction for severity.

Nakao et al. (2010) and Wilkinson et al. (1997) examined the validity of ADL indices such as BI. Nakao et al. (2010) found that, although BI is a valid measure of functional prognosis after cerebral infarction, because many patients are immobile when they arrive at hospital, the value is necessarily low, making it unsuitable as an assessment at the time of admission.

[15] Although many studies use mortality, Higuchi et al. (2016), in analyzing the prognosis of acute cardiovascular disease, showed that ADL scores are predictive indicators of patients' functional and vital outcomes (1-year survival).

II-3. Pneumonia

Table 5 shows the comparison of patient attributes among those admitted to the subject hospitals for pneumonia. The A-DROP score is used as an index of severity, which is calculated on the basis of age, dehydration, oxygen saturation, orientation disturbance, and blood pressure. A score of 0 is classified as mild, 1-2 as moderate, 3 as severe, and 4-5 as very severe.

A total of 607 patients under the age of 18 were hospitalized for pneumonia during the study period. Of these, 512 were admitted to Yonezawa City Hospital, where treatment facilities for pediatric pneumonia have been consolidated. Although the analysis in this study was limited to 2,844 hospitalizations of patients aged 18 or older, reorganization and consolidation of acute care functions for younger patients, such as pediatric emergencies and perinatal care, are also major issues in community medicine.

II-4. Femoral Fracture

Table 6 presents a comparison of the attributes of patients admitted to the three study hospitals for surgery for one-sided femoral fractures. Such femoral fractures are more common among older women, and approximately 80% of the patients admitted to each hospital with this condition are women. Prolonged immobility resulting from femoral fracture often leads to further complications such as muscle weakness and pneumonia, and although the risk of death from femoral fracture itself is low, the prognosis for return to baseline function is poor. In order to reduce these possibilities, early surgery and early rehabilitation are desirable. In the case of femoral neck fractures, bone healing is difficult to achieve, and therefore the severity of the condition is considered to be high.

Comparing the three hospitals, the major characteristic to be noted is that femoral fracture treatments are mainly concentrated at Okitama General Hospital. This may be because Okitama General Hospital has the most extensive orthopedic care center in the region, and therefore patients are often transported there owing to the need for early surgery.[16]

In terms of the treatment outcomes, while there was no significant difference in the site of femur fracture or living environment prior to admission among patients at the three hospitals, the average length of hospital stay at Yonezawa City Hospital was extremely long. In contrast to the other two hospitals, which have affiliated rehabilitative care facilities within their respective hospital alliance groups, Yonezawa City Hospital treats a mixture of patients in the acute, rehabilitative, and chronic phases in a single facility.

[16] Rachet-Jacquit et al. (2021) used the United Kingdom as an example to examine whether consolidating treatment centers for femoral fractures (to achieve economies of scale) made a difference to treatment outcomes such as 6-month mortality. Femoral fractures are a key condition to be considered in the analysis of acute care.

III. METHODS AND RESULTS

III-1. Heart Failure

III-1-1. Heart Failure

To examine in-hospital mortality (Table 7-A, left), we conducted a Probit analysis using death (= 1) and survival (= 0) as outcomes. The explanatory variables were age, sex, use of emergency transport to hospital (yes/no), route of admission, CCI, year of observation, and medical institution. We used the same explanatory variables in the analysis of each condition, except for severity indices (NYHA classification in the case of heart failure), which were condition-specific.

We found that mortality rate increases with age, and is significantly higher at the 1% level for patients aged 90 years and older. The higher the severity of heart failure on admission, the higher the mortality rate, which is significant at the 1% level for NYHA classification IV. The mortality rate was high in cases where a patient was already receiving long-term care (e.g., in a nursing home) prior to hospitalization. However, sex, use of emergency transport, degree of complications, and yearly effects were not significant.

The mortality rates of the three hospitals were 10% (109 of 1,087 cases) at Okitama General Hospital, 14% (107 of 766 cases) at Yonezawa City Hospital, and 17% (121 of 724 cases) at Sanyudo Hospital. One reason for this difference may be the decision of ambulance personnel to transport patients with a high chance of survival to the tertiary emergency hospital. Another reason may be sample bias due to missing NYHA classifications in the data. The number of patients with a missing NYHA classification was 611 at Okitama General Hospital, 97 at Yonezawa City Hospital, and 451 at Sanyudo Hospital. Whether these missing data points occur randomly or are biased toward severe cases warrants careful examination. In our analysis of the association between missing information and case severity (presented in Appendix 3 and discussed further in Section III-5) we did not find evidence of sample bias toward severe cases.

We conducted a Poisson analysis on the length of hospital stay, excluding in-hospital deaths (Table 7-A, right). The discharge destination (returning home, entering a care facility, or transfer to another hospital) was added as a further explanatory variable. We found positive and statistically significant correlation for age, severity of condition (NYHA classification), and severity of complications. The length of stay for patients who were not discharged home, particularly for those who were transferred to another institution, was also statistically significant. This may be due to the fact that patients who can return home tend to have a lower severity of condition, and that it is difficult to find another hospital or institution to which patients whose condition is severe can be transferred. In addition, the yearly effect is significant, with the average length of hospital stay generally being longer in the later years of the study period. Although it is difficult to determine the exact reasons for this, the fact that patients are aging (in line with Japan's increasingly older population) makes it harder to coordinate their discharge from hospital. Having sufficient numbers of carers working in the community to support patients after the acute stage is also considered critical for acute care institutions to operate efficiently.

In terms of differences by hospital, the lengths of stay at Yonezawa City Hospital and Sanyudo Hospital were significantly longer than that at Okitama General Hospital, with a difference in average length of stay of approximately 10 days. Even after controlling for key patient characteristics, this difference in length of stay is statistically significant. In addition, our analysis suggests that the ADL recovery of patients staying in hospital for longer periods is not commensurate with the medical resources invested over those additional days of hospitalization.

To investigate ADL at discharge as a treatment outcome, we applied a Tobit model (Table 7-B, left), with upper and lower bounds, using BI score at discharge (0–100) as the explained variable. The explanatory variables are the same as those in Table 7-A. We found ADL levels to be in accordance with age and severity of condition. The level of independence in daily activities was lower for women, and also lower for those brought to hospital by ambulance (and thus hospitalized to the emergency room), which is an indicator of the severity of their condition.

The BI at discharge for Sanyudo Hospital was significantly lower than that for the other hospitals, although there were no missing records for this hospital. By contrast, approximately 20% of BI values at admission and discharge were missing for patients at Okitama General Hospital, which may indicate a selection bias whereby records might be missing in severe cases (Appendix 3 and Section III-5).

Such biases are also observable in comparing the difference in ADL (BI) at admission and discharge (Table 7-B, center). In order to account for the characteristic that the difference in BI between admission and discharge (degree of improvement) is higher when the BI at admission is very low, we added BI at admission and length of hospital stay as explanatory variables to the linear analysis. The results were not significantly different from those of the analysis of ADL at discharge, but the differences between hospitals were no longer significant.

Change in ADL (BI) per day (Table 7-B, right) is an indicator of the pace of functional recovery. However, because the analysis excludes deaths and missing data, the results are based on only 925 out of the total of 1,315 heart failure cases. The treatment outcomes for this factor are similar to the outcomes of the other analyses, with the improvement in BI being lower when the discharge was a transfer to a different hospital.

In this analysis, the daily change in BI for Yonezawa City Hospital and Sanyudo Hospital was significantly negative, albeit by only about 1 point out of 100, and the degree of improvement was lower than that of the public Okitama General Hospital. This may be due to the fact that Yonezawa City Hospital and Sanyudo Hospital had longer hospital stays, while the difference in ADL between admission and discharge was similar. In addition, there were cases where the BI at discharge was lower than the BI at admission, occurring in 26 of 944 cases (2.7%) at Okitama General Hospital, 46 of 609 cases (7.6%) at Yonezawa City Hospital, and 43 of 594 cases (7.2%) at Sanyudo Hospital, suggesting that prolonged hospitalization may make it difficult to improve treatment outcomes in terms of ADL.

III-1-2. Myocardial Infarction

In our Probit analysis of mortality rates for myocardial infarction (Table 8-A, left), mortality increased with increasing age, and was significant at the 5% level for patients aged 90 years or older. Mortality also increased with increasing severity (measured by Killip classification), and was significant at the 1% level for Killip classification IV. However, sex, use of emergency transport, degree of complications, and yearly effects were not significant. The mortality rate was lowest at Sanyudo Hospital, which was significant at the 5% level.

When deaths are excluded, the length of hospital stay (Table 8-A, right) is significantly longer for older patients and for patients with a higher Killip classification. A long hospital stay is also a statistically significant feature in cases where the discharge destination is transfer to another hospital. Similar to the case of heart failure, this may be due to the fact that patients who can return home are less severely ill, and that it takes a longer time to coordinate and arrange transfer to other hospital facilities for those who need them. The yearly effect is not significant in length of hospital stay. The difference between hospitals was that the length of hospital stay at Yonezawa City Hospital and Sanyudo Hospital was significantly longer than that at Okitama General Hospital. This trend is similar to that observed for heart failure.

The level of ADL at discharge, as measured by BI (Table 8-B, left), is also associated with age and severity of condition. The level of functional independence was lower for women (5% significance level) than for men. Although no significant yearly effect was found, the BI at discharge from Yonezawa City Hospital was significantly higher (at the 5% level).

In our comparison of the difference in ADL (BI) between admission and discharge (Table 8-B, center), the improvement in BI tended to be significantly lower when the route of admission was from a nursing home or other care facility and when the discharge destination was transfer to another hospital. This suggests that it is difficult to improve BI if the patient had an ADL requirement for nursing care before hospitalization. The difference among the three hospitals was not significant. However, in terms of the degree of improvement in BI per day (Table 8-B, right), the scores in Yonezawa City Hospital and Sanyudo Hospital are significantly lower (typically 2-2.8 points lower than that of Okitama General Hospital). As was the case for heart failure, there was no significant variation in the ADL difference between admission and discharge between the two hospitals, but this may have been caused by the longer average length of hospital stay at these institutions.

