Predictive factors associated with poor outcomes for older adult inpatients in the convalescent rehabilitation ward

Tomoya Omura1,2, Miwa Matsuyama1, Atsushi Shiba2, Shota Nishioka2, and Mitsugu Naoe2

1Department of Oral Health Care and Rehabilitation, Doctor’s Course of Oral Health Science Graduate School of Oral Sciences, Tokushima University, Tokushima, Japan, 2Department of Rehabilitation, Naruto-Yamakami Hospital, Tokushima, Japan

Abstract: This study aimed to determine predictive factors associated with poor outcomes among older adult inpatients in the convalescent rehabilitation ward. We also examined the validity of factors that were identified as predictive of poor outcomes. Study subjects were 104 older adult inpatients in the convalescent rehabilitation ward, divided into two groups based on outcome at discharge. Group I included the outcomes of death or transfer to an acute care hospital and Group II included all other outcomes. Data were retrospectively collected from older adults’ medical records, including activities of daily living, swallowing grade, nutritional index, and blood biochemistry data. Logistic regression analysis was used to extract predictive factors associated with poor outcomes. Next, we calculated the Stratum-specific likelihood ratio (SSLR) for each extracted factor. Two items were extracted as predictive factors with AUCs ≥ 0.7: N-terminal pro-brain natriuretic peptide (NT-proBNP) and days from onset to hospitalization. The SSLRs showed the risk for a poor outcome increased when NT-proBNP was ≥ 3500 pg/ml and when there were ≥ 35 days from onset to hospitalization. Our findings suggest these predictive factors provide a valid index to predict poor outcomes among older adults from the early stage of admission.

J. Med. Invest. 67: 304-310, August, 2020

Keywords: convalescent rehabilitation ward, poor outcome, predictive factors, stratum-specific likelihood ratio

INTRODUCTION

The convalescent rehabilitation ward system started in Japan in 2000 (1). The convalescent rehabilitation ward is a sub-acute phase particularized rehabilitation ward (2). The disabled patients on whom acute phase treatment has finished are, regardless of the patients ages eligible for admission to convalescent rehabilitation ward. The diseases concerned are legally limited to stroke, femoral neck fracture, disuse syndrome following prolonged bed rest, or others (3). Convalescent rehabilitation wards provide intensive rehabilitation based on inter-professional collaboration, and promote re-integration of patients in a state of physical and mental recovery (4). However, an increasing number of patients admitted to the convalescent rehabilitation ward have severe conditions. This may be attributable to factors such as acceptance of critically ill patients based on the Nichijo-seikatsu-kino-hyokahyo form evaluates 13 items of basic daily activities such as turning over in bed and communicating prolonging bed rest, or others (3).

Convalescent rehabilitation wards provide intensive rehabilitation based on inter-professional collaboration, and promote re-integration of patients in a state of physical and mental recovery (4). However, an increasing number of patients admitted to the convalescent rehabilitation ward have severe conditions. This may be attributable to factors such as acceptance of critically ill patients based on the Nichijo-seikatsu-kino-hyokahyo form evaluates 13 items of basic daily activities such as turning over in bed and communicating prolonging bed rest, or others (3).

The rate of sudden change or death due to complications during hospitalization in the convalescent rehabilitation ward has been reported as 5.4%-10.7% (6-8). A number of patients with severe conditions cannot achieve convalescent rehabilitation ward goals because of recurrence or exacerbation of the cause disease, comorbidity, or past illness. Therefore, it is important to understand factors that may predict poor outcomes on admission to the ward. Understanding these predictive factors will help in determining appropriate risk management and rehabilitation policies. In the context of convalescent rehabilitation wards, many studies have used Activities of daily living (ADL) as a predictive factor with return to home as the outcome (9-10). However, few studies have considered death or transfer to an acute care hospital as outcomes.

Previous reports have investigated patients with stroke who died or were transferred to hospital urgently (11), and explored the characteristics of patients who referred to hospital because of complications or recurrence (8,12). In contrast, few studies have focused on outcome prediction for patients with severe conditions (7). In this study, we aimed to clarify predictive factors related to poor outcomes for older adult inpatients in a convalescent rehabilitation ward, and examined whether these factors were valid predictors of poor outcomes.

METHODS

Design

This study used a retrospective cohort design.

