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Original Paper

ICU Delirium Severity Assessment Needs to Be Introduced into the Japanese Medical Fee System

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Abstract

The impact of severity of ICU delirium on health care costs in Japan has not been clarified. The purpose of this study was to evaluate the relationship between severity of ICU delirium, hospital length of stay, and medical costs in the Japanese reimbursement system. We performed a retrospective cohort study within medical and surgical ICUs at university and general hospitals in Japan that adopt the Diagnosis Procedure Combination/Per-Diem Payment System (DPC/PDPS) system. We examined its ICU delirium severity (i.e., No delirium, Subsyndromal delirium, Delirium) relationship between the ICU length of stay and hospitalizations and medical costs for each group. The study population consisted of 122 patients (65.6% male), aged 72.5 ± 10.81 (median ± SD) years. Hospital and ICU lengths of stay were 26.0 ± 23.63 days, and 5.0 ± 3.51 days, respectively. The patients were categorized into 3 groups: No delirium (N = 32, 26.2%), Subsyndromal delirium (N = 53, 43.4%) and Delirium (N = 37, 30.4%). Statistically significant differences were observed between all 3 groups in medical costs ($P < 0.01$), between No delirium and Subsyndromal delirium ($P < 0.01$) and between No delirium and Delirium ($P < 0.01$) in ICU days, and between No delirium and Delirium in hospital length of stay ($P < 0.01$).

1. Introduction

Delirium is an acute brain dysfunction caused by a variety of risk factors[1]. Previous studies have shown that delirium, which is also observed in many patients in an intensive care unit (ICU), can lead to a worse prognosis[2,3], a lower cognitive function in the medium to long term, a lower quality of life (QOL), and a prolonged hospitalization[4-8]. The U.S. healthcare system has shown a significant increase in health care costs associated with the onset of ICU delirium[9,10]. Furthermore, significant increases in costs after adjusting for the severity of time-varying illness and the length of ICU stay associated with delirium have been reported[11].

However, treatment guidelines for ICU delirium vary widely depending on different countries. Up

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until 2018, ICU delirium management in the US was based on the Pain Agitation and Delirium (PAD) guidelines[12], and since 2018, it has been based on the Pain, Agitation/sedation, Delirium, Immobility, and Sleep disruption (PADIS) guidelines[13]. In Japan, on the other hand, ICU delirium management is generally based on the Japanese guidelines for the management of Pain, Agitation, and Delirium (J-PAD)[14]. Therefore, the insurance coverage for different types and doses of drugs vary between both countries. In other words, the comparison of the impact of ICU delirium on healthcare costs from two aspects, ICU delirium management guidelines and insurance coverage, is limited between both countries to disease severity and length of ICU stay and hospitalization.

In the DSM-5 revision (2013), the definition of delirium was revised and added the fact that delirium is time-varying in severity[1]. The Confusion Assessment Method for the Intensive Care Unit (CAM-ICU)[15] and the Intensive Care Delirium Screening Checklist (ICDSC)[16] are recommended for the assessment of delirium in the PADIS guidelines[13] that are also used as standard assessment tools in Japan[14,17-20]. The CAM-ICU is a two-category assessment (with or without delirium) and evaluates only the presence or absence of delirium[15]. The ICDSC is an 8-point scale, which is characterized to allow the assessment of delirium severity; No Delirium (ND; ICDSC 0 point), Subsyndromal Delirium (SD; ICDSC 1-3 points), and Delirium (ICDSC 4-8 points)[16].

In Japan, national health care expenditure, as a percentage of the Japanese government's general budget, has continued to increase due to the advancement of health care and an ageing population[21]. The infrastructure of the healthcare system is under pressure with limited financial sources and resources. Japan has traditionally used a fee-for-service reimbursement system, but has introduced the Diagnosis Procedure Combination/Per-Diem Payment System (DPC/PDPS)[†1] to balance the quality of medical care and economy[22,23]. However, the impact of ICU delirium severity on medical costs has not been reported in Japan's health care expenditure system.

The purpose of this study was to investigate the impact of ICU delirium severity on medical costs, which remains unknown under the Japanese healthcare system; we aimed to examine the relationship between the ICDSC total score (delirium severity) and the length of ICU stay and hospitalization, and medical costs at two university hospitals in Japan that use the DPC/PDPS system.

2. Methods

2.1 Research design

Retrospective cohort study was carried out.

2.2 Setting

ICU units of university and general hospitals in Japan that adopt the DPC/PDPS (Japanese medical expenses system).