III-2. Stroke

To compare mortality among patients admitted to hospital after having a stroke (Table 9-A, left), we performed a Probit analysis using the primary category of stroke and JCS classification as explanatory variables for severity. First, subarachnoid hemorrhage was associated with a significantly higher mortality rate (the marginal effect on mortality for subarachnoid hemorrhage is also significant, with an 11.7% increase in mortality). Mortality was higher with increasing age, and significant at the 1% level for patients aged 80 and older. The mortality rate increased with increasing severity, as measured by the JCS index, and CCI (index for the degree of complications) was also significant at the 5% level. The mortality rate for patients transported to hospital by ambulance was high and significant at the 1% level. No significant differences in mortality rates were observed between hospitals.

Regarding length of hospital stay (Table 9-A, right), the number of days spent in hospital (excluding deaths) was significantly longer for patients aged 60 to 89 than for patients aged below 60. As observed in other clinical studies, subarachnoid hemorrhage and cerebral hemorrhage resulted in significantly longer hospital stays (1% significance level) compared with those for cerebral infarction. As our results for heart failure and myocardial infarction also indicated, the average length of hospital stay for patients discharged to other care facilities or transferred to another hospital was significantly longer than that for patients discharged to their own home. In terms of yearly effects, hospital stays were significantly shorter in later years of the study period, such as FY 2018 and FY 2019. Comparing the difference between hospitals, the length of hospitalization at Sanyudo Hospital is significantly shorter than that at Okitama General Hospital. One of the features of Sanyudo Hospital is that it has been expanding its functional provision for recovery-stage patients, establishing a rehabilitation program at its affiliated institutions. These efforts may have contributed to the shorter average length of hospital stay.

ADL (as measured by BI) at discharge (Table 9-B, left) also shows a significant association with age and severity (stroke type and JCS classification). BI at discharge for cerebral hemorrhage was significantly lower than that for cerebral infarction. Furthermore, we found ADL in women to be lower than in men (1% significance level). In terms of the yearly effect, BI at discharge tended to be higher in recent years of the study period, specifically in FY 2018 and FY 2019. Regarding fixed effects by hospital, BI at discharge was significantly higher in Sanyudo Hospital (1% significance level).

The results of our analyses of the difference in ADL of stroke patients between admission and discharge, and the change in BI per day of hospital stay, are shown in Table 9-B (center and right, respectively). In the case of subarachnoid hemorrhage, the difference between BI values at admission and discharge is significantly positive, but is not for change in BI per day. This reflects the particularly low ADL level at the time of admission for this type of stroke. These ADL analyses only reflect 2,660 of the total of 3,968 cases, after excluding deaths and missing information, with a particularly large number of missing BI values at admission. In addition, the improvement in BI was significantly lower when the discharge destination was a care facility or transfer to another hospital (and the daily change in BI was significantly lower for a transfer to another hospital), which likely reflects that the severity of the patient’s condition was higher in these cases. As for the yearly effect, the degree of improvement in ADL was significantly positive in FY 2018 and FY 2019. No significant differences were observed between medical institutions for the difference in BI between admission and discharge, although our results suggest the daily change in BI at Yonezawa City Hospital was significantly negative (5% significance level), albeit with a relatively small coefficient value.

III-3. Pneumonia

We performed a Probit analysis of mortality rates for patients admitted to hospital with pneumonia (Table 10-A, left), using A-DROP classification as an index for severity. Although we observed no significant differences associated with age, the mortality rate tended to be significantly higher with increasing severity, as measured by the A-DROP index. In addition, the mortality rate tended to be significantly higher for patients who required nursing care before admission, such as those admitted from a nursing home or other care facility.

The average length of hospital stay in cases excluding deaths (Table 10-A, right) was significantly longer for higher severity (i.e., higher A-DROP score), and tended to be longer for patients who were transported to hospital by ambulance and for those who were transferred to a hospital or other care facility as their discharge destination. On closer examination, the average duration of hospital stay tended to be particularly long in cases where patients were transferred to the CCCUs established at Yonezawa City Hospital and Sanyudo Hospital, when the number of days spent at these facilities is included. Furthermore, the average length of hospital stay at Yonezawa City Hospital was significantly longer than that at Sanyudo Hospital. This is thought to reflect the characteristics of the CCCU system, in addition to the attributes of patients who may require prolonged treatment. Under the current DPC reimbursement system, for acute hospitalizations, the longer the total length of stay, the lower the basic per-admission inpatient fee becomes, creating a strong incentive to encourage early discharge (including transfer) from the hospital. In the case of CCCU beds, the points (i.e., the fees that can be claimed for reimbursement) are fixed, regardless of the length of hospital stay, and can be applied for stays of up to 60 days.

In our analysis of ADL at discharge (Table 10-B, left), we found that BI decreased significantly with increasing age and severity of condition. Patients who were transported to hospital by ambulance, or those who were discharged to another care facility, another hospital, or to a CCCU in the same hospital, were associated with lower ADL (1% significance level).

Our analysis of differences in BI between admission and discharge for patients with pneumonia (Table 10-B, center) reflects only the cases that exclude deaths and missing values (there were a particularly large number of missing BI values at admission), resulting in only 1,914 out of a total of 2,454 records being included, equivalent to a deficit of approximately 22% of cases. The results show a statistically significant tendency for the improvement in BI to be lower when the discharge destination was transfer to a care facility or other medical institution. We observed no significant variation in ADL differences between hospitals.

The degree of improvement in BI per day (Table 10-B, right) was significantly lower (1% significance level) when the patient was discharged to another institution or to a CCCU. The cases where patients were transferred in this way tended to show less improvement in ADL per day. This is possibly as a result of the patient's condition being more severe in these cases, and thus having a greater need for rehabilitative care, but it also reflects the trend toward longer hospital stays.

III-4. Femoral Fracture

Although femoral fractures are associated with poorer long-term and functional prognoses, the number of in-hospital deaths associated with hospitalization for femoral fracture is very limited (16 out of 1,681 cases in our dataset). Therefore, we did not examine mortality for this condition.

We performed a Poisson analysis of the length of hospital stay for patients admitted for femoral fracture (Table 11-A), excluding the few cases of in-hospital death. We found the length of hospital stay to be significantly longer when patients were transferred to a CCCU on discharge, but significantly shorter when the discharge destination was transfer to another hospital. While there was a difference in length of stay depending on whether patients were transferred to a CCCU within their original hospital or to another hospital entirely, our results highlight the importance of early surgery and early rehabilitation in improving the prognosis for patients with femoral fracture, because of its impact on mobility and activity functions. We found no significant differences arising from yearly effects. In terms of differences between hospitals, Yonezawa City Hospital exhibited longer hospital stays (1% significance level). The average length of hospital stay for Okitama General Hospital , which encourages early discharge and transfer of patients after the acute phase, was 19.4 days. Meanwhile, the average length of stay at Sanyudo Hospital, which has not only a CCCU but also affiliated rehabilitation facilities, was 24.3 days, and that at Yonezawa City Hospital, which has a CCCU within the hospital, was 37.1 days.

In our Tobit analysis of ADL at discharge (Table 11-B, left), we found BI values on discharge decreased with increasing age, and significantly lower BI values associated with the presence of dementia (1% significance level). Other factors associated with significantly lower BI at discharge (1% significance level) were having a nursing home or other care facility as the pathway of admission, high presence and severity of comorbidities, and being discharged to a care facility or transferred to another hospital as the discharge destination. We found that yearly effects were not significant. Regarding hospital-specific effects on ADL at discharge, Yonezawa City Hospital was significantly positive (5% significance level) and Sanyudo Hospital was significantly negative (1% significance level). This may reflect the difference between Yonezawa City Hospital, which provides care up to and including the rehabilitation and recovery stage in its own CCCU beds, and Sanyudo Hospital, where patients may have the option of being transferred to an affiliated facility at a relatively early stage.

In our analysis of the difference in ADL (BI) between admission and discharge (Table 11-B, center), we found BI improvements to be significantly lower with increasing age. In addition, there was a statistically significant tendency for the improvement in BI to be lower when the discharge destination was a care facility or transfer to another hospital. Yearly effects were not significant. Regarding hospital-specific effects, the difference in BI between admission and discharge at Yonezawa City Hospital was about 8 points higher, while that of Sanyudo Hospital was about 3.5 points lower (1% significance level). These differences may be primarily due to the availability of affiliated facilities as an alternative discharge route, but the results make the difference in discharge criteria between the two hospitals clear.

III-5. Possible Selection Bias Arising from Missing Data

In this section, for each of the five acute conditions examined in this study, we investigate whether there is a selection bias resulting from missing data for ADL (BI) at time of admission, and in the case of patients with heart failure, missing NYHA classifications. In our analysis, we compared the amount of medical resource input within 7 days of admission between the groups with and without missing severity-related indices, using this medical resource input as an indicator for severity. Medical resource input was calculated on the basis of the average daily DPC per-service (variable) medical fees incurred. Basic (fixed) hospitalization fees, rehabilitation-related fees for each hospital, and hospital-specific DPC adjustments and functional coefficients were excluded because they do not represent factors relating to the severity of the patient's condition.

The results of the analysis are presented in Appendix 3. We found that the only case in which a selection bias can be inferred (that is, where patients with missing data were likely to have had a more severe condition, based on the medical expenditure they incurred) is for those patients admitted to Sanyudo Hospital with heart failure whose NYHA classifications were missing. In fact, we found that cases of heart failure, stroke, and pneumonia at Okitama General Hospital tended to be higher in severity when there were no missing values in the reporting. In other words, missing records were not necessarily indicative of high severity at the time of admission. This reinforces the fact that thorough input and reporting of key values and health-related measures is desirable for all patients, regardless of severity.

IV. DISCUSSION

In this paper, we analyzed the treatment outcomes for patients with one of five representative acute conditions admitted to the three study hospitals, which are located in the same region and have overlapping acute care functions (including emergency care), adjusting for individual patient attributes and the severity of condition at time of admission.

