

Infectious disease during hospitalization is the major causative factor for prolonged hospitalization: multivariate analysis of diagnosis procedure combination (DPC) data of 20,876 cases in Japan

Susumu Fujii,^{1,*} Megumi Hara,² Sayuri Nonaka,¹ Shinichiro Ishikawa,¹ Yosuke Aoki,¹ Keizo Anzai,¹ Shigeki Morita,¹ Kazuma Fujimoto¹ and Masaaki Mawatari¹

¹Saga University Hospital and ²Department of Preventive Medicine, Saga University, 5-1-1 Nabeshima, Saga 849-8501, Japan

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This study aimed to evaluate causative factors for prolonged hospitalization based on hospitalization status, type of hospital ward, and comorbidities, specifically diabetes mellitus and infectious diseases, in 20,876 patients hospitalized in Saga University Hospital from April 1, 2012, to February 28, 2015. Prolonged hospitalization was defined as hospital days exceeding period 3 in the diagnosis procedure combination system. Among all factors, causative (risk) factors for prolonged hospitalization were evaluated by multiple logistic regression analysis. Multivariate analysis indicated causative factors for prolonged hospitalization were aging, comorbid diabetes mellitus, time spent in the intensive care unit, and infectious diseases contracted during hospitalization. The risk factors for contracting infectious diseases during hospitalization were aging, male sex, comorbid diabetes mellitus, and increased number of days spent in period 3 in the diagnosis procedure combination code. These data indicated that critical factors for discharge from hospital within an appropriate time frame were prevention of infectious diseases during hospitalization, and a fast and effective therapeutic approach to patients in the intensive care unit.

Key Words: DPC, diabetes mellitus, age, males, intensive care unit

The hospitalization period in acute care hospitals in Japan is regulated by several factors including disease severity, general condition of patients, and therapeutic intervention of surgery and/or other intensive cares.⁽¹⁻⁹⁾ These factors suggest that the hospitalization period is one index for evaluating quality of medical care.^(2,5,6) Namely, reducing hospitalization days is a reliable index for improving patient prognosis and quality of medical care in Japan.^(1,6)

The diagnosis procedure combination (DPC) system was introduced in 2003 in Japanese medical hospitals authorized to treat patients with health insurance.^(1,10,11) The DPC system was practiced in 55% of all general sickbeds in 1,585 hospitals with a total of 492,256 sickbeds.⁽¹²⁾ The main purpose of introducing the DPC system into intensive care hospitals in Japan is to maintain a supply of above average medical care.⁽¹⁾ The DPC system regulates diagnostic and therapeutic approaches in each DPC code for standardization of medical care, and regulates the hospitalization period in each DPC code.^(1,12) In the DPC, hospital days are set for every identical diagnostic classification (DPC code) as follows: period 1: <25 percentile of hospital days; period 2: <50 percentile

of hospital days; and period 3: within mean \pm 2SD.

The aim of the present study was to evaluate causative (risk) factors for prolongation of hospitalization days in excess of period 3 according to the DPC system in 20,869 patients in Saga University Hospital. The evaluated factors for prolongation of hospitalization period in the present study were hospitalization status with emergency or scheduled admission, selected ward of emergency care unit (ECU), intensive care unit (ICU), beds for general patients, and comorbidities regarding diabetes mellitus and infectious diseases.

Materials and Methods

In the DPC system, hospital days are set for every identical diagnostic classification (DPC code) as follows: period 1: <25 percentile of hospital days; period 2: <50 percentile of hospital days; and period 3: within mean + 2SD.^(1,11) A patient whose hospitalization period exceeds period 3 is recognized as a significantly prolonged case compared with the national case in each identical diagnostic classification (DPC code). According to the DPC definition, 20,876 patients hospitalized in Saga University Hospital from April 1, 2012, to February 28, 2015, were classified into two groups: group I, with hospitalization days within period 3, and group II, with hospitalization days exceeding period 3.