Subjects

Study subjects were 147 inpatients aged 65 years or older who were admitted to the inpatient convalescent rehabilitation ward of our hospital between October 2015 and August 2017. Exclusion criteria were patients in a hospital, a special nursing home, a nursing home, or a geriatric health services facility before admission to a convalescent rehabilitation ward as (n = 49). Patients discharged temporarily for gastrostomy (n = 6), and patients with missing data (n = 1). Total 104 subjects were included in the...
analysis (43 males; 61 females; mean age 83.1 ± 7.5 years).
Subjects were divided into two groups based on their outcomes at discharge: Group I included those with death or transfer to an acute care hospital. Group II included all other outcomes (discharge to home, sanatorium medical facility, special nursing home, nursing home, or geriatric health services facility). In this study, Group I subjects were defined as those with poor outcomes who failed to complete convalescent rehabilitation.

Assessment items

The main assessment items were patients' basic information, ADL, swallowing grade, nutritional indicators, and blood biochemical data. The 26 assessment items are shown in Table 1. "Days from onset to hospitalization" was defined as the period from the date of admission to an acute care hospital after onset or injury, or from the date of surgery in an acute care hospital until admission to a convalescent rehabilitation ward. Assessment items were investigated retrospectively from patients' medical records. We used admission data, as well as information regarding outcomes and hospitalization days. In addition, we examined the complications that caused poor outcomes.

Statistical analysis

We performed comparisons between the two groups for each assessment item. Multivariate analysis was used to extract predictive factors related to outcomes.

Next, Stratum-specific likelihood ratios (SSLR) were calculated to clarify the validity of identified predictive factors. The SSLR quantifies how test results in a given stratum will change compared to a reference stratum. Likelihood ratios > 10 or < 0.1 show large and often conclusive changes in probability that a patient has the disease in question (13).

Ethical considerations

This study was conducted with the approval of the Naruto Yamakami Hospital Ethics Committee (2018-01-1). Informed consent was obtained from all subjects. The analyses were conducted with consideration of protecting patients' personal information.

RESULTS

Seventeen cases (16%) were assigned to Group I, and 87 cases (84%) to Group II. The results of the comparison between the two groups are shown in Table 2. The outcomes for two groups are shown in Table 3. The most common complications that caused poor outcomes were chronic heart failure exacerbation (n = 5), fracture (n = 3), and pneumonia (n = 2). Exacerbation of chronic renal failure, abdominal aortic aneurysm development, recurrence of cerebral infarction, cholangitis, malignant tumor, acute abdomen, and deterioration of nutritional status were each observed in one case.

The explanatory variables for the logistic regression analysis selected were the total Functional independence measure (FIM) score because the total FIM score had a correlation coefficient of ≥ 0.7 for the Nichijo-seikatsu-kino-hykakuyo, along with motor and cognitive FIM scores. Similarly, the Geriatric nutritional risk index (GNRI) was selected because the correlation coefficient between GNRI and Alb was ≥ 0.7. Other explanatory variables were shown in Table 4. As a result, N-terminal pro-aminoterminal peptide (NT-proBNP) and days from onset to hospitalization were extracted as predictive factors related to death and transfer to an acute care hospital (Table 4). The discrimination predictive value was 85.6%. Table 5 shows the AUCs for the two predictive factors (NT-proBNP and days from onset to hospitalization) were ≥ 0.7.

Table 1. Assessment items

| Basic attributes | Total FIM, Motor FIM, Cognitive FIM |
|------------------|----------------------------------|
| ADL              |                                   |
| Swallowing ability | Swallowing grade                 |
| Nutrition indicators | Body mass index, Geriatric nutritional risk index |
| Blood biochemical data | NT-proBNP, TP (g/dl), Ab (g/dl), AST (U/L), ALT (U/L), BUN (mg/dl), CRE (mg/dl), WBC (g/dl), RBC (g/dl), Hb (g/dl) |