For heart failure and myocardial infarction, while we found no statistically significant variation in the difference in ADL between admission and discharge (i.e., improvement in the ability to perform activities and functions that form part of daily life, during the period of hospitalization) as a treatment outcome among the three hospitals, the lengths of hospital stay at Yonezawa City Hospital and Sanyudo Hospital were significantly longer. As a result, the degree of improvement in ADL per day of hospitalization was approximately 2 to 3 points lower than that at Okitama General Hospital.

In the case of stroke, Sanyudo Hospital tended to have a shorter length of hospital stay and a higher ADL at the time of discharge. This may be largely a result of external factors relating to the way in which patients are transferred to other hospitals or medical facilities on discharge. For example, Sanyudo Hospital has a longstanding rehabilitation center (opened in 1997), daycare center (opened in 2018), and other affiliated non-acute care systems, facilitating post-discharge support and leading to a reduction in the number of days patients spend in acute care beds at the hospital.

The importance of the availability of other facilities for recovery and other functions is also demonstrated by the treatment outcomes observed for pneumonia and femoral fracture. In the case of patients admitted with pneumonia, the length of stay at Yonezawa City Hospital was longer, and ADL at the time of discharge tended to be higher than at the other hospitals. In the case of femoral fracture, the length of stay at Yonezawa City Hospital was longer, and both the ADL at discharge and the ADL difference between admission and discharge tended to be higher. Yonezawa City Hospital has 322 general hospital beds, of which only 54 are rehabilitative/recovery beds (there were only 38 such beds until 2019). This suggests that acute care beds have also been used for treatment equivalent to the recovery and rehabilitation phase.

Through our analysis of the above five representative acute medical conditions, we observed two principal types of discharges: one in which ADL functions were recovered reasonably well after a long hospital stay, and the other in which relatively low ADL functions on admission were improved after a short hospital stay by using transfers and other means.[17]

Although our findings do not immediately clarify the comparative merits and demerits of different treatment outcomes, at the very least they suggest that treatment policies and environments differ from hospital to hospital, even when patients are admitted with similar individual attributes and degrees of severity. In addition, prolonged hospitalization during the acute phase of a medical condition or illness causes a psychological burden on patients and interrupts their social activities. Therefore, for the benefit of patients, it is important that their hospitalization is not prolonged for the sole purpose of treating their main medical condition or improving their ADL, but that they are instead allowed and encouraged to return to their daily lives as swiftly as is safely and practically possible.

Three of the key statistically significant results (with large regression coefficient values) found in our analysis are as follows: compared with Okitama General Hospital, (1) Yonezawa City Hospital had lower ADL at discharge for pneumonia, as a result of longer hospital stays, and higher ADL at discharge for femoral fracture; (2) Sanyudo Hospital had lower ADL at discharge for heart failure, myocardial infarction, and pneumonia; and (3) Sanyudo Hospital had higher ADL at discharge for stroke, as a result of shorter hospital stays, and lower ADL at discharge for femoral fracture.

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[17] Similar observations are also made by Kitagawa et al. (2007) and Wakao et al. (2012).

V. CONCLUSIONS

In this study, we analyzed six years of DPC hospital admission data to compare and visualize differences in the treatment outcomes at three acute care hospitals in the secondary health care zone of Okitama, Yamagata Prefecture. We used five major acute conditions for which there were large numbers of admission records available (heart failure, myocardial infarction, stroke, pneumonia, and femoral fracture) as representative examples in the analysis, and adjusted for background factors using anonymized individual records on patient attributes and severity of condition.

We found no major differences in treatment outcomes between and among the three institutions, such as a significant variation in mortality rates. Our results showed that, being located in the same region, the three medical institutions have a certain competitive and cooperative relationship with each other, and that they have established systems of care provision that do not result in serious differences in treatment outcomes.

However, for length of hospital stay and ADL at discharge, which were also analyzed in this paper, we found clear differences between medical institutions. Differences in the length of stay and ADL do not immediately affect long-term and functional prognosis; however, they may become important in the future, given the long-term relationship acute care patients can develop with medical institutions in the form of follow-up outpatient care and rehospitalization.

There is a question as to whether hospitals in the same area providing varying levels of acute care function for each medical condition is a truly desirable form of regional healthcare. If the care functions of the hospitals overlap and medical resources are thinly spread, it becomes more difficult to continue dispersed, small-scale acute care on a long-term basis. It is preferable to have stable and sustainable levels of care available in the area, rather than variable and unstable care provided by different institutions at different times. In this regard, integrating the acute care resources of Sanyudo Hospital and Yonezawa City Hospital in a mutually complementary manner, as planned for 2023, can be expected to improve the situation and to put care at both institutions on a more sustainable footing.

However, in the process of such functional reorganization, there may exist some conflicts of interest, resulting in a prolonged process to finalize decisions about the functional responsibilities of each institution involved. In such cases, the transparency and progress of the discussions would be improved by presenting objective analysis of the institutions' respective treatment systems and outcomes, with statistical adjustment for differences that are not attributable to individual facilities, such as the severity of the patient's condition at the time of admission and individual patient attributes. To this end, the method of analysis used in this paper can be applied in any region of the country where DPC admission data are available for the medical institutions concerned. We hope that the case studies analyzed in this paper will contribute to discussions on functional reorganization and the future of acute care in the region.

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Table 2. Patients hospitalized with heart failure (corresponding to ICD-10 codes I110, I500, I501, and I509) between April 2014 and March 2020

Patients with heart disease	Okitama General Hospital	Yonezawa City Hospital	Sanyudo Hospital
	n = 1,087	n = 766	n = 724
Age	80.8 (11.0)	80.9 (12.6)	84.8 (10.1)
Female	516 (47.5)	374 (48.8)	398 (55.0)
Length of hospital stay (days)	17.7 (13.3)	27.1 (22.3)	27.8 (22.6)
Classification for independence in daily living for older people with dementia			
Unclassified	556 (51.2)	375 (49.0)	436 (60.2)
I–II	422 (38.8)	319 (41.6)	267 (36.9)
III–M	51 (4.7)	63 (8.2)	17 (2.4)
Missing	58 (5.3)	9 (1.2)	4 (0.6)
Receiving home-based care before hospitalization			
No	1,058 (97.3)	709 (92.6)	709 (97.9)
Yes	29 (2.7)	55 (7.1)	15 (2.1)
Missing	0 (0.0)	2 (0.3)	0 (0.0)
Barthel Index (BI) at admission			
Fully independent (100 points)	174 (16.0)	117 (15.3)	55 (7.6)
Not independent (<100 points)	698 (64.2)	556 (72.6)	669 (92.4)
Missing	215 (19.8)	93 (12.1)	0 (0.0)
BI at discharge			
Fully independent (100 points)	420 (38.6)	301 (39.3)	137 (18.9)
Not independent (<100 points)	334 (30.7)	311 (40.6)	466 (64.4)
Missing	333 (30.6) [deaths=109]	154 (20.1) [deaths=107]	121 (16.7) [deaths=121]
Difference in BI between admission and discharge	32.1 (65.9)	27.0 (34.8)	19.2 (25.2)
Charlson Comorbidity Index (CCI)	0.8 (1.0)	1.0 (1.1)	0.9 (1.0)
Brought to hospital by emergency transport	380 (35.0)	205 (26.8)	208 (28.7)
New York Heart Association (NYHA) classification			
I	21 (1.9)	18 (2.4)	41 (5.7)
II	168 (15.5)	76 (9.9)	190 (26.2)
III	158 (14.5)	278 (36.3)	21 (2.9)
IV	122 (11.2)	229 (29.9)	16 (2.2)
Not classifiable	7 (0.6)	68 (8.9)	5 (0.7)
Missing	611 (56.2)	97 (12.7)	451 (62.3)

Note: Values shown are n (%)

Table 3. Patients hospitalized for surgery related to myocardial infarction (corresponding to ICD-10 codes I21 and I22) between April 2014 and March 2020

Patients with myocardial infarction (with surgery)	Okitama General Hospital	Yonezawa City Hospital	Sanyudo Hospital
	n = 297	n = 127	n = 82
Age	71.0 (12.9)	70.2 (12.3)	73.2 (12.4)
Female	80 (26.9)	32 (25.2)	28 (34.2)
Length of hospital stay (days)	14.3 (7.1)	22.2 (14.6)	23.3 (15.0)
Classification for independence in daily living for older people with dementia			
Unclassified	161 (54.2)	109 (85.8)	69 (84.2)
I–II	56 (18.9)	16 (12.6)	13 (15.9)
III–M	8 (2.7)	0 (0.0)	0 (0.0)
Missing	72 (24.2)	2 (1.6)	0 (0.0)
Receiving home-based care before hospitalization			
No	292 (98.3)	126 (99.2)	82 (100.0
Yes	5 (1.7)	1 (0.8)	0 (0.0)
Missing	0 (0.0)	0 (0.0)	0 (0.0)
Barthel Index (BI) at admission			
Fully independent (100 points)	12 (4.0)	13 (10.2)	9 (11.0)
Not independent (<100 points)	247 (83.2)	102 (80.3)	73 (89.0)
Missing	38 (12.8)	12 (9.5)	0 (0.0)
BI at discharge			
Fully independent (100 points)	197 (66.3)	99 (78.0)	44 (53.7)
Not independent (<100 points)	51 (17.2)	16 (12.6)	32 (39.0)
Missing	49 (16.5) [deaths=24]	12 (9.5) [deaths=9]	6 (7.3) [deaths=6]
Difference in BI between admission and discharge	75.5 (35.2)	77.8 (36.5)	49.0 (39.7)
Charlson Comorbidity Index (CCI)	0.7 (0.7)	0.9 (1.0)	0.8 (0.9)
Brought to hospital by emergency transport	185 (62.3)	74 (58.3)	38 (46.3)
Killip Classification			
Class 1	211 (71.0)	67 (52.8)	17 (20.7)
Class 2	40 (13.5)	40 (31.5)	33 (40.2)
Class 3	5 (1.7)	9 (7.1)	11 (13.4)
Class 4	41 (13.8)	10 (7.9)	20 (24.9)
Missing	0 (0.0)	1 (0.8)	1 (1.2)
Type of surgery			
Open-heart	1 (0.3)	1 (0.8)	0 (0.0)
Percutaneous	296 (99.7)	126 (99.2)	82 (100.0)

