Establishment of criteria for excluded selectees in a recovery rehabilitation ward

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当院回復期リハビリテーション病棟における重症患者の除外基準に関する指標及びカットオフ値の検討

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要約

回復期リハビリテーション病棟 I を有する施設は、効果に係る実績として入院患者の実績指数を 40 以上にすることが求められている。一方，重症患者など月間入院患者数の 3 割以下の患者を、その計算対象から除外する基準が設けられており、予め除外する患者を選定する方法がある。近年、退院時 FIM の予測モデルをはじめとして、さまざまな検証がなされているが、重症患者の実績指数を予測する研究はこれまで行われていない。今後当院が重症患者を受け入れる役割を担っていくにあたって、重症患者をアプローチしていくための当院独自の基準について検討することは重要であり、臨床的な意義は大きい。そこで本研究は、後ろ向き研究として、適切な除外選定と重症患者の予後予測を可能にするためのツールを作成することとした。本研究の対象は、当院に入院した脳血管疾患患者 417 人の患者であった。アウトカム指標は、実績指数が従属変数、年齢、性別、脳血管疾患、入院時 BMI、入院時運動 FIM、入院時認知 FIM、看護必要度 B 項目の 7 項目が独立変数であった。これらのデータに対して、重回帰分析によって得られた影響度の高い独立変数と、実績指数 40 前後から成る二分変数を用いて、ROC 解析を行った。分析の結果、最も影響力のある独立変数は看護必要度 B 項目であり、カットオフ値は 10、AUC は 0.85 であった。看護必要度 B 項目は、FIM よりも採点項目や測定の負担が少ないため、多職種の情報共有ツールとして有意義な指標である。本研究で得られたカットオフ値は、高い識別精度を示したことから、今後当院のリハビリテーションゴール設定に一定の貢献をもたらすことが期待される。

Key words
subject excluded, recovery rehabilitation ward, severely ill patient, nursing care B item, performance index

1. Introduction

A recovery rehabilitation ward was established in 2000 to shorten the length of stay in acute care hospitals and to support the independence of elderly patients. A performance index score using the Functional Independence Measure (FIM) was established in 2016 as an outcome measure for a recovery rehabilitation ward, which requires a shorter length of stay and improvement of the FIM score (Imanishi & Okuchi, 2021). The performance index is calculated using a formula that takes into account the degree of improvement in the FIM score during hospitalization and the number of days spent in the hospital. The 2020 revision of medical service fees clearly stipulated that the performance index must be 40 points or higher as a requirement for calculating the recovery phase rehabilitation ward admission fee standard I. The higher the performance index, the higher the actual rehabilitation effectiveness is judged to be (Sonoda, 2018). Furthermore, in rehabilitation wards, the level of need for nursing care B item (B score) used in acute care hospitals is required to be used as an outcome measure according to the 2008 revision of medical fees (Ohmori, Emori, & Hidaka, 2010).

Facilities such as in the target hospital in this research, (hereinafter called the hospital), that have recovery rehabilitation ward Standard I are required to have a performance index score of at least 40 points, and at least 30 % of newly admitted patients must be critically ill. On the other hand, even if the performance index score is less than 40 points, the patient can be excluded in advance at the discretion of the medical institution (subject excluded: SX).

The criteria for selecting SX includes: (1) motor FIM score of 20 or less on admission, (2) motor FIM score of 76 or more on admission, (3) cognitive FIM score of 24 or less on admission, and (4) age 80 years or older, and the patient must meet one of the four criteria. The number of patients who can be selected for SX is no more than 30 % of the number of patients admitted to the ward each month, and SX selection must be determined in the month in which the patient is admitted. There-

fore, since the selection of SX is for a limited number of people and requires an early decision, it is necessary to predict to some extent the prognosis of SX, and thus the performance index score of the patient. In fact, the choice of SX for patients with cerebrovascular disease was difficult at the hospital, with SX often being selected for patients with a performance index score of 40 or more points, a result that was frequently the opposite of our prediction. In addition, the hospital has not been able to establish appropriate rehabilitation goals for severely ill patients because it is difficult to share prognostic predictions among staff members. Therefore, it is an urgent issue to establish a criteria in selecting appropriate SX.

