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Original Article

Predictive factors of home discharge in elderly stroke patients hospitalized in a convalescent rehabilitation ward

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ABSTRACT

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Purpose: To identify predictive factors of home discharge in elderly stroke patients hospitalized in our convalescent rehabilitation ward based on markers determined during hospitalization and to evaluate their predictive capability.

Methods: Parameters measured at hospitalization in 179 elderly stroke patients aged ≥65 years hospitalized between April 1, 2015 and July 1, 2018 were compared after dividing the patients into two groups depending on whether they were discharged home. In addition, multivariate analysis was performed using whether home discharge was possible as the objective variable to prepare a prediction formula and receiver operating characteristic (ROC) curves.

Results: A total of 150 patients (84%) were discharged home. Differences in acute phase hospitalization duration, number of cohabiting people, National Institutes of Health Stroke Scale at the time of onset, functional independence measure (FIM) at hospitalization, food type, and nutritional evaluation were significant between the two groups. Multivariate analysis revealed significant differences for acute phase hospitalization duration, number of cohabiting people, and FIM at hospitalization. The area under the curve for the ROC curve was 0.891.

Conclusions: The results indicated that the combination of acute phase hospitalization duration, number of cohabiting people, and FIM at hospitalization could be used as a predictive factor for home discharge in elderly stroke patients hospitalized in a convalescent rehabilitation ward.

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Introduction

Stroke causes various symptoms that are prone to remain as sequelae. Therefore, it is known to be associated with a high risk of causing elderly individuals to require long-term caregiving.

The age at onset of both ischemic and hemorrhagic strokes in Japan is increasing with the increase in the aging population. Both survival and functional prognoses upon discharge have been reported to become poorer with increasing age [1]. According to the 2018 Annual Report on the Aging Society released by the Cabinet Office, stroke is the second most common condition that requires long-term caregiving after dementia, and is more likely than dementia in men [2].

Regarding the post-onset functional improvement, the 2015 Stroke Treatment Guidelines established by the Japan Stroke Society suggest the importance of convalescent rehabilitation, indicating that “it is recommended to perform convalescent rehabilitation following acute phase rehabilitation (Grade B)” [3]. However, the maximum hospitalization period covered by health insurance is limited in convalescent rehabilitation wards (hereafter “rehabilitation wards”). When an elderly patient is hospitalized, in addition to being discharged home, they may also be admitted to a long-term care facility covered by long-term care insurance. Therefore, a decision should be made upon discharge from the rehabilitation ward as to whether the patient will be discharged home or admitted to a facility. However, various factors make prediction of where patients will be ultimately discharged extremely difficult. Several previous reports within and outside Japan have investigated the factors that affect the home discharge of stroke patients [4−8]. However, studies attempting to predict outcomes of elderly patients from the convalescent ward are extremely limited. Moreover, no studies described the development of a prediction formula based on identified related factors and evaluated its predictive capability.

In this study, markers measured before stroke onset until admission to the rehabilitation ward were used to identify factors related to home discharge, and the predictive capability of the formula developed based on these results was evaluated.

Methods

This study comprised elderly stroke patients aged ≥65 years hospitalized in our rehabilitation ward between April 1, 2015 and July 1, 2018. Data of 179 patients were retrospectively investigated, after excluding those who met the following exclusion criteria: <14 days spent in the rehabilitation ward (11 patients), subarachnoid hemorrhage (24 patients), missing data (6 patients), transferred to an acute phase ward (14 patients), and hospitalized from a place other than home (20 patients). Patients were divided into two groups depending on whether they were discharged home (hereafter "home discharge cases") or not (hereafter "non-home discharge cases"). Univariate analysis was performed to compare the two groups. The evaluation parameters were attributes, nutritional parameters, and rehabilitation-related parameters. The following detailed parameters were also compared (see section 1 below). Moreover, multivariate analysis was performed to determine whether the patient was discharged home as the objective variable and identify parameters with significant differences. A prediction formula was developed based on the identified parameters. A receiver operating characteristic (ROC) curve was also prepared based on the obtained variables, and the area under the curve (AUC) was calculated.