Note: Values shown are n (%)

Table 4. Patients hospitalized within 3 days of stroke (corresponding to ICD-10 codes I60, I61, and I62) between April 2014 and March 2020

Patients with stroke (within 3 days)	Okitama General Hospital	Yonezawa City Hospital	Sanyudo Hospital
	n = 2,128	n = 950	n = 969
Age	76.3 (12.8)	74.5 (13.5)	76.9 (12.6)
Female	972 (45.7)	434 (45.7)	447 (46.1)
Length of hospital stay (days)	25.5 (16.9)	27.9 (24.8)	24.7 (23.6)
Classification for independence in daily living for older people with dementia			
Unclassified	1,183 (55.6)	514 (54.1)	630 (65.0)
I–II	751 (35.3)	333 (35.1)	313 (32.3)
III–M	111 (5.2)	100 (10.5)	15 (1.6)
Missing	83 (3.9)	3 (0.3)	11 (1.1)
Receiving home-based care before hospitalization			
No	2,072 (97.4)	863 (90.8)	964 (99.5)
Yes	54 (2.5)	71 (7.5)	5 (0.5)
Missing	2 (0.1)	16 (1.7)	0 (0.0)
Barthel Index (BI) at admission			
Fully independent (100 points)	77 (3.6)	63 (6.6)	79 (8.2)
Not independent (<100 points)	1,639 (79.6)	694 (73.1)	889 (91.7)
Missing	358 (16.8)	193 (20.3)	1 (0.1)
BI at discharge			
Fully independent (100 points)	526 (24.7)	268 (28.2)	261 (26.9)
Not independent (<100 points)	934 (43.9)	516 (54.3)	598 (61.7)
Missing	668 (31.4) [deaths=213]	166 (17.5) [deaths=110]	110 (11.4) [deaths=110]
Difference in BI between admission and discharge	32.4 (35.5)	22.7 (33.1)	18.3 (27.2)
Charlson Comorbidity Index (CCI)	0.5 (0.8)	0.6 (0.9)	1.3 (1.3)
Brought to hospital by emergency transport	1,203 (56.5)	540 (56.8)	457 (47.2)
Japan Coma Scale (JCS)			
0	881 (41.4)	335 (35.3)	75 (7.7)
1 digit	822 (38.6)	406 (42.7)	616 (63.6)
2 digits	211 (9.9)	102 (10.7)	171 (17.7)
3 digits	214 (10.1)	107 (11.3)	107 (11.0)
Stroke type			
Subarachnoid hemorrhage	140 (6.6)	60 (6.3)	48 (5.0)
Cerebral hemorrhage	431 (20.3)	223 (23.5)	161 (16.6)
Cerebral infarction	1,557 (73.2)	667 (70.2)	760 (78.4)
Intravenous thrombolysis (tPA)	157 (7.4)	95 (10.0)	111 (11.5)

Note: Values shown are n (%)

Table 5. Patients hospitalized with pneumonia (corresponding to ICD-10 codes J12-J18) between April 2014 and March 2020

Patients with pneumonia	Okitama General Hospital	Yonezawa City Hospital	Sanyudo Hospital
	n = 1,281	n = 820	n = 743
Age	78.6 (12.9)	79.1 (14.4)	80.8 (12.4)
Female	483 (37.7)	364 (44.4)	293 (39.4)
Length of hospital stay (days)	16.4 (11.8)	25.6 (26.3)	23.0 (21.8)
Classification for independence in daily living for older people with dementia			
Unclassified	673 (52.5)	341 (41.6)	434 (58.4)
I–II	427 (33.3)	348 (42.4)	281 (37.8)
III–M	92 (7.2)	121 (14.8)	15 (2.0)
Missing	89 (7.0)	10 (1.2)	13 (1.8)
Receiving home-based care before hospitalization			
No	1,215 (94.9)	707 (86.2)	683 (91.9)
Yes	66 (5.2)	107 (13.1)	60 (8.1)
Missing	0 (0.0)	6 (0.7)	0 (0.0)
Barthel Index (BI) at admission			
Fully independent (100 points)	324 (25.3)	123 (15.0)	81 (10.9)
Not independent (<100 points)	639 (49.9)	586 (71.5)	662 (89.1)
Missing	318 (24.8)	111 (13.5)	0 (0.0)
BI at discharge			
Fully independent (100 points)	518 (40.4)	248 (30.2)	186 (25.0)
Not independent (<100 points)	354 (27.6)	412 (50.2)	479 (64.5)
Missing	409 (31.9)	160 (19.5)	78 (10.5)
	[deaths=124]	[deaths=121]	[deaths=78]
Difference in BI between admission and discharge	16.2 (28.3)	19.7 (31.5)	16.2 (21.4)
Charlson Comorbidity Index (CCI)	1.1 (1.1)	0.9 (1.1)	0.8 (1.0)
Brought to hospital by emergency transport	381 (29.7)	227 (27.7)	180 (24.2)
A-DROP score			
Mild (0 points)	116 (9.1)	72 (8.8)	80 (10.8)
Moderate (1–2 points)	713 (55.7)	446 (54.4)	449 (60.4)
Severe (3 points)	337 (26.3)	144 (17.6)	125 (16.8)
Very severe (4–5 points)	107 (8.4)	121 (14.8)	84 (11.3)
Missing	8 (0.6)	37 (4.5)	5 (0.7)

Note: Values shown are n (%)

Table 6. Patients hospitalized for surgery related to one-sided femoral fracture (corresponding to ICD-10 codes S720 and S721) between April 2014 and March 2020

Patients with femoral fracture (with surgery)	Okitama General Hospital	Yonezawa City Hospital	Sanyudo Hospital
	n = 1,071	n = 248	n = 362
Age	84.0 (9.9)	82.1 (10.9)	84.5 (9.3)
Female	851 (79.5)	198 (79.8)	281 (77.6)
Length of hospital stay (days)	19.4 (6.0)	37.1 (20.2)	24.3 (14.9)
Classification for independence in daily living for older people with dementia			
Unclassified	403 (37.6)	84 (33.9)	216 (59.7)
I–II	539 (50.3)	144 (58.1)	128 (35.4)
III–M	85 (7.9)	20 (8.1)	17 (4.7)
Missing	44 (4.1)	0 (0.0)	1 (0.3)
Receiving home-based care before hospitalization			
No	1,054 (98.4)	237 (95.6)	339 (93.7)
Yes	17 (1.6)	11 (4.4)	23 (6.4)
Missing	0 (0.0)	0 (0.0)	0 (0.0)
Barthel Index (BI) at admission			
Fully independent (100 points)	96 (9.0)	0 (0.0)	2 (0.6)
Not independent (<100 points)	731 (68.3)	214 (86.3)	359 (99.2)
Missing	244 (22.8)	34 (13.7)	1 (0.3)
BI at discharge			
Fully independent (100 points)	62 (5.8)	37 (14.9)	12 (3.3)
Not independent (<100 points)	686 (64.1)	174 (70.2)	344 (95.0)
Missing	323 (30.2) [deaths=8]	37 (14.9) [deaths=6]	6 (1.7) [deaths=2]
Difference in BI between admission and discharge	22.7 (38.5)	47.6 (31.3)	30.2 (24.2)
Charlson Comorbidity Index (CCI)	0.6 (0.8)	0.3 (0.6)	0.6 (0.8)
Brought to hospital by emergency transport	628 (58.6)	139 (56.1)	182 (50.3)
Femoral neck fracture	398 (37.2)	105 (42.3)	146 (40.3)

Note: Values shown are n (%)

Table 7-A. Comparison of treatment outcomes for patients admitted with heart failure (mortality rate and length of hospital stay)

Patients with heart failure		Mortality (Probit model; death=1)				Length of hospital stay (excluding in-hospital deaths) (Poisson; unit: days)			
		Coefficient		Robust standard error	P-value	Coefficient		Robust standard error	P-value
Age									
below 60	(base category)								
60–69		0.448		0.383	0.242	0.316	**	0.109	0.004
70–79		0.593		0.334	0.076	0.258	**	0.086	0.003
80–89		0.795	*	0.320	0.013	0.302	**	0.082	0.000
90 or above		1.062	**	0.326	0.001	0.377	**	0.091	0.000
Sex									
Male	(base category)								
Female		-0.081		0.106	0.445	0.089	*	0.040	0.027
Brought to hospital by emergency transport									
No	(base category)								
Yes		-0.002		0.114	0.984	0.034		0.046	0.458
New York Heart Association (NYHA) classification									
I	(base category)								
II		0.106		0.299	0.723	0.396	**	0.095	0.000
III		0.544		0.319	0.088	0.491	**	0.102	0.000
IV		1.484	**	0.318	0.000	0.660	**	0.105	0.000
Route of admission									
Home	(base category)								
Care facility		0.625	**	0.175	0.000	-0.277	**	0.108	0.010
Charlson Comorbidity Index (CCI)		0.014		0.053	0.786	0.073	**	0.022	0.001
Discharge destination									
Home	(base category)								
Care facility						0.302	**	0.103	0.003
Transfer to another hospital						0.591	**	0.077	0.000
Admission year									
FY 2014	(base category)								
FY 2015		0.164		0.120	0.170	0.091		0.049	0.063
FY 2016		0.147		0.225	0.514	0.233	**	0.084	0.006
FY 2017		-0.028		0.214	0.897	0.172		0.092	0.062
FY 2018		0.219		0.228	0.337	0.267	**	0.078	0.001
FY 2019		0.059		0.224	0.791	0.287	**	0.089	0.001
Hospital									
Okitama General Hospital	(base category)								
Yonezawa City Hospital		-0.218		0.146	0.135	0.282	**	0.054	0.000
Sanyudo Hospital		0.467	**	0.178	0.009	0.456	**	0.071	0.000
Intercept		-2.904	**	0.447	0.000	1.849	**	0.133	0.000
Number of observations		1315				1167			
Wald chi2 (18)		133.67				217.650			
Prob＞chi2		0.000				0.000			
Pseudo R2		0.1614				0.160			