In previous studies, there have been active studies attempting to use multivariate analysis to predict patient prognosis. Most of these studies have focused on stroke patients, and have revealed that motor FIM score on admission, cognitive FIM score on admission, nutritional status, dysphagia, age, hemispatial neglect, and socioeconomic status are important independent variables as predictors of the FIM score on discharge and recovery of physical function (Bagg, Pombo, & Hopman, 2002; Kokura, Maeda, Wakabayashi, Nishioka, & Higashi, 2016; Yoshimura, Wakabayashi, Bise, Nagano, Shimazu, Shiraishi, Yamaga, & Koga, 2019; García-Rudolph, Cegarra, Opisso, Tormos, Bernabeu, & Saurí, 2020; Hiragami, Hiragami, & Inoue, 2019). In addition to this, some studies have found that the aforementioned B score items “transfer,” “communication of will to others,” “transfer method,” and “oral cleanliness” are important items that affect discharge home (Ohmori et al., 2010). Sakamoto & Yamamoto (2019) conducted a logistic regression analysis using the B score as a dependent variable, and suggest that age on admission, time of stroke onset, and level of disability in Activities of Daily Living (ADL) affected the severity and risk of a stroke in stroke patients. Thus, the B score has been shown to be a factor that can predict the prognosis of stroke patients, and these results may be an important reference for the hospital, which has introduced the B score but has not yet been validated to lead to SX selection criteria.

Therefore, this study was conducted to clarify the selection criteria for SX using data on patients with cerebrovascular disorders accumulated so far at the hospital.

2. Methods

2.1 Subjective and outcome indicators

This study was a retrospective study. Of the 516 patients with cerebrovascular disease admitted to the hospital between January 1, 2015, and December 31, 2020, 417 patients who fit the SX selection criteria were included. Since the purpose of this study was also to construct a measure to share the prognosis of severely ill patients with multiple professions, it was decided to exclude “(2) motor FIM score of 76 or more on admission,” which was included in the criteria for selecting SX (Figure 1).

As described above, since the hospital is required to select

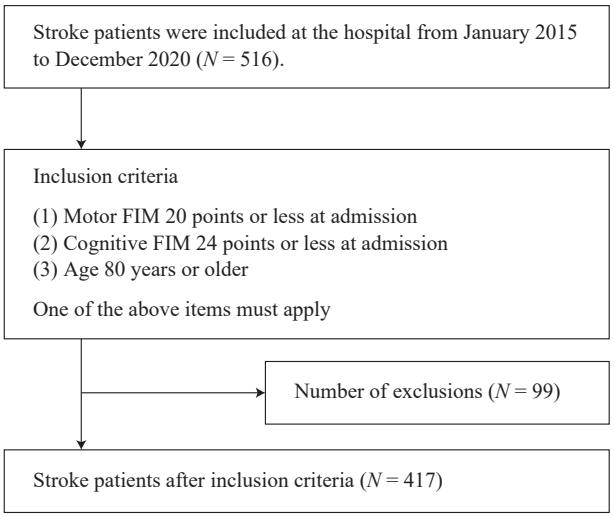

Figure 1: Flowchart of patients included in this study

SX for inpatients using performance index score as an indicator during the month of admission, it is meaningful to validate SX using the index obtained at the time of admission. Therefore, this study decided to use performance index score, age, gender, cerebrovascular disease, BMI kg/m^2 on admission, motor FIM score on admission (m-FIM score), cognitive FIM score on admission (c-FIM score), and B score on admission as outcome measures. The seven items listed as independent variables are indicators at the time of admission that facilities with recovery rehabilitation wards are required to report as part of the fact-finding survey, and are indicators classified into four categories according to the presence or absence of stroke-causing disease or higher-order brain dysfunction (Table 2). FIM score is a standardized method of evaluating activities of daily living, consisting of 18 items (13 motor items and 5 cognitive items), and is rated on a 7 point scale from 1 to 7 for each item. The B score is an indicator of the amount of nursing needed for a patient’s condition. The content of the category includes seven items: “turning over in bed,” “transferring,” “oral care,” “meal intake,” “changing clothes,” “understanding the instructions regarding medical instructions and therapy,” and “risk behaviors.” Each item is evaluated on a three-point scale from 0 to 2.