In groups I and II, the present study evaluated age, gender, hospitalization days, mortality rate during hospitalization, number of days in period 3 in each DPC code, emergency or planned hospitalization, ambulance transportation, use of ICU and/or ECU, and underlying diseases (comorbidities) before and/or during hospitalization, focusing on diabetes mellitus and infectious diseases. Among these factors, causative factors for prolongation of hospitalization (group II) were evaluated by multiple logistic regression analysis. All procedures performed in this study were approved by the Ethical Committee of Saga University Hospital (2015-05-05).

In the statistical analysis, chi square test or Mann-Whitney *U* test was used for comparison between the two groups, and $p < 0.05$ was used for significant difference. Multiple logistic regression analysis was conducted, with prolonged number of hospital days and onset of infection during hospitalization as objective vari-

*To whom correspondence should be addressed.
E-mail: sfujii@cc.saga-u.ac.jp

ables. StatFlex (Windows software) ver. 6 was used for statistical analysis.

Results

Table 1 shows the baseline characteristics of the patients hospitalized in Saga University Hospital in the DPC system. Mean age was 57.6 years, and mean hospitalized days were 15.0. ECU was required for 1,237 patients and ICU for 859 patients. As indicated in Table 2, the mortality rate during hospitalization was 1.0%, i.e., 215 of 20,876 patients. The number of patients transported by ambulance was 2,724 (13.1%), and the number requiring emergency hospitalization was 3,008 (14.4%). In total, 2,534 patients (12.1%) had diabetes mellitus, while 765 patients (3.7%) had infectious diseases at admission and 502 patients (2.4%) during hospitalization. The number of patients categorized into group II (hospitalization days beyond period 3) was 2,356 of

20,876 (11.3%).

Table 3 shows causative factors for prolongation of hospitalization days beyond period 3 evaluated by univariate analysis. Aging but not gender was a risk factor for long hospitalization. Mortality was high in group II compared with group I ($p = 0.020$). Setting days of period 3 in each DPC influenced categorization of group II, indicating that DPC code with short setting DPC days was significantly higher when classified into group II ($p < 0.001$). Ambulance transportation and unplanned (emergency) hospitalization did not prolong hospitalization days. Compared with group I, the patients in group II were more likely to occupy beds for general patients and ICU, but not ECU. Comorbidity of infectious diseases at admission was not a risk factor for prolongation of hospitalization, whereas comorbidities of diabetes mellitus and infectious diseases during hospitalization significantly prolonged hospitalization days ($p < 0.001$ for each).

Causative factors for long hospitalization (group II) analyzed by

Table 1. Backgrounds of the 20,876 hospitalized patients

Age (years)	57.6 ± 24.2 (0–105)
Gender (males/females)	10,221/10,664 (49.0%/51.0%)
Setting days of period 3 in each DPC	25.9 ± 18.8 (3–129)
Hospitalization days	15.0 ± 16.2 (1–349)
Days in beds for general patients ($n = 18,794$)	13.29 ± 15.03 (1–312)
Days in ECU ($n = 1,237$)	4.04 ± 3.70 (1–14)
Days in ICU ($n = 859$)	4.20 ± 5.29 (1–54)

Data are mean ± SD. DPC, diagnosis procedure combination; ECU, emergency care unit; ICU, intensive care unit.

Table 2. Characteristics of the 20,876 hospitalized patients

Mortality during hospitalization	215 (1.0%)
Ambulance transportation	2,724 (13.1%)
Emergency and/or unplanned hospitalization	3,008 (14.4%)
Complication of diabetes mellitus	2,534 (12.1%)
Complications of infectious diseases	
At admission	765 (3.7%)
During hospitalization	502 (2.4%)
Group II (hospitalization days beyond period 3)	2,356 (11.3%)

Table 3. Comparison between patients with standard hospitalization time within period 3 (group I) and long hospitalization beyond period 3 (group II)