2.3 Ethical approval

Consent was obtained through an opt-out method and patient consent forms were posted on the institutional websites where the investigations were carried out. This study was conducted with the approval of the Ethics Committees of Kawasaki University of Medical Welfare (Approval No.: 18-047) and Kawasaki Medical School Hospital (Approval No.: 3147).

2.4 Participants

Since the Japanese medical fee system is revised every two years, all scheduled cardiovascular and esophageal surgery patients who entered the ICU and left the ICU between April 1, 2016 and March 31, 2018, the period to which the fiscal 2016 medical fee revision applies, were included in the study. Exclusion criteria were those who were under 20 years of age, had a history of psychiatric disorders, or were unable to communicate in Japanese.

2.5 Data collection

2.5.1 Measurements

The survey items included basic patient information, ICU delirium severity, number of days with ICU delirium, length of hospitalization, length of stay in ICU, and medical expenses.

(1) Obtain basic patient information such as age, gender, diagnosis, and surgery from Form 1 in DPC/PDPS data (impact assessment survey to be prepared and submitted by the hospital).

(2) ICU delirium severity

In this study, ICU-delirium severity was determined by the highest ICDSC score (ICDSCmax) during the ICU stay. The Japanese version of the ICDSC was developed from the original version of the ICDSC. The validity and reliability have been verified, and are recommended in the Japanese version of the PAD guidelines. ICDSC at the time of ICU discharge was defined as ICDSC exit.

(3) ICU delirium days

The number of days with the highest ICDSC score of 4 or more was counted as the number of days with ICU delirium.

(4) Hospital length of stay (HLOS)

Hospital length of stay (HLOS) is the period from hospital admission date to discharge in the DPC/PDPS data.

(5) ICU length of stay (ICULOS)

ICU length of stay was calculated by obtaining information on ICU admission and ICU discharge from a patient's electronic medical record.

(6) Medical cost (Cost)

Medical expenses were calculated as the sum of the medical fee points extracted from the D file in the DPC/PDPS data and the cost of drugs and materials required for medical treatment.

(7) Conversion period from US dollars into Japanese yen: The exchange rate at an annual average of 110.89 yen/US dollar (the exchange rate of the period from April 2017 to March 2018) was used.

2.5.2 Procedures

Information not registered in the DPC/PDPS data was obtained from the electronic medical records using the patient ID provided by the medical affairs section of each hospital. Basic patient information, hospitalization period, and medical cost data were extracted from the DPC/PDPS data. The ICU delirium severity (ICDSC), the number of days of ICU delirium, and the duration of ICU stay were extracted from the electronic medical records.

2.6 Statistical analysis

The analysis was performed by dividing the subjects into three groups according to the highest ICDSC scores: the No delirium group (NDg: ICDSC 0 points), the Subsyndromal delirium group (SDg: ICDSC 1-3 points), and the Delirium group (Dg: ICDSC 4-8 points). The median and standard deviation of hospitalization duration, ICU stay, and medical costs were calculated for each group. Between-group comparisons were performed using the Kruskal-Wallis test to compare the three groups, followed by the Bonferroni's test which was used to compare each combination of the groups. To clarify the trend in the patients' outcome associated with the change in delirium severity, we used the Jonckheere-Terpstra test for the duration of hospitalization and ICU stay. We also calculated Pearson's product-moment correlation coefficients between the highest ICDSC score and the duration of hospitalization, ICU stay, and medical costs. In addition, a single regression analysis was performed using the duration of hospitalization and ICU stay as independent variables and the highest ICDSC scores as a dependent variable. In both analyses, EZR on R commander (Version 1.53) was used and the significance level was set at $P < 0.05$.

3. Results

3.1 Participants

A total of 122 patients participated in the study at two hospitals (Table 1). The mean age was 72.50 ± 10.81 (SD) (range 38-94) years, of which 106 (86.9%) were post cardiovascular surgery patients and 80 (65.6%) were male. The median ICU length of stay (ICULOS) was 5.00 ± 3.51 (± SD; range 2.00-16.00) days, the median hospital length of stay (HLOS) was 26.00 ± 23.63 (± SD; range 10.00-160.00) days, and the median medical cost (Cost) was 45233.16 ± 19786.66 (± SD; range 33540.74-56218.08) USD. The higher incidence and severity of delirium were observed in older participants. The median age was 68 ± 11.31(SD) years in the NDg, 71 ± 11.36 years in the SDg, and 76 ± 7.58 years in the Dg, with statistically significant differences ($P < 0.05$) between NDg vs. Dg and SDg vs. Dg.