2.2 Analysis method and statistical analysis

Multiple regression analysis was performed using the outcome measures used in this study to determine the independent variables that had the greatest impact on the performance index score. Receiver Operating Characteristic (ROC) curve analysis was also performed to verify the cutoff value around 40 points for the performance index score using the independent variables obtained from the multiple regression analysis.

For multiple regression analysis, the statistical software HAD version 16.0 (Shimizu, 2016) was used. The Epi package (Bendix, Martyn, Esa, & Michael, 2022) was used in R version 4.2.2 to validate cutoff values.

2.3 Ethical consideration

The research was approved by the research ethics committee of Tokorozawa Rehabilitation Hospital (date of approval: January 5, 2021).

3. Results

Basic attribute data for 417 subjects are shown in Table 1.

Table1: Basic attribute data for 417 eligible patients

Age (years old)	78.2 ± 10.4 (42.0-99.0)
Gender (*n*)	
Male	230
Female	187
Cerebrovascular disease (*n*)	
System 1	241
System 2	100
System 3	17
System 4	59
BMI (kg/m^2)	21.4 ± 3.4 (12.4-35.9)
m-FIM (score)	29.9 ± 14.6 (13.0-73.0)
c-FIM (score)	16.2 ± 6.5 (5.0-33.0)
B (score)	8.7 ± 4.5 (0.0-17.0)
Performance index (score)	56.9 ± 63.2 (–72.0-675.0)

Notes: Numerical value; Number of patients or mean ± standard deviation (min-max). System 1 = Cerebrovascular disease with a calculation limit of 150 days or less. System 2 = Other than 1 above with a calculation limit of 150 days or less. System 3 = Severe cerebrovascular disorder with higher cerebral dysfunction with a calculation limit of 180 days or less. System 4 = Other than 3 above with a calculation limit of 180 days or less.

The results of multiple regression analysis showed that the independent variables with significant differences were B score on admission and age (Table 2), and the Variance Inflation Factor (VIF) from multiple regression analysis was less than 10 points for all variables. Based on these results, the ROC curve was analyzed with the performance index score as the dependent variable to clarify the cutoff value for the B score on admission, which had a sensitivity of 0.67, 1-specificity of 0.14, and a cut-off value of 10.0 points. The area under the curve (AUC) was 0.85, indicating that the model is highly accurate (Figure 2).

Table 2: Results of multiple regression analysis

Variable name	95 % CI		VIF	SPRC
Age (years old)	–0.218	–0.046	1.055	.132**
m-FIM (score)	–0.146	0.202	4.312	.028
c-FIM (score)	–0.111	0.150	2.424	.019
BMI (kg/m^2)	–0.132	0.037	1.020	.047
Gender (*n*)	–0.102	0.070	1.052	.016
Disease (*n*)	–0.031	0.137	1.011	.053
B (score)	–0.617	–0.260	4.542	.439**
R^2				.259**

Notes: ** $p < .01$; CI = Confidence Interval; VIF = Variance Inflation Factor; SPRC = Standardized Partial Regression Coefficient.

4. Discussion

The aim of this study is to establish a criteria for selecting appropriate SX in severely ill patients. To achieve this, it was necessary to predict the performance index score to some extent. Therefore, in this study, ROC analysis was performed using data from 417 patients with cerebrovascular disease admitted to the hospital to verify the cutoff values of the most influential variables derived from multiple regression analysis. The performance index score was used as the dependent variable, and age, gender, cerebrovascular disease, BMI kg/m^2 on admission, m-FIM score and c-FIM score on admission, and B score on admission were used as independent variables.