1. Evaluation parameter details

1.1 Attributes

Age, sex, disease type, recurrence, acute phase hospitalization duration, number of cohabiting people, and degree of daily independence before the onset of stroke were compared between the two groups. Disease type was classified as either cerebral infarction or cerebral hemorrhage using the main disease name as a reference. Hemorrhagic infarction cases included cerebral infarction cases. Cohabiting people were defined as those sharing the same living space and did not include those living in a separate space within the same premises. The matter of whether cohabiting people were blood relatives was not considered. If the patient lived alone, the number of cohabiting people was described as "1." Pre-hospitalization activities of daily living (ADL) were evaluated as the degree of daily independence.

1.2 Nutritional and rehabilitation-related parameters

A previous report by Nishioka et al. [9] comparing a group with good nutritional status and one with poor nutritional status indicated that the proportion of those discharged home was 81.6% for the former and 44.6% for the latter group, revealing a statistically significant difference. Therefore, nutritional parameters were included as items for comparison in this study.

Detailed parameters for comparison were weight and body mass index (BMI) upon hospitalization, nutritional evaluation, and food type. BMI was calculated as weight (kg)/height (m) × height (m). Food type was evaluated as non-oral, swallowing training, or normal meals. Nutritional intake route was defined as "non-oral cases" if a meal was administered by a non-oral route even once per day in the rehabilitation ward. Nutritional state was evaluated using the Mini Nutritional Assessment®-Short Form (MNA®-SF) and Geriatric Nutritional Risk Index (GNRI). GNRI was calculated as 14.89 × serum albumin (g/dL) + 41.7 × current weight (kg)/ideal weight (kg). Ideal weight was calculated using Lorentz's formula. Current weight/ideal weight of >1was treated as "1" for the calculations.

Severity at onset was evaluated using the National Institutes of Health Stroke Scale (NIHSS). Functional independence measure (FIM) upon hospitalization was compared based on motor and cognitive items when comparing the two groups. For multivariate analysis, multi-collinearity was observed when motor and dementia parameters were considered as separate variables. Therefore, only FIM upon hospitalization was used, which comprised the total score.

2. Statistical analysis

When comparing the home discharge cases and non-home discharge cases, we performed univariate analysis using Fisher's exact test, *t* test, or Mann–Whitney *U* test considering whether the target for comparison was a continuous or nominal variable and whether a Gaussian distribution was conformed to. Binomial logistic regression analysis was performed using items for which a significant difference was noted on univariate analysis as explanatory variables, and whether cases were discharged home as the objective variable (1 = home, 0 = other than home). Items that exhibited a significant difference on logistic regression analysis were then used to develop a prediction formula. The ROC curve was created based on the objective variables obtained from the prediction formula, and the AUC was calculated. We calculated the cutoff value to be the closest point to the upper left corner of the ROC curve; next, using a 2 × 2 contingency table, we determined the sensitivity, specificity, positive predictive value, and negative predictive value. The level of statistical significance was set at <0.05. The statistical software used was EZR version 1.37.

Results

Table 1 presents the attributes of the subjects. The overall mean age was 76.6 ± 7.2 years. In terms of disease type, several patients suffered from cerebral infarction, and recurrence cases accounted for 25% of the patients. The median number of cohabiting people was 2 (including the patient themselves), and acute phase hospitalization duration was approximately 3 weeks. Pre-hospitalization ADL was almost independent in daily lifestyle for >80% of the patients, indicating that the population was able to go on outings alone.