Table 1 Participants

		ALL (n=122)	Delirium (n=32)	Subsyndromal delirium (n=53)	Not delirium (n=37)
Age		72.50 ± 10.81 [38-94]	76 ± 7.58 [73-82]	71 ± 11.36 [63-78]	68 ± 11.31 [63-76]
Sex	Male	80 (65.6%)	21 (65.6%)	36 (67.9%)	23 (62.1%)
	Female	42 (34.4%)	11 (34.4%)	17 (32.1%)	14 (37.8%)
Surgery	Cardiovascular surgery	106 (86.9%)	27 (84.4%)	44 (83.0%)	35 (94.6%)
	Esophageal surgery	16 (13.1%)	5 (15.6%)	9 (17.0%)	2 (5.4%)
ICULOS		5.00 ± 3.51 [2.00, 16.00]	7 ± 3.88 [5.00, 9.00]	5 ± 3.28 [3.00, 7.00]	2 ± 2.14 [2.00, 4.00]
HLOS		26.00 ± 23.63 [10.00, 160.00]	31 ± 32.00 [23.00, 51.00]	27 ± 20.40 [21.00, 36.00]	22 ± 11.36 [16.00, 32.00]
Cost (USD)		45233.16 ± 19786.66 [33540.74, 56218.08]	53546.04 ± 19546.7 [45322.21,62036.88]	45596.54 ± 19385.21 [33243.76,57241.95]	34648.30 ± 12504.61 [23874.47,43090.18]

3.2 Delirium-related findings

The number of patients who showed the highest ICDSC scores (ICDSCmax) during ICU admission was 32 (26.2 % of a total of 122 patients) in the NDg, 52 (42.6 %) in the SDg and 37 (30.3 %) in the Dg. The number of patients who showed the highest ICDSC scores at point of ICU discharge (ICDSC discharge) was 82 (67.2 %) in the NDg, 36 (29.5 %) in the SDg and 4 (3.3 %) in the Dg.

3.3 ICU delirium severity and ICU length of stay (ICULOS)

The median ICU length of stay (ICULOS) was 2 ± 2.14 days (SD; range 2-10) in the NDg, 5 ± 3.28 days (SD; range 3-7) in the SDg, and 7 ± 3.88 days (SD; range 5-9) in the Dg with significant differences ($P < 0.01$) between NDg vs. Dg and SDg vs. Dg. The Jonckheere-Terpstra test showed that the duration of ICU tended to prolong as the severity of the disease worsened ($P < 0.05$, Figure 1).

3.4 Delirium severity and hospital length of stay (HLOS)

The hospital length of stay (HLOS) was prolonged in patients with the Dg (ICDSC points 4 or more); the median length of hospital stay was 22 ± 11.36 (SD; range 16-32) days in the NDg, 27 ± 20.42 (SD; range 21-36) days in the SDg, and 31 ± 32.00 (SD; range 23-51) days in the Dg (Table 1). The HLOS in the Dg was significantly longer than the NDg ($P < 0.01$, Figure 2). The Jonckheere-Terpstra test showed that the length of hospital stay tended to increase with the severity of ICU delirium ($P < 0.05$).

3.5 ICU delirium severity and medical costs

Medical costs increased with the severity of delirium (increase of ICDSCmax). The medical costs were

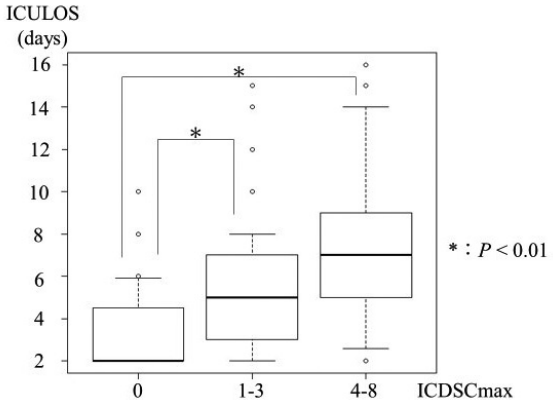

Figure 1 ICU delirium severity and ICU length of stay (ICULOS)

