Clinical Neurology and Neurosurgery 158 (2017) 108–113

Contents lists available at ScienceDirect

Clinical Neurology and Neurosurgery

journal homepage: www.elsevier.com/locate/clineuro

Development of a prognostic scale for severely hemiplegic stroke patients in a rehabilitation hospital

Yoshitake Hirano[a,b,*], Osamu Nitta[a], Takeshi Hayashi[c], Hidetoshi Takahashi[d], Yasuhiro Miyazaki[e], Hiroshi Kigawa[b]

[a] Department of Physical Therapy, Graduate School of Human Health Sciences, Tokyo Metropolitan University, Tokyo, Japan
[b] Rehabilitation Center, Hanno-Seiwa Hospital, Saitama, Japan
[c] Department of Neurology and Cerebrovascular Medicine, Saitama Medical University International Medical Center, Saitama, Japan
[d] Department of Rehabilitation Medicine, Saitama Medical University International Medical Center, Saitama, Japan
[e] Department of Rehabilitation, Kansai Electric Power Hospital, Japan

ARTICLE INFO

Keywords:
Prognostic scale
Stroke
Severely hemiplegic
Rehabilitation hospital
Prediction
Walking ability
ADL
Destination

ABSTRACT

Objectives: For patients with severe hemiplegia in a rehabilitation hospital, early prediction of the functional prognosis and outcomes is challenging. The purpose of this study was to create and verify a prognostic scale in severely hemiplegic stroke patients and allowing for prediction of (1) the ability to walk at the time of hospital discharge, (2) the ability to carry out activities of daily living (ADL), and (3) feasibility of home discharge.

Patients and methods: The study was conducted on 80 severely hemiplegic stroke patients. A prognostic scale was created as an analysis method using the following items: mini-mental state examination (MMSE) at the time of admission, modified NIH stroke scale (m-NIHSS); trunk control test (TCT); and the ratio of the knee extensor strength on the non-paralyzed side to the body weight (KES/BW-US). We verified the reliability and validity of this scale.

Results: We established a prognostic scale using the MMSE, m-NIHSS, TCT, and KES/BW-US. A score of 56.8 or higher on the prognostic scale suggested that the patient would be able to walk and that assistance with ADL would be unnecessary at the time of hospital discharge. In addition, a score of 41.3 points indicated that the patient's return home was feasible. The reliability and the results were in good agreement. These findings showed that the ability or inability to walk was predictable in 85%, the need of assistance with ADL in 82.5%, and the feasibility of home return in 76.3% of cases.

Conclusion: At the time of admission, four evaluation items permitted the prediction of three outcomes at time of discharge. Our formula predicts three outcomes with an accuracy of more than 76%.

1. Introduction

There are many goals involved with stroke rehabilitation. The main goals are: (1) the ability to walk; (2) to improve the activities of daily living (ADL); and (3) to return home after recovery. To date, different scales have been proposed in stroke rehabilitation for the prediction of the prognosis in terms of the ability to walk [1–3], ability to carry out ADL [4–6], duration of hospital stay [7–9], and destination [10]. However, most of these methods are aimed at predicting a single goal, and as a result, they allowed for the extraction of factors that are important for the prognosis of the concerned goals, but did not allow for determination of the patients' characteristics or overall condition. In addition, previous studies have mostly been conducted on patients in the acute phase or patients with total stroke which did not apply a prognosis prediction for severely hemiplegic stroke patients hospitalized in a rehabilitation hospital. Moreover, using multiple scales to examine a patient's prognosis is complicated and impractical. If the ability or inability to walk at the time of hospital discharge, need of assistance with ADL, and the possibility of returning home after hospital discharge could all be predicted with a single prognostic scale, such a scale could be important in the design of rehabilitation plans. The purpose of this study was to create a prognostic scale allowing for the prediction of (1) the ability or inability to walk at the time of hospital discharge, (2) need of assistance with ADL, (3) and the possibility of returning home after hospital discharge, based on findings at the time of admission of severely hemiplegic stroke patients.

* Corresponding author at: RPT Rehabilitation Center, Hanno Seiwa Hospital, Hanno, Saitama, 357-0016, Japan.
E-mail address: take56overpower@yahoo.co.jp (Y. Hirano).

http://dx.doi.org/10.1016/j.clineuro.2017.04.020
Received 26 July 2016; Received in revised form 23 April 2017; Accepted 27 April 2017
Available online 28 April 2017
0303-8467/

2. Patient and methods

2.1. Patients

This study was conducted with the approval of Hanno-Seiwa Hospital's Ethical Review Board (approval number: 150118) as well as the approval of the Research Safety and Ethics Committee of the Arakawa Campus, Tokyo Metropolitan University (approval number: 15080).

The participants consisted of 80 out of 98 patients who were admitted to our hospital's rehabilitation ward between July 2008 and August 2015 on the first onset of stroke, who presented with severe hemiplegia, and whose paralysis of the affected lower extremity was classified as stage II or less according to the Brunnstrom recovery stage [11]. However, 18 of the 98 patients as follows were excluded from the study: 8 patients who had not been able to walk before the onset of disease, and 10 patients who could not undergo rehabilitation because of severe heart failure. We considered it better to exclude these patients, because we cannot evaluate the effect of rehabilitation on prognosis.