Note: ** p<0.01 (1% significance level); * p<0.05 (5% significance level)

Table 7-B. Comparison of treatment outcomes for patients admitted with heart failure (ADL at discharge, difference in ADL between admission and discharge, and change in ADL per day of hospitalization)

Patients with heart failure	ADL at discharge (BI: 0–100) (Tobit; censored at 0 and 100)			ADL difference (BI at discharge – BI at admission; BI: 0–100) (Linear; excluding missing values)			Change in ADL per day (ADL difference / length of hospital stay) (Linear; excluding missing values)		
	Coefficient	Robust standard error	P-value	Coefficient	Robust standard error	P-value	Coefficient	Robust standard error	P-value
Age									
below 60 (base)									
60–69	-12.451	12.851	0.333	-0.698	2.431	0.774	-0.655	0.936	0.484
70–79	-46.271 **	10.819	0.000	-6.347 **	2.426	0.009	-0.877	0.837	0.295
80–89	-71.153 **	10.184	0.000	-13.946 **	2.191	0.000	-0.880	0.828	0.288
90 or above	-91.170 **	10.419	0.000	-25.829 **	2.746	0.000	-1.665 *	0.827	0.044
Sex									
Male (base)									
Female	-15.655 **	3.233	0.000	-5.097 **	1.635	0.002	-0.125	0.204	0.540
Brought to hospital by emergency transport									
No (base)									
Yes	-10.414 **	3.575	0.004	1.099	2.047	0.591	1.385 **	0.242	0.000
New York Heart Association (NYHA) classification									
I (base)									
II	-19.121 **	6.092	0.002	-6.082 *	2.523	0.016	-0.926 *	0.438	0.035
III	-25.175 **	6.826	0.000	-5.152	2.825	0.069	-0.704	0.503	0.162
IV	-28.954 **	7.401	0.000	-3.477	3.330	0.297	-0.531	0.477	0.266
Route of admission									
Home (base)									
Care facility	-31.089 **	8.779	0.000	-17.469 **	5.898	0.003	-0.053	0.286	0.854
Charlson Comorbidity Index (CCI)	-0.487	1.669	0.771	0.818	0.765	0.286	-0.096	0.110	0.382
Discharge destination									
Home (base)									
Care facility	-31.099 **	6.810	0.000	-15.939 **	4.953	0.001	-0.820 **	0.210	0.000
Transfer to another hospital	-59.685 **	6.879	0.000	-30.316 **	4.567	0.000	-1.669 **	0.348	0.000
Admission year									
FY 2014 (base)									
FY 2015	-0.300	3.697	0.935	1.619	1.775	0.362	0.210	0.251	0.404
FY 2016	-6.489	6.112	0.289	-4.266	3.252	0.190	-0.109	0.319	0.734
FY 2017	-2.747	7.242	0.705	1.216	4.007	0.762	0.312	0.357	0.383
FY 2018	1.193	7.460	0.873	4.050	3.353	0.227	0.098	0.347	0.777
FY 2019	-7.870	6.999	0.261	-1.556	3.308	0.638	-0.049	0.521	0.926
Barthel Index (BI) at admission				-0.727 **	0.027	0.000			
Length of hospital stay (days)				-0.191 **	0.054	0.000			
Hospital									
Okitama General Hospital (base)									
Yonezawa City Hospital	1.973	5.142	0.701	2.100	2.304	0.362	-1.096 **	0.313	0.000
Sanyudo Hospital	-13.855 **	4.935	0.005	-1.173	2.318	0.613	-0.846 **	0.326	0.010
Intercept	199.073 **	12.613	0.000	88.033	4.085	0.000	4.093 **	0.946	0.000
Number of observations	1034			925			925		
(Uncensored, Left, Right)	(488, 50, 496)								
Prob＞chi2	0.000								
Pseudo R2	0.076			0.1403			0.093		

Note: ** p<0.01 (1% significance level); * p<0.05 (5% significance level)

Table 8-A. Comparison of treatment outcomes for patients admitted with myocardial infarction (mortality rate and length of hospital stay)

Patients with myocardial infarction		Mortality (Probit model; death=1)				Length of hospital stay (excluding in-hospital deaths) (Poisson; unit: days)			
		Coefficient		Robust standard error	P-value	Coefficient		Robust standard error	P-value
Age									
below 60	(base category)								
60–69		0.213		0.396	0.591	-0.048		0.047	0.307
70–79		0.168		0.430	0.697	-0.040		0.055	0.460
80–89		0.666		0.372	0.074	0.134	*	0.060	0.026
90 or above		1.076	*	0.502	0.032	0.242	*	0.101	0.017
Sex									
Male	(base category)								
Female		0.051		0.219	0.814	0.079		0.053	0.136
Brought to hospital by emergency transport									
No	(base category)								
Yes		0.153		0.219	0.486	0.063		0.039	0.102
Killip Classification									
Class I	(base category)								
Class II		0.109		0.354	0.757	0.135	**	0.044	0.002
Class III		0.466		0.486	0.337	0.230	**	0.076	0.002
Class IV		2.019	**	0.271	0.000	0.236	**	0.077	0.002
Route of admission									
Home	(base category)								
Care facility		0.591		0.464	0.203	0.054		0.103	0.603
Charlson Comorbidity Index (CCI)		0.120		0.148	0.417	0.022		0.023	0.341
Discharge destination									
Home	(base category)								
Care facility		0.189		0.329	0.566	0.038		0.132	0.771
Transfer to another hospital		0.267		0.336	0.426	0.375	**	0.103	0.000
Admission year									
FY 2014	(base category)								
FY 2015		0.189		0.329	0.566	-0.009		0.062	0.883
FY 2016		0.267		0.336	0.426	0.065		0.091	0.475
FY 2017		0.326		0.328	0.320	0.013		0.059	0.823
FY 2018		-0.277		0.407	0.495	-0.027		0.061	0.660
FY 2019		-1.004		0.615	0.102	-0.059		0.061	0.339
Hospital									
Okitama General Hospital	(base category)								
Yonezawa City Hospital		0.165		0.278	0.552	0.400	**	0.054	0.000
Sanyudo Hospital		-0.593	*	0.291	0.042	0.324	**	0.057	0.000
Intercept		-2.780	**	0.421	0.000	2.537	**	0.065	0.000
Number of observations		503				462			
Wald chi2 (18)		103.47				274.090			
Prob＞chi2		0.000				0.000			
Pseudo R2		0.4026				0.160			

Note: ** p<0.01 (1% significance level); * p<0.05 (5% significance level)

Table 8-B. Comparison of treatment outcomes for patients admitted with myocardial infarction (ADL at discharge, difference in ADL between admission and discharge, and change in ADL per day of hospitalization)

Patients with myocardial infarction		ADL at discharge (BI: 0–100) (Tobit; censored at 0 and 100)			ADL difference (BI at discharge – BI at admission; BI: 0–100) (Linear; excluding missing values)			Change in ADL per day (ADL difference / length of hospital stay) (Linear; excluding missing values)		
		Coefficient	Robust standard error	P-value	Coefficient	Robust standard error	P-value	Coefficient	Robust standard error	P-value
Age										
below 60	(base)									
60–69		0.772	16.886	0.964	0.133	2.193	0.952	0.470	0.474	0.322
70–79		-37.257 **	14.279	0.009	-6.049 *	2.693	0.025	-0.547	0.402	0.174
80–89		-57.953 **	14.443	0.000	-9.646 **	3.566	0.007	-0.848	0.458	0.065
90 or above		-64.790 **	22.237	0.004	-16.578	9.516	0.082	-1.751 **	0.657	0.008
Sex										
Male	(base)									
Female		-19.676 *	8.645	0.023	-0.821	2.810	0.770	-0.122	0.350	0.727
Brought to hospital by emergency transport										
No	(base)									
Yes		-3.176	9.150	0.729	-1.811	2.048	0.377	0.189	0.329	0.566
Killip Classification										
Class I	(base)									
Class II		-10.732	11.910	0.368	-1.845	2.731	0.500	-0.390	0.357	0.276
Class III		-34.530	18.558	0.063	-6.946	6.860	0.312	-0.646	0.524	0.219
Class IV		-14.112	12.633	0.265	-1.367	3.220	0.671	-0.816 *	0.403	0.043
Route of admission										
Home	(base)									
Care facility		-128.44 **	42.852	0.003	-62.414 **	14.186	0.000	-3.616 **	0.722	0.000
Charlson Comorbidity Index (CCI)		-2.783	5.312	0.601	-1.025	1.079	0.343	-0.324	0.181	0.074
Discharge destination										
Home	(base)									
Care facility		81.777	48.473	0.092	-15.939 **	4.953	0.001	1.997	1.148	0.083
Transfer to another hospital		-103.10 **	18.356	0.000	-30.316 **	4.567	0.000	-3.494 **	0.518	0.000
Admission year										
FY 2014	(base)									
FY 2015		1.722	14.179	0.903	2.125	3.509	0.545	-0.795	0.659	0.228
FY 2016		-4.636	14.565	0.750	-0.966	3.639	0.791	-0.847	0.611	0.166
FY 2017		1.227	16.030	0.939	2.407	4.151	0.562	-0.606	0.650	0.352
FY 2018		10.380	14.054	0.461	2.324	3.466	0.503	-0.410	0.595	0.492
FY 2019		12.326	15.468	0.426	3.115	3.662	0.396	-0.287	0.595	0.630
Barthel Index (BI) at admission					-0.918 **	0.022	0.000			
Length of hospital stay (days)					-0.108	0.219	0.621			
Hospital										
Okitama General Hospital	(base)									
Yonezawa City Hospital		20.851 *	10.502	0.048	5.236	2.847	0.067	-1.973 **	0.342	0.000
Sanyudo Hospital		-14.251	11.457	0.214	-2.774	3.549	0.435	-2.787 **	0.372	0.000
Intercept		193.96 **	17.064	0.000	84.623 **	4.073	0.000	7.166 **	0.694	0.000
Number of observations		434			392			392		
(Uncensored, Left, Right)		(85, 9, 340)								
Prob > chi2		0.000								
Pseudo R2		0.114			0.193			0.2616		