FIM, Functional independence measure; NT-proBNP, N-terminal pro-brain natriuretic peptide; TP, Total protein; Ab, Albumin; AST, Aspartate transaminase; ALT, Alanine transaminase; BUN, Blood urea nitrogen; CRE, Creatinine; WBC, White blood cell; RBC, Red blood cell; Hb, Hemoglobin.
### Table 2. Subjects basic attributes

| Assessment items                              | Total n = 104 | Group I n = 17 (16%) | Group II n = 87 (84%) | p-value |
|-----------------------------------------------|---------------|----------------------|------------------------|---------|
| **Age (years), mean ± SD**                    | 83.1 ± 7.5    | 84.4 ± 6.3           | 82.9 ± 7.7             | 0.650   |
| **Sex (n). male/female**                      | 43/61         | 10/7                 | 33/54                  | 0.110   |
| **Cause disease**                             |               |                      |                        |         |
| Cerebrovascular disease. n (%)                | 23 (22)       | 6 (35)               | 17 (20)                | 0.152   |
| locomotive. n (%)                             | 55 (53)       | 5 (29)               | 50 (57)                | 0.034   |
| Disuse syndrome. n (%)                        | 26 (25)       | 6 (35)               | 20 (23)                | 0.284   |
| History of heart failure. n (%)               | 17 (16)       | 6 (35)               | 11 (13)                | 0.032   |
| History of coronary artery disease. n (%)     | 8 (8)         | 1 (6)                | 7 (8)                  | 1.000   |
| **Days from onset to hospitalization (days)** | 28 (17-39)    | 39 (28-52)           | 24 (17-35)             | 0.002   |
| Hospitalization days (days)                   | 87 (56-89)    | 39 (26-59)           | 88 (84-89)             | < 0.001 |
| Nichijo-seikatsu kikan-kyokahyo (score)       | 5 (3-9)       | 8 (4-14)             | 5 (2-8)                | 0.027   |
| **Total FIM (score)**                         | 60 (34-81)    | 41 (22-73)           | 62 (38-83)             | 0.009   |
| **Motor FIM (score)**                         | 37 (19-55)    | 21 (13-30)           | 37 (22-56)             | 0.018   |
| **Cognitive FIM (score)**                     | 21 (13-38)    | 14 (8-22)            | 25 (14-33)             | 0.009   |
| **Swallowing grade**                          | 9 (8-10)      | 9 (6-10)             | 9 (8-10)               | 0.022   |
| **BMI**                                       | 20.0 (14.2-22.0) | 19.6 (15.4-21.8)   | 20.2 (17.6-22.4)       | 0.057   |
| **GNRI**                                      | 89.2 (82.2-95.6) | 82.9 (76.5-88.4)  | 90.4 (83.1-96.8)       | 0.002   |
| **Blood biochemical data**                   |               |                      |                        |         |
| NT-proBNP (pg/ml)                             | 356 (164-874) | 1530 (489-2435)      | 272 (150-663)          | < 0.001 |
| TP (g/dl)                                     | 6.2 (5.9-6.7) | 6.2 (5.7-6.4)        | 6.4 (5.9-6.7)          | 0.228   |
| Alb (g/dl)                                    | 34 (3.1-3.7)  | 31 (2.9-3.3)         | 35 (3.2-3.8)           | 0.001   |
| A/G ratio                                     | 1.2 (1.0-1.4) | 1.1 (0.9-1.3)        | 1.3 (1.1-1.4)          | 0.041   |
| AST (U/L)                                     | 20 (17-27)    | 22 (20-25)           | 20 (16-28)             | 0.214   |
| ALT (U/L)                                     | M 14 (9-19)   | 12 (10-16)           | 14 (9-20)              | 0.412   |
|                                             | F 15 (11-25)  | 13 (8-31)            | 15 (11-24)             | 0.717   |
| BUN (mg/dl)                                   | 17.3 (13.2-23.0) | 19.8 (14.9-34.0)   | 16.9 (12.8-21.6)       | 0.085   |
| CRE (mg/dl)                                   | M 0.69 (0.59-0.90) | 0.71 (0.58-0.93)   | 0.69 (0.52-0.86)       | 0.555   |
|                                             | F 0.69 (0.54-0.99) | 0.81 (0.65-1.56)   | 0.68 (0.52-0.95)       | 0.085   |
| WBC (g/dl)                                    | 58 (47-66)    | 72 (49-91)           | 56 (48-73)             | 0.455   |
| Hb (g/dl)                                     | M 302 (317-418) | 318 (299-413)       | 305 (357-419)          | 0.226   |
|                                             | F 371 (338-409) | 351 (398-392)       | 372 (339-411)          | 0.422   |
| RBC (g/dl)                                    | M 11.9 (10.4-13.1) | 12.3 (11.1-13.2)    | 11.6 (10.2-13.1)       | 0.300   |
|                                             | F 11.4 (9.9-13.2) | 12.2 (10.4-13.2)    | 11.3 (9.4-12.1)        | 0.147   |

Data shown as median (interquartile range), except for Age. Gender. Underlying disease and History of heart failure and coronary artery disease.