Of the 179 subjects, 150 (84%) were discharged home. Comparison of the home discharge cases and non-home discharge cases indicated significant differences ($p < 0.05$) for acute phase hospitalization duration and number of cohabiting people. The acute phase hospitalization duration was approximately 8 days longer for the non-home discharge cases than for the home discharge cases. The number of cohabiting people also tended to be lower for the non-home discharge cases than for the home discharge cases. Although mean age and the proportion of recurrent cases both tended to be higher for the non-home discharge cases than for the home discharge cases, no significant differences were observed between the two groups. No significant differences were observed between the two groups in terms of sex, disease type, or pre-onset degree of daily independence. Nutritional evaluation revealed significant differences for the MNA®-SF, GNRI, and food type ($p < 0.01$, Table 2). It was confirmed that MNA®-SF and GNRI scores were low in the non-home discharge cases, indicating a tendency for a high proportion of cases being determined as undernourished or at high risk of such undernutrition. Regarding food type, approximately 80% of the home discharge cases were consuming "normal meals." In contrast, just 40% of non-home discharge cases were consuming "normal meals" and large proportions of these cases were consuming dysphagia meals or non-oral meals. In terms of rehabilitation-related items, significant differences were noted between the groups for NIHSS at the time of onset and FIM at hospitalization. The non-home

Table 1. Univariate analysis of the attributes of home discharge cases and non-home discharge cases (*n* = 179).

	Overall (*n* = 179)	Home discharge cases: 150 (84%)	Non-home discharge cases: 29 (16%)	*p* Value
Age (years)	76.6±7.2	76.2±7.3	78.6±6.4	0.103
Sex (male cases)	106 (59%)	89 (59%)	17 (59%)	1.000
Disease type (history of cerebral infarction)	130 (73%)	111 (74%)	19 (66%)	0.367
Recurrence cases	44 (25%)	34 (23%)	11 (38%)	0.102
Acute phase hospitalization duration (days)	23 (17−29.5)	22 (17−28)	30 (21−44)	0.001>
Number of co-habituating people (people)	2 (2−3)	2 (2−3)	2 (1−2)	0.037
Pre-onset degree of daily independence ("Rank J" cases)	170 (84%)	125 (83%)	25 (83%)	0.810

Values are shown as number of cases (proportion: %), mean ± SD or median values (interquartile range).
SD, Standard Deviation.

Table 2. Univariate analysis of nutritional parameters and rehabilitation-related parameters.

	Home discharge cases	Non-home discharge cases	*p* Value
Weight at hospitalization (kg)	56 (46.7−64.9)	51 (46.7−58.2)	0.086
BMI at hospitalization (kg/m^2)	22.2 (19.7−25.1)	20.2 (19.2−22.6)	0.051
MNA®-SF at hospitalization (score)	8 (6−10)	5 (3−8)	0.001>
GNRI at hospitalization (score)	95.8 (89.2−102.1)	86.8 (82.5−95.6)	0.001>
Food type (normal, dysphagia, non-oral)	119 (79%), 26 (17%), 5 (3%)	12 (41%), 8 (28%), 9 (31%)	0.001>
NIHSS at onset (score)	7 (4-11)	18.5 (7.25−24.8)	0.001>
FIM at hospitalization (score)	77 (60−92)	34 (25−55)	0.001>
Motor items (score)	51 (39−64)	19 (15−41)	0.001>
Cognitive items (score)	26 (20−32)	13 (7.0−20)	0.001>

Values are shown as number of cases (proportion: %), or median values (interquartile range).
BMI, Body Mass Index; MNA®-SF, Mini Nutritional Assessment®Short Form; GNRI, Geriatric Nutritional Risk Index; NIHSS, National Institutes of Health Stroke Scale; FIM, Functional Independence Measure.

Table 3. Multiple logistic regression analysis.

	Odd's ratio	95% confidence interval	*p* Value
NIHSS at onset (score)	0.955	0.886−1.030	0.236
FIM at hospitalization (score)	1.050	1.020−1.090	0.001
Acute phase hospitalization duration (days)	0.943	0.901−0.988	0.013
Number of co-habituating people (people)	1.640	1.030−2.620	0.037
Food type	0.906	0.347−2.370	0.841
MNA®-SF (score)	0.990	0.769−1.270	0.940
GNRI (score)	0.985	0.914−1.060	0.682

MNA®-SF, Mini Nutritional Assessment®Short Form; GNRI, Geriatric Nutritional Risk Index; NIHSS, National Institutes of Health Stroke Scale; FIM, Functional Independence Measure.

Table 4. 2 × 2 contingency table based on prediction formula and cutoff values.