Note: ** p<0.01 (1% significance level); * p<0.05 (5% significance level)

Table 9-A. Comparison of treatment outcomes for patients admitted with stroke (mortality rate and length of hospital stay)

Patients with stroke		Mortality (Probit model; death=1)				Length of hospital stay (excluding in-hospital deaths) (Poisson; unit: days)			
		Coefficient		Robust standard error	P-value	Coefficient		Robust standard error	P-value
Age									
below 60	(base category)								
60–69		0.312	*	0.139	0.025	0.142	**	0.043	0.001
70–79		0.326	*	0.129	0.011	0.169	**	0.037	0.000
80–89		0.526	**	0.126	0.000	0.135	**	0.036	0.000
90 or above		0.714	**	0.145	0.000	0.099	*	0.047	0.036
Sex									
Male	(base category)								
Female		-0.089		0.069	0.192	0.000		0.021	0.994
Type of stroke									
Cerebral infarction	(base category)								
Subarachnoid hemorrhage		0.681	**	0.112	0.000	0.594	**	0.067	0.000
Cerebral hemorrhage		0.104		0.076	0.174	0.116	**	0.025	0.000
Brought to hospital by emergency transport									
No	(base category)								
Yes		0.280	**	0.075	0.000	0.035		0.024	0.135
Japan Coma Scale (JCS)									
0	(base category)								
1 digit		0.239	*	0.098	0.015	-0.041		0.028	0.137
2 digits		0.808	**	0.117	0.000	0.084	*	0.040	0.036
3 digits		1.867	**	0.113	0.000	0.181	**	0.051	0.000
Route of admission									
Home	(base category)								
Care facility		0.085		0.109	0.433	-0.167	**	0.055	0.002
Charlson Comorbidity Index (CCI)		0.070	*	0.035	0.046	0.034	**	0.013	0.009
Discharge destination									
Home	(base category)								
Care facility						0.562	**	0.083	0.000
Transfer to another hospital						0.584	**	0.027	0.000
Admission year									
FY 2014	(base category)								
FY 2015		-0.143		0.109	0.190	-0.016		0.030	0.592
FY 2016		-0.012		0.104	0.911	-0.002		0.038	0.964
FY 2017		-0.128		0.107	0.233	-0.068	*	0.035	0.048
FY 2018		-0.184		0.110	0.094	-0.097	**	0.031	0.002
FY 2019		-0.049		0.108	0.653	-0.196	**	0.033	0.000
Hospital									
Okitama General Hospital	(base category)								
Yonezawa City Hospital		0.059		0.080	0.461	0.012		0.026	0.647
Sanyudo Hospital		-0.019		0.087	0.830	-0.109	**	0.036	0.003
Intercept		-2.506	**	0.151	0.000	2.802	**	0.043	0.000
Number of observations		3968				3534			
Wald chi2 (20)		736.39				1207.610			
Prob＞chi2		0.000				0.000			
Pseudo R2		0.2983				0.221			

Note: ** p<0.01 (1% significance level); * p<0.05 (5% significance level)

Table 9-B. Comparison of treatment outcomes for patients admitted with stroke (ADL at discharge, difference in ADL between admission and discharge, and change in ADL per day of hospitalization)

Patients with stroke	ADL at discharge (BI: 0–100) (Tobit; censored at 0 and 100)			ADL difference (BI at discharge – BI at admission; BI: 0–100) (Linear; excluding missing values)			Change in ADL per day (ADL difference / length of hospital stay) (Linear; excluding missing		
	Coefficient	Robust standard error	P-value	Coefficient	Robust standard error	P-value	Coefficient	Robust standard error	P-value
Age									
below 60 (base)									
60–69	-13.062 **	3.702	0.000	-3.382 *	1.649	0.040	-0.044	0.213	0.836
70–79	-30.257 **	3.452	0.000	-7.608 **	1.590	0.000	-0.208	0.192	0.279
80–89	-49.865 **	3.430	0.000	-17.294 **	1.621	0.000	-0.528 **	0.179	0.003
90 or above	-65.252 **	4.429	0.000	-25.569 **	2.156	0.000	-0.999 **	0.226	0.000
Sex									
Male (base)									
Female	-7.241 **	1.908	0.000	-2.245 *	1.004	0.025	0.054	0.104	0.603
Type of stroke									
Cerebral infarction (base)									
Subarachnoid hemorrhage	5.645	5.070	0.266	12.089 **	2.748	0.000	-0.258	0.165	0.118
Cerebral hemorrhage	-9.291 **	2.528	0.000	-0.853	1.360	0.531	0.043	0.133	0.745
Brought to hospital by emergency transport									
No (base)									
Yes	-10.400 **	2.002	0.000	-2.203 *	1.084	0.042	0.483 **	0.128	0.000
Japan Coma Scale (JCS)									
0 (base)									
1 digit	-23.993 **	2.346	0.000	-8.621 **	1.283	0.000	0.002	0.135	0.991
2 digits	-52.618 **	3.570	0.000	-20.618 **	1.933	0.000	-0.367 *	0.164	0.025
3 digits	-74.777 **	5.874	0.000	-24.741 **	2.461	0.000	-0.735 **	0.156	0.000
Route of admission									
Home (base)									
Care facility	-35.936 **	4.854	0.000	-16.681 **	2.118	0.000	-0.728 *	0.311	0.019
Charlson Comorbidity Index (CCI)	-2.548 **	0.978	0.009	-0.808	0.482	0.094	-0.083	0.048	0.088
Discharge destination									
Home (base)									
Care facility	-48.327 **	5.516	0.000	-21.632 **	2.963	0.000	-0.830	0.604	0.170
Transfer to another hospital	-67.101 **	2.176	0.000	-28.710 **	1.434	0.000	-2.117 **	0.111	0.000
Admission year									
FY 2014 (base)									
FY 2015	3.283	3.151	0.298	1.613	1.590	0.310	0.068	0.137	0.618
FY 2016	1.119	3.145	0.722	0.754	1.576	0.633	-0.036	0.163	0.826
FY 2017	3.021	3.199	0.345	1.872	1.624	0.249	0.033	0.126	0.792
FY 2018	6.717 *	3.249	0.039	4.455 **	1.644	0.007	0.363 *	0.165	0.028
FY 2019	7.948 *	3.335	0.017	6.195 **	1.725	0.000	0.685 **	0.177	0.000
Barthel Index (BI) at admission				-0.676 **	0.021	0.000			
Length of hospital stay (days)				-0.254 **	0.027	0.000			
Hospital									
Okitama General Hospital (base)									
Yonezawa City Hospital	1.923	2.369	0.417	-2.506	1.282	0.051	-0.337 *	0.141	0.017
Sanyudo Hospital	19.686 **	2.523	0.000	2.338	1.325	0.078	-0.109	0.130	0.403
Intercept	161.279 **	4.249	0.000	89.189 **	2.250	0.000	2.933 **	0.202	0.000
Number of observations	3035			2660			2660		
(Uncensored, Left, Right)	(1408, 582, 1045)								
Prob＞chi2	0.000								
Pseudo R2	0.141			0.226			0.189		

Note: ** p<0.01 (1% significance level); * p<0.05 (5% significance level)

Table 10-A. Comparison of treatment outcomes for patients admitted with pneumonia (mortality rate and length of hospital stay)

Patients with pneumonia		Mortality (Probit model; death=1)				Length of hospital stay (excluding in-hospital deaths) (Poisson; unit: days)			
		Coefficient		Robust standard error	P-value	Coefficient		Robust standard error	P-value
Age									
below 60	(base category)								
60–69		0.371		0.287	0.196	0.027		0.128	0.831
70–79		0.080		0.278	0.775	0.016		0.111	0.884
80–89		0.416		0.272	0.127	0.062		0.107	0.562
90 or above		0.537		0.278	0.054	0.086		0.106	0.415
Sex									
Male	(base category)								
Female		-0.137		0.077	0.076	0.038		0.033	0.254
Brought to hospital by emergency transport									
No	(base category)								
Yes		0.241	**	0.074	0.001	0.143	**	0.036	0.000
A-DROP score									
0	(base category)								
1–2		0.912	*	0.363	0.012	0.107		0.098	0.275
3		1.423	**	0.373	0.000	0.257	*	0.109	0.018
4–5		2.020	**	0.375	0.000	0.332	**	0.114	0.004
Route of admission									
Home	(base category)								
Care facility		0.289	**	0.099	0.004	-0.019		0.055	0.733
Charlson Comorbidity Index (CCI)		-0.006		0.034	0.854	0.088	**	0.016	0.000
Discharge destination									
Home	(base category)								
Care facility						0.193	**	0.056	0.001
Transfer to another hospital						0.638	**	0.053	0.000
Transferred to comprehensive community care unit (CCCU)									
No									
Yes		-0.117		0.130	0.368	0.891	**	0.047	0.000
Admission year									
FY 2014	(base category)								
FY 2015		-0.0753414		0.130	0.563	0.014		0.063	0.818
FY 2016		-0.017		0.124	0.893	-0.147	**	0.053	0.006
FY 2017		-0.037		0.124	0.767	-0.097		0.050	0.052
FY 2018		-0.104		0.124	0.402	-0.195	**	0.049	0.000
FY 2019		-0.291	*	0.133	0.029	-0.113	*	0.056	0.041
Hospital									
Okitama General Hospital	(base category)								
Yonezawa City Hospital		0.144		0.084	0.086	0.337	**	0.041	0.000
Sanyudo Hospital		0.120		0.096	0.211	-0.029		0.036	0.414
Intercept		-2.854	**	0.376	0.000	2.406	**	0.154	0.000
Number of observations		2760				2454			
Wald chi2 (18)		254.24				1581.5			
Prob＞chi2		0.000				0.000			
Pseudo R2		0.1509				0.321			