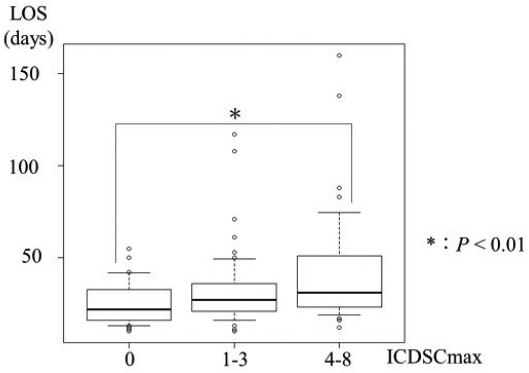

Figure 2 Delirium severity and hospital length of stay (HLOS)

34648.30 ± 12504.61USD (median ± SD; range 23874.47-43090.18) in the NDg, 45596.54 ± 19385.21 (median ± SD; range 33243.76-57241.95) in the SDg, and 53546.04 ± 19546.7 (median ± SD; range 45322.21-62036.88) in the Dg (Table 1). All group comparisons were significantly different (Kruskal-Wallis test, $P < 0.01$; Figure 3). The Bonferroni test showed significant differences between all groups (NDg vs. SDg: $P < 0.01$; NDg vs. Dg: $P < 0.01$; SDg vs. Dg: $P < 0.05$).

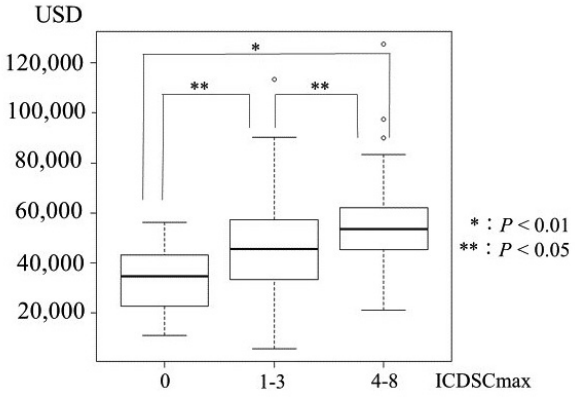

Figure 3 ICU delirium severity and medical costs

3.6 Correlation of the highest ICDSC scores with ICULOS, HLOS and medical costs

There were moderate positive correlations between the highest ICDSC score (ICDSCmax) with the ICULOS, the HLOS and the medical costs (ICDSCmax vs. ICLOS: r = 0.474, 95% confidence interval [CI], 0.323 to 0.601, $P < 0.01$; ICDSCmax vs. HLOS: r = 0.384, 95% CI, 0.221 to 0.526, $P < 0.01$; ICDSCmax vs. medical costs: r = 0.511, 95% CI, 0.367 to 0.631, $P < 0.01$).

3.7 The effect of the highest ICDSC scores on ICULOS and HLOS

The single regression analysis demonstrated that ICU length of stay (ICULOS) and hospital length of stay (HLOS) were significantly associated with the highest ICDSC scores (ICDSCmax). Table 2 shows the effect of the highest ICDSC scores on the duration of ICU admission. In the single regression analysis, with ICULOS as an independent variable and ICDSCmax as a dependent variable, the adjusted R^2 of the model was 0.22 indicating a significant association between the ICDSCmax and the ICULOS ($\beta = 0.79$, $P < 0.05$, Table 2). Furthermore, in the single regression, with the HLOS as an independent variable and ICDSCmax as a dependent variable, the adjusted R^2 was 0.14 indicating a significant association between the ICDSCmax and the HLOS ($\beta = 4.3$, $P < 0.05$, Table 3).

Table 2 The effect of the ICDSCmax on ICULOS

	β	SE	95%CI	P
Intercept	3.65	0.43	2.81-4.50	<0.05
ICDSCmax	0.79	0.13	0.52-1.05	<0.05

Adjusted R-squared: 0.22

Table 3 The effect of the ICDSCmax on HLOS

	β	SE	95%CI	P
Intercept	22.89	3.00	16.94-28.85	<0.05
ICDSCmax	4.3	0.94	2.43-6.17	<0.05

Adjusted R-squared: 0.14

4. Discussion

We found that an increase in ICU delirium severity was associated with an increase in ICU length of stay, hospitalization duration and medical costs under Japan's healthcare cost system. In addition, ICU delirium severity was significantly related to ICU length of stay and hospitalization period. Because of the DPC/PDPS system in Japan, the burden on medical institutions increases as the length of hospital stay increases. This result is similar to a previous study from other countries[9,11], however, most previous studies on the cost impact of ICU delirium have examined the presence or absence of ICU delirium, not the severity of ICU delirium. In our study, we found significant differences in medical costs between all NDg, SDg and Dg groups, underscoring the importance of evaluating the economic health policies of each country based on ICU delirium severity.