	Home discharge (*n* = 150)	Non-home discharge (n = 29)
Less than 1.122 (positive)	113	3
1.122 or more (negative)	37	26

Prediction formula: Objective variable = 1/1 + e⁻(0.05531 × FIM at hospitalization (score) + 0.51761 × number of co-habituating family members (people) − 0.06119 × acute phase hospitalization duration (days) − 1.08616)

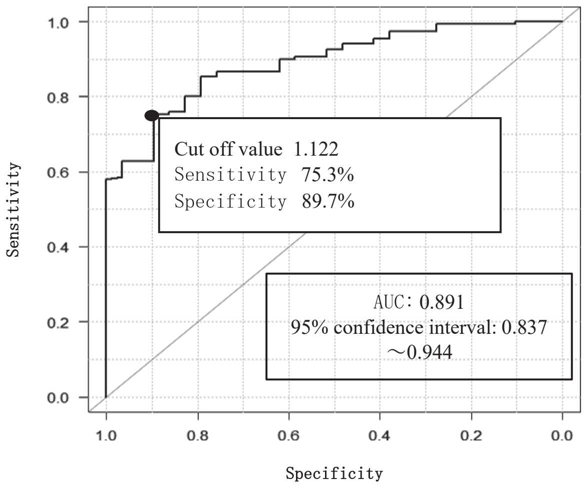

Figure 1. ROC curve.

discharge cases tended to exhibit high NIHSS at the time of onset and low FIM at hospitalization. It was also confirmed that both motor and cognitive items on the FIM were lower in the non-home discharge cases ($p < 0.01$).

Multiple logistic regression analysis revealed significant differences for acute phase hospitalization duration, number of cohabiting people, and FIM at hospitalization ($p < 0.05$, Table 3). The prediction formula developed based on these items was objective variable = 1/1 + e⁻ (0.05531 × FIM at hospitalization (points) + 0.51761 × number of cohabiting family (people) − 0.06119 × acute phase hospitalization duration (days) − 1.08616). When an ROC curve was created based on the calculated objective variable, the AUC was found to be 0.891 (95% confidence interval: 0.837–0.944, Figure 1). The optimal cutoff value was 1.122, sensitivity was 75.3%, and specificity was 89.7%. The positive and negative predictive values were 97.4% and 41.3%, respectively (Table 4).

Discussion

This study targeted elderly stroke patients aged ≥65 years. We identified factors influencing discharge to home based on indices obtained while subjects were hospitalized at a rehabilitation ward. Next, we used a prediction formula created by combining acute phase hospitalization duration, number of cohabiting people, and FIM at hospitalization to evaluate the ability of the formula to predict home discharge using the ROC curve.

As stated above, no previous studies have investigated convalescent ward outcome prediction for elderly patients. Moreover, no previous studies have used the ROC curve to evaluate predictive ability, as our study did. Therefore, although we were unable to discuss how useful and accurate our prediction formula and its predictive ability are, the AUC of 0.891 indicates that it offers a reasonably high level of precision (in general, higher precision is indicated by closer proximity to the AUC of the ROC curve to 0.9−1.0).

The results of previous studies investigating the home discharge of stroke patients have indicated that social factors including age, NIHSS, ADL at hospitalization and discharge (degree of paralysis and level of required nursing care), whether oral nutrition is possible, and family aspects as well as rehabilitation intervention units are factors that contribute to home discharge for stroke patients [4, 10−14]. For example, according to a report by Iwai et al. who analyzed the stroke data of 482 cases registered with the Japanese Association of Rehabilitation Medicine, predictive factors for home discharge were age, FIM at hospitalization, and long-term caregiving ability (evaluated on a scale from 1−5) [14]. In their study, no limitations were placed on age of stroke patient, and it was reported that age was a direct predictive factor for discharge to home. However, in the current study, as univariate analysis did not indicate any significant difference for age, age was not used as a factor for multivariate analysis. This lack of a significant difference could be attributed to the fact that our subjects were limited to individuals aged ≥65 years. This suggested that factors enabling home discharge differ between elderly and non-elderly individuals. As was also the case for the aforementioned study, our results for multivariate analysis confirmed that FIM at hospitalization was an independent predictive factor. Degree of severity according to NIHSS and severity of paralysis according to Brunnstrom Stage have been confirmed to affect decreased ADL in previous studies, and the effects of FIM at hospitalization could be confirmed with the evaluation in the current study.