Note: ** p<0.01 (1% significance level); * p<0.05 (5% significance level)

Table 10-B. Comparison of treatment outcomes for patients admitted with pneumonia (ADL at discharge, difference in ADL between admission and discharge, and change in ADL per day of hospitalization)

Patients with pneumonia	ADL at discharge (BI: 0–100) (Tobit; censored at 0 and 100)				ADL difference (BI at discharge – BI at admission; BI: 0–100) (Linear; excluding missing values)				Change in ADL per day (ADL difference / length of hospital stay) (Linear; excluding missing values)			
	Coefficient		Robust standard error	P-value	Coefficient		Robust standard error	P-value	Coefficient		Robust standard error	P-value
Age												
below 60 (base)												
60–69	-7.987		8.060	0.322	1.750		1.727	0.311	0.071		0.234	0.763
70–79	-17.462	*	7.670	0.023	-2.062		2.024	0.308	0.076		0.273	0.781
80–89	-46.009	**	7.461	0.000	-7.101	**	2.143	0.001	0.179		0.272	0.509
90 or above	-71.246	**	7.686	0.000	-17.662	**	2.524	0.000	-0.434		0.290	0.134
Sex												
Male (base)												
Female	-7.175	**	2.774	0.010	-2.577	*	1.099	0.019	-0.181		0.120	0.130
Brought to hospital by emergency transport												
No (base)												
Yes	-18.761	**	2.964	0.000	2.309		1.517	0.128	0.900	**	0.161	0.000
A-DROP score												
0 (base)												
1–2	-18.616	**	7.004	0.008	4.121	*	1.651	0.013	0.470	*	0.233	0.043
3	-30.637	**	7.577	0.000	4.607	*	2.190	0.036	0.624	*	0.279	0.025
4–5	-35.966	**	8.459	0.000	3.293		2.940	0.263	0.383		0.339	0.259
Route of admission												
Home (base)												
Care facility	-32.93	**	5.781	0.000	-9.479	**	2.503	0.000	0.002		0.185	0.990
Charlson Comorbidity Index (CCI)	-1.505		1.228	0.220	0.408		0.511	0.424	-0.086		0.056	0.128
Discharge destination												
Home (base)												
Care facility	-46.065	**	5.518	0.000	-18.413	**	2.453	0.000	-0.850	**	0.164	0.000
Transfer to another hospital	-69.22	**	4.548	0.000	-25.176	**	2.238	0.000	-1.552	**	0.188	0.000
Transferred to comprehensive community care unit (CCCU)												
No (base)												
Yes	-20.661	**	4.109	0.000	-1.550		1.954	0.428	-0.944	**	0.129	0.000
Admission year												
FY 2014 (base)												
FY 2015	-1.680		4.748	0.724	-1.606		1.841	0.383	0.141		0.201	0.482
FY 2016	2.277		4.686	0.627	-1.214		1.892	0.521	0.320		0.209	0.125
FY 2017	1.969		4.634	0.671	0.414		1.905	0.828	0.291		0.208	0.162
FY 2018	3.708		4.498	0.410	-0.743		1.853	0.688	0.320		0.202	0.113
FY 2019	1.052		4.688	0.822	1.228		1.888	0.515	0.4215158		0.2185843	0.054
Barthel Index (BI) at admission					-0.461		0.022	0.000				
Length of hospital stay (days)					-0.172		0.033	0.000				
Hospital												
Okitama General Hospital (base)												
Yonezawa City Hospital	20.851	*	10.502	0.048	-0.916		1.383	0.508	0.045		0.156	0.772
Sanyudo Hospital	-14.251		11.457	0.214	-0.809		1.240	0.514	0.427	**	0.142	0.003
Intercept	193.96	**	17.064	0.000	52.330	**	3.095	0.000	0.743	**	0.247	0.003
Number of observations	2137				1914				1914			
(Uncensored, Left, Right)	(940, 261, 936)											
Prob＞chi2	0.000				0.000				0			
Pseudo R2	0.094				0.1053				0.088			

Note: ** p<0.01 (1% significance level); * p<0.05 (5% significance level)

Table 11-A. Comparison of treatment outcomes for patients admitted with femoral fracture (mortality rate and length of hospital stay)

Patients with femoral fracture	Length of hospital stay (excluding in-hospital deaths) (Poisson; unit: days)			
	Coefficient		Robust standard error	P-value
Age				
below 60				
60–69	0.125		0.093	0.181
70–79	0.209	*	0.093	0.025
80–89	0.165		0.092	0.071
90 or above	0.171		0.096	0.073
Sex				
Male				
Female	-0.041		0.025	0.105
Classification for independence in daily living for older people with dementia				
Unclassified				
I–II	0.015		0.023	0.519
III–M	0.019		0.047	0.678
Brought to hospital by emergency transport				
No				
Yes	-0.016		0.021	0.437
Route of admission				
Home				
Care facility	-0.203		0.043	0.000
Charlson Comorbidity Index (CCI)	0.029	*	0.015	0.050
Discharge destination				
Home				
Care facility	0.001		0.069	0.986
Transfer to another hospital	-0.143		0.040	0.000
Transferred to comprehensive community care unit (CCCU)				
No				
Yes	0.651	**	0.052	0.000
Admission year				
FY 2014				
FY 2015	0.061		0.037	0.098
FY 2016	0.004		0.032	0.902
FY 2017	0.000		0.033	0.997
FY 2018	-0.001		0.034	0.985
FY 2019	-0.028		0.035	0.427
Hospital				
Okitama General Hospital				
Yonezawa City Hospital	0.466	**	0.030	0.000
Sanyudo Hospital	0.048		0.026	0.067
Intercept	2.959	**	0.090	0.000
Number of observations	1556			
Wald chi2 (18)	1007.06			
Prob＞chi2	0.000	**		
Pseudo R2	0.275			

Note: ** p<0.01 (1% significance level); * p<0.05 (5% significance level)

Table 11-B. Comparison of treatment outcomes for patients admitted with femoral fracture (ADL at discharge, difference in ADL between admission and discharge, and change in ADL per day of hospitalization)

Patients with femoral fracture	ADL at discharge (BI: 0–100) (Tobit; censored at 0 and 100)			ADL difference (BI at discharge – BI at admission; BI: 0–100) (Linear; excluding missing values)			Change in ADL per day (ADL difference / length of hospital stay) (Linear; excluding missing		
	Coefficient	Robust standard error	P-value	Coefficient	Robust standard error	P-value	Coefficient	Robust standard error	P-value
Age									
below 60 (base)									
60–69	-12.877	7.623	0.091	-7.815	4.559	0.087	-0.535	0.356	0.133
70–79	-23.084 **	7.109	0.001	-13.203 **	4.212	0.002	-0.926 **	0.341	0.007
80–89	-36.075 **	7.053	0.000	-25.430 **	4.249	0.000	-1.384 **	0.339	0.000
90 or above	-44.247 **	7.117	0.000	-32.907 **	4.365	0.000	-1.685 **	0.350	0.000
Sex				**					
Male (base)									
Female	3.067	1.971	0.120	2.885	1.840	0.117	0.217	0.126	0.085
Classification for independence in daily living for older people with dementia									
Unclassified									
Ⅰ–Ⅱ	-19.400 **	1.713	0.000	-16.677 **	1.695	0.000	-0.517 **	0.129	0.000
Ⅲ–M	-32.541 **	3.534	0.000	-25.920 **	3.213	0.000	-1.033 **	0.194	0.000
Brought to hospital by emergency transport									
No (base)									
Yes	-1.013	1.431	0.479	-0.488	1.343	0.716	0.039	0.100	0.696
Route of admission									
Home (base)									
Care facility	-7.52 **	2.499	0.003	-6.548 **	2.295	0.004	-0.201	0.165	0.223
Charlson Comorbidity Index (CCI)	-2.293 *	0.945	0.015	-1.905 *	0.883	0.031	-0.098	0.068	0.152
Discharge destination									
Home (base)									
Care facility	-19.982 **	3.898	0.000	-18.011 **	3.511	0.000	-0.329	0.206	0.111
Transfer to another hospital	-14.31 **	3.058	0.000	-12.813 **	2.671	0.000	-0.230	0.138	0.095
Transferred to comprehensive community care unit (CCCU)									
No (base)									
Yes	3.957	3.432	0.249	1.714	3.373	0.611	-0.897 **	0.128	0.000
Admission year									
FY 2014 (base)									
FY 2015	-3.180	2.358	0.178	-2.161	2.150	0.315	-0.125	0.164	0.445
FY 2016	-1.718	2.250	0.445	-0.959	2.088	0.646	-0.050	0.163	0.758
FY 2017	-0.422	2.222	0.849	-0.678	2.111	0.748	-0.165	0.176	0.350
FY 2018	1.460	2.600	0.574	1.828	2.591	0.481	0.274	0.192	0.154
FY 2019	-1.030	2.484	0.679	-2.877	2.350	0.221	-0.036	0.183	0.844
Barthel Index (BI) at admission				-0.808	0.024	0.000			
Length of hospital stay (days)				-0.002	0.078	0.981			
Hospital									
Okitama General Hospital (base)									
Yonezawa City Hospital	5.643 *	2.274	0.013	7.874 **	2.345	0.001	0.267 *	0.121	0.028
Sanyudo Hospital	-6.675977 **	1.548	0	-3.546 *	1.493	0.018	0.317 **	0.114	0.005
Intercept	106.993 **	7.268	0.000	88.311 **	4.655	0.000	3.022 **	0.359	0.000
Number of observations	1222			1061			1061		
(Uncensored, Left, Right)	(1077, 63, 82)								
Prob＞chi2	0.000			0.000			0.000		
Pseudo R2	0.058			0.2295			0.130		