SD, Standard deviation; FIM, Functional independence measure; BMI, Body mass index; GNRI, Geriatric nutritional risk index; NT-proBNP, N-terminal pro-brain natriuretic peptide; TP, Total protein; Alb, Albumen; AST, Aspartate transaminase; ALT, Alanine transaminase; BUN, Blood urea nitrogen; CRE, Creatinine; WBC, White blood cell; RBC, Red blood cell; Hb, Hemoglobin.

### Table 3. Outcomes

|                  | n = 17 (16%) |
|------------------|-------------|
| **Death. n (%)** | 6 (6)       |
| **Transfer to an acute care hospital. n (%)** | 11 (11) |

|                  | n = 87 (84%) |
|------------------|-------------|
| **Discharge to home. n (%)** | 30 (29) |
| **Sanatorium medical facility. n (%)** | 16 (15) |
| **Special nursing home. n (%)** | 14 (13) |
| **Nursing home. n (%)** | 11 (11) |
| **Geriatric health services facility. n (%)** | 16 (15) |
The SSLRs are shown in Table 6. When NT-proBNP was ≥ 2500 pg/ml, the SSLR was 20.5 and the posterior probability was 80%. When NT-proBNP was ≤ 400 pg/ml, the SSLR was 0.4 and the posterior probability was 7%. When there were 35-44 days from onset to hospitalization, the SSLR was 2.8 and the posterior probability was 36%. At ≥ 45 days from onset to hospitalization, the SSLR was 2.6 and the posterior probability was 33%. Further, when there were 0-14 days from onset to hospitalization, the SSLR was 0.2 and the posterior probability was 5%. At 15-24 days from onset to hospitalization, the SSLR was 0.4 and the posterior probability was 8%.

**DISCUSSION**

This study revealed that initial data for NT-proBNP and days from onset to hospitalization were predictive factors for death or transfer to an acute care hospital among older adult inpatients in the convalescent rehabilitation ward. Because the AUC was 0.789 for NT-proBNP and 0.741 for days from onset to hospitalization, these factors were confirmed to have diagnostic performance.

The poor outcome group (Group I) accounted for 16% of our sample. This was higher than the 5.4%-10.7% reported in previous studies (6-8). In Group I, 35% of subjects had a history of heart failure (Table 2). In addition, there were five cases (29%)

| Table 4. Predictive factors associated with poor outcomes |
|----------------------------------------------------------|
| **Objective variable**: Group I (Death/Transfer to an acute care hospital) and Group II (Discharge to home. Sanatorium medical facility. Special nursing home. Nursing home. Geriatric health services facility). Explanatory variables: Locomotive. History of heart failure. Days from onset to hospitalization. Total Functional independence measure. Swallowing grade. Geriatric nutritional risk index score. NT-proBNP. Albumin/Globulin ratio. |

| Regression coefficient | p-value | Odds ratio | 95% CI |
|------------------------|---------|------------|--------|
| NT-proBNP (pg/ml)      | -2.245  | 0.001      | 0.106  | 0.028-0.401 |
| Days from on set to hospitalization | 0.042 | 0.023 | 0.958 | 0.924-0.994 |

**CI. Confidence interval. NT-proBNP. N-terminal pro-brain natriuretic peptide.**

| Table 5. Receiver operating characteristic curve analysis of NT-proBNP and days from onset to hospitalization |
|----------------------------------------------------------|
| **AUC** | 95%CI | p-value |
| NT-proBNP (pg/ml) | 0.789 | 0.671-0.907 | < 0.001 |
| Days from on set to hospitalization | 0.741 | 0.615-0.867 | 0.002 |