	Group I ($n = 18,520$)	Group II ($n = 2,356$)	p value
Age (years)	57.5 ± 24.2	58.6 ± 23.5	0.018
Gender (males/females)	9,062/9,456	1,159/1,197	ns*
Setting days of period 3 in each DPC	26.5 ± 18.6	21.5 ± 19.5	<0.001
Mortality	180 (0.97%)	35 (1.49%)	0.02*
Ambulance transportation	2,425 (13.1%)	299 (14.5%)	ns*
Unplanned hospitalization	2,674 (14.4%)	334 (14.2%)	ns*
Hospitalization days	12.7 ± 0.8	32.9 ± 32.2	<0.001
Days in beds for general patients	11.6 ± 10.6	30.2 ± 31.7	<0.001
Days in ECU (total days = 1,092,145)	3.99 ± 3.72 (1–14)	4.35 ± 3.55 (1–14)	ns
Days in ICU (total days = 718,141)	3.55 ± 4.22 (1–21)	7.51 ± 8.19 (1–54)	<0.001
Diabetes mellitus	2,169 (11.7%)	365 (15.5%)	<0.001*
Infectious diseases			
At admission	674 (3.6%)	91 (3.9%)	ns*
During hospitalization	395 (2.1%)	107 (4.5%)	<0.001*

Data are mean ± SD. *Evaluation by chi square test. ns, not significant; DPC, diagnosis procedure combination; ECU, emergency care unit; ICU, intensive care unit.

multivariate analysis are indicated in Table 4. Mortality rate and hospitalization days were not included in the analysis. Age, short setting period in DPC days, and days spent in ICU were risk factors for prolonged hospitalization. Regarding comorbidities, diabetes mellitus and infection diseases during the hospital stay were risk factors for long hospitalization.

Table 5 shows risk factors for contracting infectious diseases during hospitalization evaluated by univariate analysis. These were aging, long setting days of period 3 in each DPC, high mortality rate, ambulance transportation, unplanned hospitalization, long periods of using beds for general patients, ECU, and

ICU, and comorbidity of diabetes mellitus and infectious diseases at admission. As indicated in Table 6, multivariate analysis showed that significant risk factors for suffering from infectious diseases during hospitalization were aging, DPC code with long setting days of period 3, days in ICU, and comorbid diabetes mellitus.

Discussion

The present study clearly demonstrated that the main causative factors for prolongation of hospitalization in an acute and inten-

Table 4. Factor analysis of long hospitalization over period 3 (group II) evaluated by multiple logistic regression analysis

Variable	β	SE (β)	z value	p value	OR	95% CI
Age	0.0056	0.001	5.67	0.00	1.006	1.004–1.008
Setting days of period 3 In each DPC	-0.023	0.002	14.67	0.00	0.98	0.975–0.98
Using days of ICU	0.14	0.012	11.35	0.00	1.15	1.12–1.18
Diabetes mellitus	0.273	0.063	4.34	0.00	1.31	1.16–1.49
Infectious diseases During hospitalization	1.06	0.117	9.06	0.00	2.89	2.29–3.63

Conformity degree index of the regression: AIC = 14309.06186. AUC = 0.64011. OR, odds ratio; CI, confidence interval; β , regression coefficient; SE (β), standard error (β); DPC, diagnosis procedure combination; ICU, intensive care unit.

Table 5. Risk factors for infection diseases during hospitalization evaluated by chi square test or Mann-Whitney U test

	No infection during hospitalization (n = 20,374)	Infection during hospitalization (n = 502)	p value
Age (years)	57.5 ± 24.3	64.4 ± 19.2	<0.001
Gender (males/females)	10,375/9,999	280/222	0.032*
Setting days of period 3 in each DPC	25.4 ± 18.1	46.0 ± 30.6	<0.001
Mortality	179 (0.88%)	36 (7.17%)	<0.001*
Ambulance transportation	2,617 (12.8%)	107 (21.3%)	<0.001*
Unplanned hospitalization	2,889 (14.1%)	119 (23.7%)	<0.001*
Hospital days	14.5 ± 5.2	33.2 ± 33.6	<0.001
Days in beds for general patients	11.6 ± 10.6	30.1 ± 31.7	<0.001
Days in ECU	3.91 ± 3.58 (1–14)	6.92 ± 5.19 (1–14)	<0.001
Days in ICU	4.19 ± 5.31 (1–54)	4.34 ± 5.13 (1–20)	<0.001
Diabetes mellitus	2,444 (12.0%)	90 (17.9%)	<0.001*
Infectious disease On admission	785 (4.1%)	74 (9.5%)	<0.0335*

Data are mean ± SD. *Evaluation by chi square test. DPC, diagnosis procedure combination; ECU, emergency care unit; ICU, intensive care unit.