Note: ** p<0.01 (1% significance level); * p<0.05 (5% significance level)

Appendix 1. Overview of the facilities at the three study hospitals (from the FY 2020 Hospital Bed Function Report)

				Okitama General Hospital	Yonezawa City Hospital	Sanyudo Hospital (private)
				Kawanishi Town, Yamagata Prefecture	Yonezawa City, Yamagata Prefecture	Yonezawa City, Yamagata Prefecture
Establishing body (as of July 1, 2020)				Prefecture	City	Other corporation
DPC hospital grouping				Standard DPC hospital	Standard DPC hospital	Standard DPC hospital
Approvals		Approved Regional Medical Care Support Hospital		Yes	No	No
Number of beds by function		Highly acute phase		20	5	5
		Acute phase		400	263	108
		Rehabilitative phase		—	54 (*Note 1)	60
		Chronic phase		—	—	12
		Beds out of use (ward scheduled to be closed)		26	—	—
Registration status for additional medical fee reimbursements		Registered for comprehensive acute care services		Level 2 registration	Level 3 registration	No
		Registered for home care support		No	No	Yes
Number of home care patients for whom palliative care was provided (*Note 2)	Palliative care provided outside of medical institution	Number of deaths		0	0	16
			Of these, the number which occurred at home	0	0	12
			Of these, the number which did not occur at home	0	0	4
	Palliative care provided at medical institution	Number of deaths		0	0	5
			Of these, the number which occurred at affiliated medical institutions	0	0	5
			Of these, the number which did not occur at affiliated medical institutions	0	0	0
Emergency hospital certifications		Certified tertiary emergency hospital		Yes	No	No
		Certified secondary emergency hospital		Yes	Yes	Yes
		Certified emergency hospital		Yes	Yes	Yes
Status of emergency medical services	Total number of patients seen on Sundays and public holidays			4,856	3,899	1,454
		Of these, the total number of patients who were hospitalized immediately after examination		846	621	327
	Total number of patients seen out-of-hours and at night			6,563	4,958	2,611
		Of these, the total number of patients who were hospitalized immediately after examination		1,487	990	795
	Number of patients received by ambulance			3,702	1,568	1,076
Number of medical devices	CT	Multislice CT	64 slices or more	2	1	1
			16 up to 64 slices	2	0	0
			Less than 16 slices	0	0	0
		Other CT		0	0	0
	MRI	3.0 Tesla or more		1	0	0
		1.5 up to 3.0 Tesla		1	1	1
		Less than 1.5 Tesla		0	0	0
	Other medical devices	Continuous intravascular imaging		2	1	1
		SPECT		1	1	0
		Intensity-modulated radiation therapy (IMRT)		1	0	0
Number of staff	Entire facility	Doctors	Full-time	116	43	18
			Part-time	0.9	1.7	3
		Nurses	Full-time	353	241	125
			Part-time	12.3	21.2	20

*Note 1: Yonezawa City Hospital increased its total number of community comprehensive care unit (CCCU) beds from 38 to 54 in February 2019.
*Note 2: Only reportable for registered home care support hospitals.
Source: Hospital Bed Function Report (FY 2020), wards and facilities reporting forms

Appendix 2. Group comparison of treatment outcomes by one-way ANOVA

Heart failure	Okitama General Hospital	Yonezawa City Hospital	Sanyudo Hospital	Difference between groups (p-value)
Number of admissions	1079	695	719	
Mean Barthel Index (BI) at admission	37.4	45.8	38.3	<0.01
Standard deviation (SD)	38.3	36.2	30.9	
Mean length of hospital stay (days)	17.7	27.2	27.9	<0.01
SD	13.3	22.1	22.6	
Mean BI at discharge	75.7	77.9	61.2	<0.01
SD	34.1	30.7	33.7	
Mean difference in BI between admission and discharge	32.1	28.3	19.3	<0.01
SD	35.9	35.2	25.2	
Mean hospitalization fees per day (Japanese yen [JPY])	49939.7	40216.7	35413.5	
Mean unit cost per hospitalization (JPY)	883084.8285	1095166.645	989310.8475	
Myocardial infarction	Okitama General Hospital	Yonezawa City Hospital	Sanyudo Hospital	Difference between groups (p-value)
Number of admissions	298	126	81	
Mean BI at admission	11.9	15.1	33.2	<0.01
SD	23.8	32.7	35.9	
Mean length of hospital stay (days)	14.5	22.8	23.0	<0.01
SD	7.7	15.7	13.6	
Mean BI at discharge	89.4	93.8	83.4	0.02
SD	26.1	20.1	28.4	
Mean difference in BI between admission and discharge	75.5	76.8	50.3	<0.01
SD	34.0	37.2	39.4	
Stroke	Okitama General Hospital	Yonezawa City Hospital	Sanyudo Hospital	Difference between groups (p-value)
Number of admissions	2124	949	969	
Mean BI at admission	21.0	27.6	34.8	<0.01
SD	27.5	34.9	33.0	
Mean length of hospital stay (days)	25.5	27.5	24.7	<0.01
SD	16.8	21.3	23.6	
Mean BI at discharge	59.8	54.4	56.3	<0.01
SD	41.2	41.9	39.8	
Mean difference in BI between admission and discharge	32.4	22.7	18.3	<0.01
SD	35.5	33.1	27.2	
Mean hospitalization fees per day (JPY)	49923.85	47222.58333	56253.08333	
Mean unit cost per hospitalization (JPY)	1275291.269	1298546.43	1388388.538	
Pneumonia	Okitama General Hospital	Yonezawa City Hospital	Sanyudo Hospital	Difference between groups (p-value)
Number of admissions	1281	820	743	
Mean BI at admission	50.3	36.4	40.3	<0.01
SD	42.8	38.6	34.2	
Mean length of hospital stay (days)	16.4	25.6	23.0	<0.01
SD	11.8	26.3	21.8	
Mean BI at discharge	74.8	59.8	59.5	0.02
SD	37.0	40.4	37.7	
Mean difference in BI between admission and discharge	16.2	19.7	16.2	<0.01
SD	28.3	31.5	21.4	
Mean hospitalization fees per day (JPY)	43494.35	43094.65	38386.56667	
Mean unit cost per hospitalization (JPY)	712988.0915	1102224.537	881857.667	
Femoral fracture	Okitama General Hospital	Yonezawa City Hospital	Sanyudo Hospital	Difference between groups (p-value)
Number of admissions	1071	248	362	
Mean BI at admission	21.5	6.3	12.3	<0.01
SD	34.0	12.1	14.6	
Mean length of hospital stay (days)	19.4	37.1	24.3	<0.01
SD	6.0	20.2	14.9	
Mean BI at discharge	45.1	53.9	42.7	<0.01
SD	29.0	31.8	25.0	
Mean difference in BI between admission and discharge	22.7	47.6	30.2	<0.01
SD	38.5	31.3	24.2	
Mean hospitalization fees per day (JPY)	63122.2	48414.3	63013.9	
Mean unit cost per hospitalization (JPY)	1227021.698	1797769.869	1529043.852	

Note: p<0.01 indicates that the null hypothesis (no difference between groups) is rejected at the 1% significance level.

Appendix 3. Comparison of medical resource input between groups with and without missing data relating to severity of condition (Barthel Index [BI] and New York Heart Association [NYHA] classification at admission)

	Heart failure	Without missing BI at admission	With missing BI at admission	P-value
Okitama General Hospital	Mean daily medical resource input per patient within 7 days of admission (Japanese yen [JPY])	57,858.8	51,110.1	0.03**
	SD	40,050.2	2,501.9	
Yonezawa City Hospital	Mean daily medical resource input per patient within 7 days of admission (JPY)	18,643.1	19,070.8	0.88
	SD	24,749.6	20,298.4	
	Heart failure	Without missing NYHA at admission	Without missing NYHA at admission	P-value
Okitama General Hospital	Mean daily medical resource input per patient within 7 days of admission (JPY)	58,377.9	55,108.5	0.18
	SD	46,130.7	33,419.3	
Yonezawa City Hospital	Mean daily medical resource input per patient within 7 days of admission (JPY)	18,469.6	20,094.5	0.54
	SD	24,397.2	23,544.2	
Sanyudo Hospital	Mean daily medical resource input per patient within 7 days of admission (JPY)	24,131.0	28,665.2	<0.01***
	SD	16,189.0	17,521.3	
	Myocardial infarction	Without missing BI at admission	With missing BI at admission	P-value
Okitama General Hospital	Mean daily medical resource input per patient within 7 days of admission (JPY)	271,445.6	293,544.0	0.60
	SD	202,371.0	428,695.9	
Yonezawa City Hospital	Mean daily medical resource input per patient within 7 days of admission (JPY)	168,975.2	178,741.2	0.75
	SD	100,203.3	107,550.7	
	Stroke	Without missing BI at admission	With missing BI at admission	P-value
Okitama General Hospital	Mean daily medical resource input per patient within 7 days of admission (JPY)	73,126.9	65,714.1	0.07*
	SD	70,463.6	63,865.4	
Yonezawa City Hospital	Mean daily medical resource input per patient within 7 days of admission (JPY)	41,123.8	33,743.0	0.14
	SD	65,546.2	49,205.5	
	Pneumonia	Without missing BI at admission	With missing BI at admission	P-value
Okitama General Hospital	Mean daily medical resource input per patient within 7 days of admission (JPY)	40,608.7	37,908.1	0.05*
	SD	22,635.8	18,564.9	
Yonezawa City Hospital	Mean daily medical resource input per patient within 7 days of admission (JPY)	16,811.5	16,366.3	0.80
	SD	17,288.1	14,160.5	
	Femoral fracture	Without missing BI at admission	With missing BI at admission	P-value
Okitama General Hospital	Mean daily medical resource input per patient within 7 days of admission (JPY)	101,149.1	99,900.8	0.53
	SD	28,094.7	24,308.2	
Yonezawa City Hospital	Mean daily medical resource input per patient within 7 days of admission (JPY)	74,381.6	79,592.9	0.52
	SD	44,038.3	41,159.6	