**AUC. Area under the curve. CI. Confidence interval. NT-proBNP. N-terminal pro-brain natriuretic peptide.**

| Table 6. Stratum-specific likelihood ratio of NT-proBNP and days from onset to hospitalization |
|----------------------------------------------------------|
| **NT-proBNP (pg/ml)** | **Group I** | **Group II** | **Sensitivity** | **Specificity** | **LR (95%CI)** | **Posterior probability (%)** |
|------------------------|-------------|-------------|----------------|----------------|----------------|-----------------|
| < 400                  | 4           | 52          | 0.24           | 0.4            | 0.4 (0.2-0.9)  | 7               |
| 400-899                | 2           | 22          | 0.12           | 0.75           | 0.5 (0.1-1.5)  | 8               |
| 900-1499               | 3           | 4           | 0.18           | 0.95           | 3.8 (1.04-1.1) | 43              |
| 1500-1999              | 3           | 4           | 0.18           | 0.95           | 3.8 (1.041-1)  | 43              |
| 2000-2499              | 1           | 4           | 0.06           | 0.95           | 1.3 (0.2-7.6)  | 20              |
| ≥ 2500                 | 4           | 1           | 0.24           | 0.99           | 20.5 (3.5-120.8)| 80              |

**Days from on set to hospitalization**

| Days from on set to hospitalization | **Group I** | **Group II** | **Sensitivity** | **Specificity** | **LR (95%CI)** | **Posterior probability (%)** |
|------------------------------------|-------------|-------------|----------------|----------------|----------------|-----------------|
| 0-14                               | 1           | 21          | 0.06           | 0.76           | 0.2 (0.1-1.2)  | 5               |
| 15-24                              | 2           | 23          | 0.12           | 0.74           | 0.4 (0.1-1.5)  | 8               |
| 25-34                              | 2           | 20          | 0.12           | 0.77           | 0.5 (0.2-1.7)  | 9               |
| 35-44                              | 5           | 9           | 0.29           | 0.9            | 2.8 (1.1-7.1)  | 36              |
| ≥ 45                               | 7           | 14          | 0.41           | 0.84           | 2.6 (1.2-5.2)  | 33              |

**LR. Likelihood ratio. NT-proBNP. N-terminal pro-brain natriuretic peptide.**
of exacerbation of chronic heart failure as the cause of poor outcomes and there were more cardiovascular diseases (e.g. heart failure) in our sample compared with previous studies (5, 8). A reason for this may be that our subjects had an average age of 83.1 years and were older than subjects in previous studies (mean age 71.9–76.0 years, 6–8). It has been reported that heart failure increases rapidly among those in their 80s (16). NT-proBNP is a biomarker for heart failure, and its concentration in blood increases with severity. The median NT-proBNP level in Group I was 1530 pg/ml, which was significantly higher compared with Group II (272 pg/ml). BNP is an important predictor of in-hospital mortality in acute heart failure (17). It was reported that high initial NT-proBNP levels and increases in NT-proBNP levels were useful for screening for risk of death or emergency transfer (18), which was consistent with the findings obtained in this study. In this study, a history of heart failure was not a predictive factor. The reason for this was considered that a history of heart failure could not reflect the current clinical status of the subjects. However, there was a significant difference between the two groups, so a medical history should be checked before the admission.

The median days from onset to hospitalization in Group I was 39 days, which was significantly longer than in Group II (24 days). We observed that many Group I subjects experienced complications such as cardiac dysfunction. Tokunaga et al. reported that for patients with stroke, a later transfer from an acute hospital to a convalescent rehabilitation ward was associated with a lower initial FIM and higher rates of patient death or transfer to an acute care hospital (19). In addition, complications have been reported as the main cause of long-term hospitalization for patients with acute stroke (20). These findings suggest that days from onset to hospitalization could reflect patients’ physical status in an acute care hospital.

Total FIM score, swallowing grade, GNR1, and AG ratio were not significantly associated from the multivariate analysis in this study. Although each of these factors was considered to be related to returning to home (21, 23), our results suggested that they did not predict poor outcomes. In the convalescent rehabilitation ward, ADL improvement has been reported to be affected by complications (24). Patients with high medical risk may have difficulty improving ADL. Therefore, progress in ADL improvement was considered more important than ADL on admission. Swallowing grade which was used to assess swallowing function in this survey is one of the scales to classify the severity of dysphagia. This tool is a 10-grade scale scored from grade 1 (swallowing difficult or not possible, not indicated for swallowing training) to grade 10 (normal swallowing function) (25). Dysphagia causes aspiration pneumonia and leads to death in severe cases (26). However, in this study, the median swallowing grade for Group I was 9, and few subjects had severe dysphagia. Therefore, there were no subjects with severe pneumonia leading to poor outcomes. Malnutrition is considered a poor prognostic factor (27), and patients who show no improvement in nutritional status may have serious complications. Conversely, patients who improve with nutritional support during hospitalization were reported to show improved ADL thereafter (28). Therefore, it is thought that nutritional conditions at admission alone cannot predict the risk for poor outcomes.