Long-term caregiving ability was cited as the third factor in the aforementioned study. It was confirmed in the current study that the number of cohabiting people had similar implications for long-term caregiving ability, and we confirmed that it was an important factor in enabling home discharge. However, as a cohabiting person was defined as a person sharing the same living space in the current study and the frequency and amount of time spent interacting with the patient was not taken into consideration, it must be noted that the number of cohabiting people is not exactly the same as long-term caregiving ability, as described in previous studies. As a wide range of factors, including physical elements such as the caregiver's state of health, cognitive function, and ADL and financial elements such as economic power are involved in long-term caregiving ability, studies investigating predictive factors for home discharge must carefully discuss whether long-term caregiving ability should be taken into consideration as an independent evaluation parameter. In general, because factors themselves need to be simplified and user-friendliness is required when investigating practical prediction indices, the number of cohabiting people, which was used in the current study, might be a more useful index for evaluation than long-term caregiving ability. In recent years, as types of cohabiting are becoming more diverse and some cohabiting people take on the role of long-term caregiver despite not being related to the patient by blood, it would be better to use the number of cohabiting people rather than the number of cohabiting family members as an evaluation parameter.

It was also demonstrated in the current study that acute phase hospitalization duration was a useful predictive factor for home discharge. Although it is impossible to determine the factors associated with prolonged duration of acute phase hospitalization among stroke patients based on the results of the current study, a study by Okabayashi et al. found that swallowing function-related items such as severity during onset, fasting duration, and respiratory tract infection complications correlated with acute phase hospitalization duration [15]. However, in the current study, we confirmed that even when adjusted for NIHSS at the time of onset, food type at hospitalization, and nutritional status, acute phase hospitalization duration produced a significant difference according to multiple logistic regression analysis. Urakawa et al. found that complications and exacerbation of symptoms of the underlying disease that occurred during the acute phase hospitalization period were also related to the acute phase hospitalization duration [16]; these factors prolonged the time until ambulation, thereby increasing the number of days spent in hospital during the acute phase. Although the question of what disease the complications in this study specifically indicated was not clarified, previous studies have cited ischemic heart disease, pneumonia, urinary tract infections, and deep vein thrombosis as complications of stroke [17−20]. However, evaluation of each of these individual complications as predictive factors for home discharge could result in an overly complicated analysis. Moreover, as diseases other than the complications cited above could also be the complications of stroke, it would not be feasible to include complications occurring during acute phase hospitalization as predictive factors for home discharge. In this context, the current study is interesting because it demonstrated that the index of acute phase hospitalization duration comprehensively including the effects of these complications is useful as a predictive factor for home discharge. It is an objective and simple evaluation parameter that can be easily counted as the number of days.

The current study had several limitations. First, the only social factor that we could investigate was the number of cohabiting people. Other social factors, including regional characteristics such as home ownership rates, specific housing environment, annual household income, use of public assistance, and degree of intervention with long-term care insurance, will need to be considered in future studies. Because pre-hospitalization cognitive function and newly occurring higher brain dysfunction can strongly affect long-term caregiving, the question of how these indices influence home discharge is an important topic for future research. Furthermore, in the current study, we did not consider evaluation parameters that arise in the rehabilitation ward such as complications that occur during hospitalization in the rehabilitation ward and waiting period until hospitalization based on the bed occupancy status in the rehabilitation ward. However, these indices must be evaluated to understand how operations in the rehabilitation ward affect home discharge.

Conclusions

Our results suggested that acute phase hospitalization duration, number of cohabiting people, and FIM at hospitalization should be combined to form a predictive factor for the home discharge of elderly stroke patients hospitalized in a convalescent rehabilitation ward.

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