Moreover, in addition to the conventional relationship between the cost and the number of delirium days and days hospitalized, our study provided an important finding to support that the new relationship between ICU delirium severity and cost by ICDSCmax can be used as an economic health indicator. However, we cannot deny the possibility that these data may specifically represent the situations in the Japanese ICU care system because ICU care situations vary across different countries; it is necessary to take into account that the ICU admission situation, the healthcare cost system, and the ICU nurse staffing

ratio differ in each country.

There are disparities in the number of ICU beds in each country. Germany has the largest number of beds (33.9 beds/100,000), whereas Mexico has the smallest (3.3 beds/100,000), and the OECD average (data from 22 countries) is 12 beds/100,000[24]. There is a large disparity in the number of ICU beds in each country as shown in the number of ICU beds in the U.S, which provided the PAD guidelines, 25.8 beds/100,000, while the number in Japan is 5.2 beds/100,000, which presumes that the length of ICU stay is affected by the number of ICU beds, and therefore it is necessary to interpret the data based on each country's situation.

The ICU delirium management in Japan is influenced by the Japanese healthcare cost system. The Japanese version of the PAD guideline (J-PAD) is not a Japanese translation of the PAD guideline, but it has been modified to take into account the Japanese insurance coverage on drugs. Dexmedetomidine was found to be effective in preventing ICU delirium in a randomized controlled trial (RCT)[25] where the dexmedetomidine was administered at a dose of 1.4 μg/kg/hr, which accords with the PAD guidelines. However, as the Japanese insurance coverage for the administration of dexmedetomidine is at a dose of 0.2-0.7 μg/kg/hr[14], it is considered that the dose difference affects the duration of sedation and this may not only affect the period of onset of ICU delirium but also the length of ICU stay and hospitalization.

Furthermore, changes in the duration of sedation also affect the duration of ventilation and the start of weaning, which affect the overall management of ICU patients as seen the ABCDE bundle[26], and are influenced by many confounding factors. The status of ICU nurse staffing also affects the PAD management[27], therefore a cost analysis needs to be performed by taking into account the number of ICU nurses and ICU delirium severity. Previous studies have considered the relationship between disease severity and cost, but we were not able to collect disease severity score data in this study. However, while the severity scores (sequential organ failure assessment [SOFA] score, Acute Physiology And Chronic Health Evaluation [APACHE] II & III, Simplified Acute Physiology Score [SAPS] II) adopted in Japan and other countries are not standardized, the fact that we showed the impact of ICU delirium severity on healthcare costs is an important finding for evaluating economic healthcare policies not only in Japan but also in other countries; there is a clear need to investigate the impact of ICU delirium severity on healthcare costs under each country's healthcare system.

5. Limitations

Since two methods of assessing ICU delirium, CAM-ICU and ICDSC, are commonly used in Japan, the results may vary depending on the difference in ICU delirium detection power between these two assessments. In addition, since this was a survey of only two facilities, a nationwide survey will be needed. As Japan's healthcare funding system did not require a disease severity assessment (e.g., SOFA score) at the time of the survey, we could not conduct the survey taking into account the disease severity data of all eligible patients. However, we were able to show the impact on healthcare costs by using the recommended measures in the standard ICU guideline, which can be performed solely by nurses. Although there were some limitations of the study, we believe our findings enhance the feasibility for future economic health research. On the other hand, the SOFA score was added to the requirements for the inpatient management fee calculated at the time of ICU admission in the FY 2018 revision of medical fees in Japan. Data analysis combined with the SOFA scores will be necessary in the future.

6. Conclusion

ICU delirium severity prolongs ICU length of stay and hospitalization duration, increasing healthcare costs in the Japanese healthcare cost system. It is recommended that the Japanese healthcare cost system introduces the ICU delirium severity assessment. The impact of ICU delirium severity on different healthcare cost systems needs to be investigated in each country.

Acknowledgements

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Notes

† 1) The Diagnosis Procedure Combination/Per-Diem Payment System (DPC/PDPS) is different from the conventional fee-for-service reimbursement system based on the number of points for each medical procedure; the DPC is a calculation method that combines the portion of conventional fee-for-service evaluation (surgery, gastroscopy, rehabilitation, etc.) and the portion of comprehensive evaluation (basic hospital fees, tests, medication, injections, diagnostic imaging, etc.), which has fixed points per day set by the Ministry of Health, Labor and Welfare for only one disease for which the most medical resources were invested during the hospitalization period.

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