In this study, SSLRs were calculated to clarify the validity and criteria for predictive factors. The interpretation of SSLR has excellent discrimination ability when the likelihood ratio is ≥ 10 or ≤ 0.1, and greatly changes the posterior probability. The SSLR for NT-proBNP indicated it was more likely to lead to a poor outcome at ≥ 2500 pg/ml, whereas ≤ 400 pg/ml was unlikely to lead to a poor outcome. In addition, although the likelihood ratio was not high when NT-proBNP was 900-1499 pg/ml and 1500-1999 pg/ml (3, 8), the posterior probability increased to 43%. NT-proBNP levels above 900 pg/ml may indicate there is likely to be heart failure requiring treatment (29); our findings showed the same tendency.

In terms of days from onset to hospitalization, the posterior probability for 35–44 days was 36% and that for ≥ 45 days or more was 33%. This was about twice the previous probability of 16%. The 16% probability shown here reflects the probability of patients with poor outcomes as identified in this study. For this reason, when the days from onset to hospitalization was more than 1 month, the number of patients with high medical risk leading to a poor outcome increased. However, both likelihood ratios and posterior probabilities were lower when days from onset to hospitalization was 24 days or less (Table 6). Thus, when days from onset to hospitalization was 24 days or less, the risk of poor outcome was lowered.

The predictive factors in this study were quantitative variables and the results were stratified using SSLRs. Therefore, it was possible to calculate the sensitivity, specificity, likelihood ratio, and posterior probability for each layer. In addition, the criteria for predictive factors were clearer in predicting poor outcomes as these two factors could predict patients with poor outcomes by calculating the posterior probability at admission. The posterior probability for the two predictive factors can be shown by multiplying the likelihood ratio of the predictive factors.

Group I (39 days) had significantly shorter hospitalization days in the convalescent rehabilitation ward compared to Group II (88 days). Stabilization of a patient’s general condition is a prerequisite for the implementation of rehabilitation. As seen in Group I, patients with high NT-proBNP levels at admission and long duration of treatment in acute care hospitals were likely to have difficulty achieving adequate rehabilitation. It may be necessary to consider continued care in acute care hospitals or admission control in general wards for such patients. Convalescent rehabilitation was dose sensitive due to careful risk management because of the increasing number of patients with severe conditions. It may be possible to use NT-proBNP and days from onset to hospitalization as an index for predicting poor outcomes to identify patients requiring risk management from the time of admission. In particular, BNP is an indicator of cardiac rehabilitation effects (30, 31), and cardiac rehabilitation may reduce BNP and NT-proBNP (31). Therefore, it may also be necessary to consider cardiac rehabilitation for patients with high NT-proBNP levels at admission.

Given global population aging, it is expected that the increased number of patients with heart failure will result in a “heart failure pandemic” (32). Japan has an aging rate of 27.7% (33), and an increase in patients with heart failure has been predicted (34). The age of patients being admitted to a convalescent rehabilitation ward is also increasing each year, with admission of older adults aged over 75 years reported at 63% (33). In addition, it is predicted that an increasing number of older adults will have complications such as cardiac dysfunction. It is therefore important to understand medical risks from the early stage after admission.

This was a retrospective study involving 104 subjects from a single institution with an average age of 83.1 years. Therefore, we did not examine whether the identified predictive factors could be applied to younger age groups. In further studies, multiple institutions may need to work together to examine predictive factors across a range of age groups to predict outcomes with greater accuracy.
CONCLUSION

NT-proBNP and days from onset to hospitalization can be considered predictive factors associated with poor outcomes among older adults receiving inpatient convalescent rehabilitation. Our findings suggested NT-proBNP of ≥ 2500 pg/ml or ≥ 35 days from onset to hospitalization could be related to poor outcomes among older adult inpatients in the convalescent rehabilitation ward. We concluded that outcomes for older adult inpatients could be predicted with data for NT-proBNP and days from onset to hospitalization from the early stage of admission in the convalescent rehabilitation setting.