The results of the multiple regression analysis indicate that the B score on admission was the most significant independent variable, followed by age. Conversely, gender, cerebrovascular disease, m-FIM score on admission, and c-FIM score on admission did not demonstrate any significant independent variables. These findings suggest that the B score on admission is the most crucial factor in determining the performance index score. In addition, this study concluded that there was no multicollinearity, as the VIF was less than 10 for all independent variables used in the multiple regression analysis.

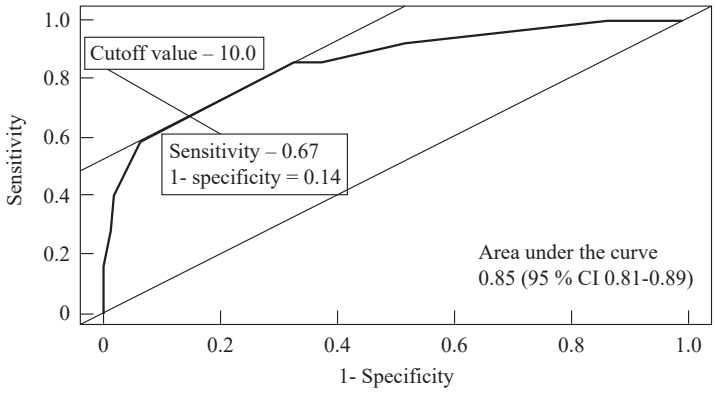

Figure 2: ROC curves

4.1 Age

Tokunaga & Sannomiya (2020) analyzed the explanatory variables that predicted the FIM score at discharge in patients with m-FIM score of 40 or less on admission to a rehabilitation ward. The result found that age had the strongest effect on FIM score at discharge. This study is similar to the inclusion criteria of the present study in that the m-FIM score was less than 40 points. And, this study likewise reveals that “age” has an impact on the performance index score next to the B score, showing the same trend as in previous studies (Tokunaga, Nishikawa, Matsumoto, Nanbu, Nakagawa, Maeda, & Kamiyoshi, 2015). In this study, age was not introduced into the ROC analysis because it focused on the most influential variables obtained in the multiple regression analysis. Given that age is an important independent variable, it is worth continuing to examine how age affects the prediction of rehabilitation effectiveness and patient prognosis.

4.2 Cerebrovascular disease

In the four types of cerebrovascular disorders used in this study, the majority of patients were System 1 or 2. Various measures of cognition have been cited as important variables reflected in the FIM at discharge (Hiragami et al., 2019, Maruyama & Hitomi, 2019, Tokunaga & Sannomiya, 2020). The reason cerebrovascular disease was not listed as a significant independent variable in this study may be due to the small number of System 3 patients with higher brain dysfunction. It is also possible that the c-FIM score, discussed below, may have influenced the results. This point needs to be re-examined with a larger number of System 3 patients.

4.3 BMI kg/m^2 on admission

Yagi, Inoue, Ogawa, & Okamura (2022) reported that sarcopenia affects the performance index score in patients admitted to a recovery unit. Uno & Kubo (2021) analyzed the effect of BMI kg/m^2 on FIM score gain in patients admitted to a community comprehensive care unit. The results showed that BMI kg/m^2 was associated with FIM score gain. These reports suggest that BMI kg/m^2 and nutrition, which indicate sarcopenia, are important factors that improve the FIM score, which is reflected in the performance index score. However, BMI kg/m^2 on admission, which was used as an independent variable in this study, had a low impact on the performance index score. This was thought to be due to the fact that Yagi et al. (2022) used a different patient population than the inclusion criteria for this study (Figure 1). The study by Uno & Kubo (2021) showed that the group with low BMI kg/m^2 had a significantly lower overall FIM score on admission compared to the non-low BMI kg/m^2 group. These suggest that BMI kg/m^2 may not have been a specific factor affecting the performance index scores of critically ill patients who met the inclusion criteria for this study, since the lower the BMI kg/m^2, the more severe the patient’s condition.