Table 6. Multiple logistic regression analysis for related factors in infectious diseases during hospitalization

Variable	β	SE (β)	z value	p value	OR	95% CI
Age	0.01	0.002	4.36	0.000	1.01	1.005–1.015
Gender (males)	-0.194	0.093	2.06	0.038	0.82	0.69–0.98
Setting days of period 3 In each DPC	0.031	0.001	19.33	0.000	1.03	1.029–1.035
Ambulance transportation	0.125	0.175	0.715	0.473	1.13	0.80–1.6
Unplanned hospitalization	0.248	0.167	1.486	0.137	1.28	0.92–1.78
Days in ECU	-0.009	0.023	0.39	0.696	0.99	0.95–1.04
Days in ICU	0.083	0.018	4.459	0.000	1.09	1.05–1.13
Diabetes mellitus	0.365	0.123	2.958	0.003	1.44	1.13–1.83
Infectious disease On admission	0.261	0.196	1.328	0.183	1.30	0.88–1.91

Conformity degree index of the regression: AIC = 4,295.79865, AUC = 0.72483. OR, odds ratio; 95% CI, 95% confidence interval; β , regression coefficient; SE (β), standard error (β); DPC, diagnosis procedure combination; ECU, emergency care unit; ICU, intensive care unit.

sive care hospital in Japan were: i) contracting infectious disease during hospitalization; ii) aging; iii) comorbid diabetes mellitus; and iv) a long stay in ICU. Infectious diseases at admission were not risk factors for increased hospitalization days.

Infectious diseases during hospitalization were caused by several factors including nosocomial infection and infection following intensive intervention including surgery.^(13,14) The results of the present study suggest that infectious disease complications during hospitalization were linked to increased severity of the patient's illness. This was demonstrated by the higher mortality rate in group II (the prolonged hospitalization group) of 1.49%, which was significantly higher than in group I (0.97%). However, the present study did not examine in detail the causes of mortality and/or infectious diseases during hospitalization because of ethical limitations, and these areas warrant further exploration. Aging and diabetes mellitus, which might exacerbate infectious diseases, were also risk factors for prolongation of hospitalization. Regulation and control of infectious diseases during hospitalization has been enforced by the infectious diseases control division in the hospital,^(13,15,16) and the present study clearly demonstrated the importance of infectious disease control during hospitalization.

In contrast to infectious diseases during hospitalization, infectious diseases at admission were not a risk factor for long hospitalization. This might be because treating these diseases was the main purpose of hospitalization, and/or that control of these comorbidities was relatively achieved before admission for therapeutic intervention. This study indicated that diabetes mellitus and aging were risk factors for infection during hospitalization, which suggests that careful medical support is required for these patients during hospitalization. The results of the present study showed that long duration in ICU was equivalent to long hospitalization, indicating that speedy movement from ICU to general beds, with appropriate therapeutic intervention, was required for quick discharge, in turn leading to improved prognosis for these patients.

Regarding setting days of period 3 in each DPC, this study revealed two results: i) the setting days of period 3 was shorter in group II compared with group I, and ii) setting days of period 3 was longer in the patients with infectious diseases during hospital-

ization. The first result suggests that setting days may be re-evaluated in several DPC codes, while the second indicates that setting days of DPC was appropriately long in severe diseases with infection during hospitalization.

In conclusion, this relatively large study with 20,876 patients indicated that the most important factor for reducing hospitalization days was to prevent infection during hospitalization especially for aged and/or diabetes mellitus patients. Rapid removal from ICU with appropriate therapeutic approaches might be also important for reducing hospitalization days.

Authors' Contributions

Principal investigator, data collection, statistical analysis, and manuscript preparation: Susumu Fujii. Statistical analysis: Megumi Hara. Data collection and statistical analysis: Sayuri Nonaka. Data collection: Shinichiro Ishikawa, Yosuke Aoki, Keizo Anzai, Shigeki Morita, Kazuma Fujimoto, and Masaaki Mawatari.

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Abbreviations

DPC	diagnosis procedure combination
ECU	emergency care unit
ICU	intensive care unit

Conflict of Interest

No potential conflicts of interest were disclosed.

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