ACKNOWLEDGEMENTS

The authors thank all members of the Naruto Yamakami Hospital for their help in this research. We also thank Edanz Group (www.edanzediting.com/ac) for editing a draft of this manuscript.

DISCLOSURE STATEMENT

The authors declare no conflicts of interest.

REFERENCES

1. Miyai I, Sonoda S, Nagai S, Takayama Y, Inoue Y, Yokoi A, Kurishina M, Ishikawa M : Results of new policies for inpatient rehabilitation coverage in Japan. Neurol Rehabil Neural Regen 25 : 540-547, 2011
2. Yoshikawa T, Nakama T, Minamih H, Amooya T, Yamasaki M : Rehabilitation in a convalescent rehabilitation ward following an acute ward improves functional recovery and mortality for hip fracture patients: a sequence in a single hospital. J Phys Ther Sci 29 : 1102-1107, 2017
3. Okamoto T, Ando S, Sonoda S, Miyai I, Ishikawa M : Kaifukuki Rehabilitation Ward in Japan. Jpn J Rehabil Med 51 : 629-633, 2014
4. Association. KRW : What is the Kaifukuki Rehabilitation Ward? [Available from: http://www.rehabilitation.jp/visitor.html. (Accessed May 24, 2019)]
5. Okamoto T, Matsukawa K, Sasaki E, Sato M, Sakano Y, Oka M, Tashibana K, Arakawa R : Treatment of comorbidities in the kaifukuki rehabilitation ward. Journal of Clinical Rehabilitation 27 : 120-129, 2018 (in Japanese)
6. Association KRW : Survey report on the current status and issues of convalescent rehabilitation wards. J Jpn J Rehabil Med 51 : 629-633, 2014
7. Segawa Y, Sato Y, Takemae T, Nomoto N, Endo I, Kudo Y, Izu Y, Miyai I : The possibility of the prediction of sudden condition changes in convalescent rehabilitation patients from the analysis of the general state and findings on admission. Journal of Clinical Rehabilitation 16 : 1089-1092, 2007 (in Japanese)
8. Yanamoto Y : Patients transferred to acute hospitals with complications: analysis of factors including the outcome after transfer. Journal of Clinical Rehabilitation 20 : 595-599, 2011 (in Japanese)
9. Hamazaki K, Maeda H, Ohayashiki M, Sugiura A, Yanaka T, Yamashita S, Hashimoto T, Yoshikawa Y : Functional Independence Measure reference values for the discharge to home of stroke patients. Rigakukyo Kagaku 29 : 933-937, 2014 (in Japanese)
10. Kaneko T, Sato N, Tateishi M, Endo N, Kanda M, Sakimura Y : The tendency at the time of discharge of stroke patients from the point of FIM total score at admission to our hospital in the convalescent rehabilitation ward. Rigakukyo Kagaku 20 : 19-17, 2017 (in Japanese)
11. Tokunaga M, Okumura K, Miyamoto U, Katsurak K, Watanabe S, Nakashita R, Yamagami H : A survey of the stroke patients transferred to acute hospitals or died with complications in a convalescent rehabilitation ward. Journal of Clinical Rehabilitation 24 : 734-739, 2015 (in Japanese)
12. Funakoshi M, Miyano S : Patients transferred from our recovery phase hospital to acute phase hospital. Journal of Clinical Rehabilitation 15 : 973-976, 2006 (in Japanese)
13. Peirce JC, Cornell RG : Integrating stratum specific likelihood ratios with the analysis of ROC curves. Med Decis Making 13 : 141-151, 1993
14. Jaeschke R, Guyatt GH, Sackett DL : Users' guides to the medical literature. III. How to use an article about a diagnostic test. B. What are the results and what will they help me in caring for my patients? The Evidence-Based Medicine Working Group, Jama 271 : 703-707, 1994
15. Swets JA : Measuring the accuracy of diagnostic systems. Science 248 : 1285-1293, 1988
16. Kannel WB, Belanger AJ : Epidemiology of heart failure. Am Heart J 121 : 951-957, 1991
17. Fonarow GC, Peacock WF, Phillips CO, Givertz MM, Lopatin A : Admission B-type natriuretic peptide levels and in hospital mortality in acute decompensated heart failure. J Am Coll Cardiol 49 : 1943-1950, 2007
18. Shiba A, Kurata H, Sasaki H, Naoe M, Kunitomo K, Yamakami A : Terminal Pro Brain Natriuretic Peptide Level as a Prognostic Predictor in Elderly Patients in a Convalescent Rehabilitation Ward. Progress in Rehabilitation Medicine 2, 2017
19. Tokunaga M, Watanabe S, Yonemura T, Terasaki T, Takita T, Yamamoto K, Kawanou N, Takii T, Yamaguchi M, Hashimoto Y : Length of stay in acute phase hospitals in Kumamoto. Journal of Clinical Rehabilitation 22 : 823-828, 2013 (in Japanese)
20. Hashimoto Y, Terasaki T, Ikedo K, Yoshino U, Ichino M : Outcome and hospital-clinic cooperation in acute brain infarction. J Jpn Stroke 21 : 203-204, 1999 (in Japanese)
21. Nishiooka S, Takayama M, Watanabe M, Usuihisa K, Kimi D, Hjosa S, Nutrition Committee Kwa : Prevalence of malnutrition in convalescent rehabilitation wards in Japan and correlation of malnutrition with ADL and discharge outcome in elderly stroke patients. J Spine 30 : 1145-1151, 2015 (in Japanese)
22. Okamoto K, Fujishima I, Shigematsu T, Hatake K, Ohashi T, Influence of dysphagia and its complications in stroke patients after home discharge from a rehabilitation hospital. Deglutition 2 : 243-246, 2013 (in Japanese)
23. Yoshida S : Undernutrition: sarcopenia, frailty complex of the elderly: Incidence of undernutrition and influence to outcome rehabilitation hospital. J Jpnal Kyicho Eiyu 28 : 1051-1056, 2013 (in Japanese)
24. Seungwon J, Inoue Y, Katsunomi K, Dasuke M, Shuihiki N : Formula for predicting FIM for stroke patients at discharge from an acute ward or convalescent rehabilitation ward. J Jpnal of Comprehensive Rehabilitation Science 5(2014) : 19-25, 2014
25. Fujishima I : Rehabilitation for swallowing Disorders associated with Stroke. (ed 1), Ishiyaku publishers Inc, Tokyo, 1993 (in Japanese)
26. Teramoto S, Yoshida K, Hisawa N : Update on the...
pathogenesis and management of pneumonia in the elderly: roles of aspiration pneumonia. Respir Investig 53: 178-184, 2015