4.4 m-FIM score and c-FIM score on admission

On the other hand, m-FIM score and c-FIM score on admission were also reported to be predictors of the FIM score at discharge related to the performance index score (Tokunaga & Sannomiya, 2020), however in the present study, the effects of m-FIM score and c-FIM score on admission were lower, suggesting that the results of this study may differ from those of this report. In addition to the fact that the FIM score at discharge was not validated as the dependent variable in this study, there may have been a difference in the inclusion of critically ill patients. To clarify this, it is necessary to examine the association between the FIM score at discharge and the performance index score in critically ill patients. Furthermore, the number of Systems 3 patients with higher brain dysfunction should be increased and the impact of the c-FIM score on admission should be re-examined.

4.5 B score on admission and cutoff values

Following multiple regression analysis, ROC curves were generated and AUC was obtained to clarify the cutoff value of the B score on admission, which was set at the 40th point of the performance index score. The results suggest that the cutoff value of the B score on admission is 10 points and the AUC of the created model is 0.85, which is a high discrimination accuracy. Sakamoto & Yamamoto (2019) suggest that higher levels of impairment in daily living are strongly reflected in the severity criteria indicated by the B score. Ohmori et al. (2010) argued that in patients with cerebrovascular disease admitted to a recovery rehabilitation ward, the B score indicates daily functioning that makes discharge home difficult. Therefore, the B score is an indicator of the level of activities of daily living and it is an important independent variable for predicting the performance index score. The B score on admission shown in this study, which is limited to patients with severe diseases, have fewer scoring items than the m-FIM score and c-FIM score on admission, and because it is an index of daily living function, it is considered to be a meaningful index for information sharing by multiple professions. The cutoff values obtained in this study showed high discriminative accuracy and are expected to be used in future prediction models.

5. Limitations and challenges of this study

The data verified in this study are limited to hospitalized patients and cannot be generalized. According to previous studies, an R^2 coefficient of determination of at least 0.7 is recommended for a highly accurate multiple regression model (Maruyama & Hitomi, 2019; Tokunaga et al., 2015). In contrast, the R^2 coefficient of determination shown in this study is 0.26, which does not indicate that the precision of the multiple regression model is high, however the purpose of this study is to clarify the relationship with the performance index score, and the purpose of multiple regression analysis is not necessary to construct a mul-

tiple regression model with high precision (Yoshida & Murai, 2021). The purpose of multiple regression analysis is not only to construct a highly accurate multiple regression model (Yoshida & Murai, 2021). On the other hand, in addition to the results of this study, it is essential for the target hospital in this research to construct highly accurate multiple regression models in order to deepen an understanding of the subject population in the future. The risk of reaching the criterion of severity is 1.06 times higher for a 1-year increase in age on admission, which is similar to the high standardization coefficient of age shown in this study. As mentioned above, it would be meaningful to construct a highly accurate multiple regression model for predicting the performance index score in the future, taking into consideration the influence of age in addition to the B score on admission. Moreover, according to reports by Sakamoto & Yamamoto (2019), each item on the B score is potentially associated with indicators of ADL. Thus, it would be valuable to conduct a comprehensive analysis of each component of the B score on admission in the future. This could potentially lead to the development of a more precise prediction model for patients with varying degrees of severity, and provide further insights into the characteristics of the B score on admission.

Based on the above, the clarification of the B score on admission cutoff value for patients falling under the exclusion category is considered a groundbreaking study, as it has not been demonstrated in prior research. This study not only enhances the precision of patient selection for exclusion but also indicates the potential to unify treatment strategies for severely ill patients in a team-based medical care system. Moving forward, the results of this study will be used to develop a team-based approach to predicting patient prognoses and to validate the accuracy of the predictive model.

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