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

1. Objective

For patients with severe hemiplegia to 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 predicting (1) the ability to walk at the time of hospital discharge, (2) ability to carry out activities of daily living (ADL), and (3) feasibility of home discharge.

2. Methods

The study was conducted on 80 severely hemiplegic stroke patients. 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 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. 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 result of validating sample size was 0.63 on using the KMO test. 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. 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: $Y = 0.7 \times (MMSE) - 3.1 \times (NIHSS)$

+ 0.3 × (TCT) + 33.5 × (KES/BW-US) + 56.7. The cutoff value of the prognostic scale which predicted the ability or inability to walk at the time of hospital discharge, and the need for assistance in carrying out ADL had a score of 56.8 points based on the Youden Index. In addition, the cut-off value of prognostic scale which predicted the possibility of returning home after hospital discharge had a score of 41.3 points based on the Youden Index. Further, three AUCs from the ROC curve measured 0.79 or higher, which was good (Fig 1). The predictive value was 85.0% for the ability or inability to walk. The predictive value was 82.5% for the need of assistance with ADL. Patients who were eligible to return home after hospital discharge accounted for 76.3%, and all items displayed a significant difference by the Fisher's exact test.

To validate the measured value and predict value of three outcomes, we performed validation using the BCa bootstrap method. The results obtained with the original and the Bca bootstrap sample were in good agreement.
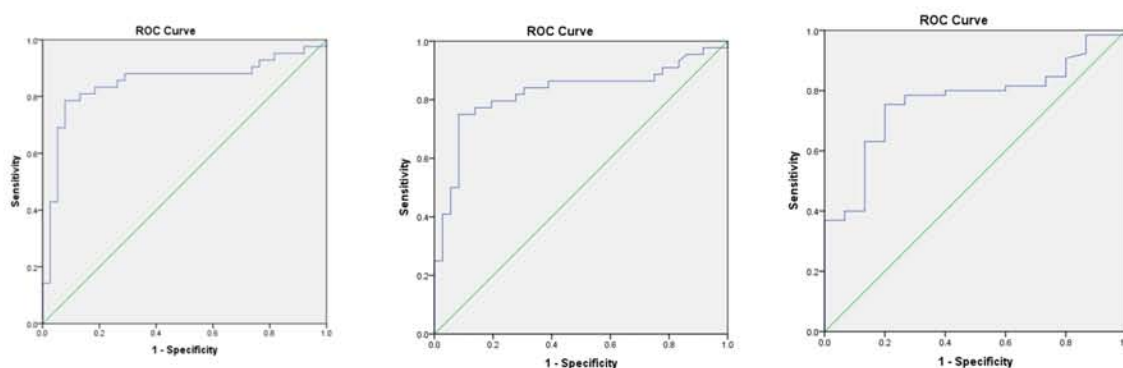

Fig. 1. Prognostic scale and walking ability, ADL and destination at discharge

4. Discussion

In stroke rehabilitation, it is important that the treatment program is designed by predicting the patient's eventual ability to walk, ability to carry out ADL, and outcomes. In this study, we developed a prognostic scale allowing the prediction of: (1) the ability or inability to walk at the time of discharge; (2) the need for assistance with ADL; and (3) the feasibility of returning home after discharge, on the basis of functional findings at the time of admission, namely MMSE, m-NIHSS, TCT, and muscle strength in the lower extremity on the non-paralyzed side.

Our study revealed a scale, which allowed for predicting all outcomes, the ability to carry out ADL, and the ability to walk at the time of hospital discharge, on the basis of functional findings at the time of admission to a rehabilitation hospital.

5. 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%.