27. Antonelli Incalzi R, Landi F, Cipriani L, Bruno E, Pagano F, Gemma A, Capparella O, Carbonin PU : Nutritional assessment: a primary component of multidimensional geriatric assessment in the acute care setting. J Am Geriatr Soc 44: 166-174, 1996

28. Gariballa SE, Parker SG, Taub N, Castle den CM: A randomized, controlled, single-blind trial of nutritional supplementation after acute stroke. JPN En Parenter Enteral Nutr 22: 315-319, 1998

29. Society TJHF : On points to be noted in heart failure medical care using blood BNP and NT-proBNP levels. [Available from: http://www.asas.or.jp/jhfs/topics/bnp201300403.html (in Japanese) (Accessed April 10, 2019)]

30. Akashi YJ, Koike A, Omiya K, Osada N, Maeda T, Tajima A, Oikawa K, Aizawa T, Iinuma H, Fu LT, Itok H: Relationship between exercise capacity and brain natriuretic peptide in patients after cardiac surgery. J Cardiol 42: 67-74, 2003

31. Passino C, Severino S, Poletti R, Pegoli MF, Mannucci C, Clerico A, Gabutti A, Nasa G, Endri M: Aerobic training decreases B-type natriuretic peptide expression and adrenergic activation in patients with heart failure. J Am Coll Cardiol 47: 1835-1839, 2006

32. Savarese G, Lund LH: Global Public Health Burden of Heart Failure. Card Fail Rev 3: 7-11, 2017

33. Cabinet Office: Annual Report on the Ageing Society: 2018. [Available from: http://www8.cao.go.jp/kourei/whitepaper/index-w.html (in Japanese) (Accessed May 10, 2019)]

34. Okura Y, Ramadan MM, Ohno Y, Mitsuma W, Tanaka K, Ito M, Suzuki K, Tanabe N, Kodama M, Aizawa Y: Impending epidemic: future projection of heart failure in Japan to the year 2055. Circ J 72: 489-491, 2008