For the rehabilitation program, the participants underwent physical therapy, occupational therapy, and speech therapy in accordance with the 2009 stroke guidelines for Japan [12] daily, with a goal of achieving 9 units per day (this is the daily maximum limit according to the national system for diagnosis and treatment, in which a 20-min session is considered as 1 unit). In physical therapy, standing up, sitting, and standing motions in daily life, transfer motions, wheelchair driving, walking, as well as stair climbing and descending practice, were performed in a stepwise manner. In addition, during the initial period after admission, all patients carried out the standing-up, walking, and stair climbing and descending exercises while wearing a knee-ankle-foot orthosis (KAFO); and depending on the patients' degree of recovery from paralysis, the KAFO was replaced with an ankle-foot orthosis in some cases. In occupational therapy, patients were subjected to exercises involving ADL such as toilet activities, grooming, dressing, and bathing activities, functional exercises of the upper extremities including changing the dominant hand, and evaluation and training of higher brain functions. In speech therapy, rehabilitation was targeted at aphasia, dysarthria, eating disorders, and dysphagia [13].

2.2. Methods

Principal component analysis is the process performed to extract the principal components that explain the characteristics of the data from sample data without external criteria (dependent variable). We used this technique to determine the overall score of the patients who participated in our study. For the selection of evaluation items, those recommended for the 2009 stroke guidelines for Japan and Japanese Guidelines for the Physical Therapy (2011) [14] were used.

The evaluation items used for the development of the prognostic scale in this study consisted of cognitive functions, neurological symptoms, and physical functions at the time of admission to the rehabilitation hospital. Cognitive functions were measured using the mini-mental state examination (MMSE), the neurological symptoms were measured using the modified NIH Stroke Scale (m-NIHSS) [15], and the physical functions were measured based on the trunk control test [16], and by calculating the ratio of the knee extensor strength on the non-paralyzed side to the body weight (KES/BW-US), which was used as an index.

The outcomes consisted of the ability to walk at the time of hospital discharge, the ability to carry out ADL, and the ability to return home. The ability to walk at the time of hospital discharge was evaluated using the Functional Ambulation Category (FAC) [17]. Patients with FAC scores of 3–5 (ranging from the ability to walk under supervision to the ability to walk independently) were considered as able to walk, while those with FAC scores of 2–0 (ranging from the ability to walk with assistance to the inability to walk) were considered as unable to walk. The ability to carry out ADL was evaluated using the Barthel index (BI), and was classified into partial independence (total BI scores of 60 points or higher) or in need of assistance (total BI scores less than 60 points) in accordance with the criteria stated by Granger et al. [18]. For outcomes after discharge, the feasibility of returning home was evaluated.

2.3. Analysis methods

2.3.1. Development of prognostic scale

To create a prognostic scale, the four items (MMSE, m-NIHSS, TCT and KES/BW-US) measured at the time of hospital admission of the 80 participants and performed a principal component analysis, and thus, each item was weighted. Next, in order to ensure that the score could be easily calculated, the scores were replaced by numbers ranging from 0 to 100 points, and re-structuring was carried out in a manner that also included each item in the multiple regression analysis. Last, we examined whether the prognostic scale allowed for the prediction of the: (1) ability or inability to walk; (2) need for assistance with ADL; and (3) possibility of returning home after hospital discharge. To do so, we used the Receiver Operating Characteristic (ROC) curve to calculate three prognostic scales allowing for the determination of the prognosis, namely, the predicted values (cutoff value), hit rates, and the area under the curve (AUC).

The validity of the sample size was measured using the Kaiser-Meyer-Olkin (KMO) test. The cut off of ROCs were obtained using the Youden Index [19] and the hit rate as a cross-tabulation was performed, followed by the Fisher's exact test.

To validate the accuracy estimates of a prognostic scale, we selected the bias-corrected and accelerated (Bca) bootstrap method because it adjusted for both bias and skewedness of data. For this analysis, we followed the actual measurement value of the three outcomes and the prediction value of the three outcomes by the Spearman's rank correlation coefficient of the Bca bootstrap method. This process was repeated 1000 times.

Statistical analyses were carried out with SPSS for Windows (version 24, IBM, Armonk, New York). The statistical significance level was set at 5%.

3. Results

The participants' attributes were as follows: mean age, 62.7- ± 11.6 years and the percentage of very old patients (aged 85 years or more), 1.25%; sex, 50 males and 30 females; types of stroke, cerebral infraction accounted for 19 patients, intracerebral hemorrhage accounted for 55 patients, and subarachnoid hemorrhage accounted for 6 patients; the paralyzed side was the right for 34 patients and the left for 46 patients. The average number of days from disease onset to hospital transfer was 30.6 ± 15.2 days. Regarding the ability to carry out ADL at the time of admission, the mean BI score was 15.5 ± 14.9 points. The average number of days of stay in our hospital was 106.6 ± 44.5 days.

The result of validating sample size was 0.63 on using the KMO test. Table 1 shows the findings from each evaluation conducted on the patients. To calculate the prognostic scale, we carried out a principle component analysis using MMSE, m-NIHSS, TCT and KES/BW-US. The results revealed that the component matrix showing the correlation with the principal component was high for all four items (Table 2). It was found that a variable exists that explains this principal component well in one formula. The participants' scores were distributed from 2.1 points to- 2.3 points. Moreover, for the scores to be applicable in actual clinical settings, they were re-structured to range from 0 to 100 points, and we achieved this by adapting the numerical values of the four items. The calculated prognostic scale is as follows: $Y = 0.7 \times (\text{MMSE}) - 3.1 \times (\text{NIHSS}) + 0.3 \times (\text{TCT}) + 33.5 \times (\text{KES/BW-US}) + 56.7$. The cutoff value of the prognostic scale which predicted the ability or inability to walk at the time