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SHORT COMMUNICATION

CROSS-VALIDATION OF A MODEL FOR PREDICTING FUNCTIONAL STATUS AND LENGTH OF STAY IN PATIENTS WITH STROKE

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Objective: **In a study published in 2002, it was observed that a variable composed by the Functional Independence Measure (FIM™) and the trunk control test at admission predicted 66.5% of the FIM™ at discharge in stroke patients. The objective was to confirm the reproducibility of this predictive model.**

Methods: **Retrospective study of 245 hemiparetic stroke inpatients of the rehabilitation department. The main variables studied were: trunk control test FIM™ at admission and compound variable (FIM™+trunk control test) as independent variables and FIM™ at discharge and inpatient rehabilitation length of stay as dependent variables.**

Results: **Correlation between the compound variable and the length of stay was statistically significant (r =0.59), as was its correlation with the total FIM™ at discharge (r =0.82). The regression analysis predicted 34.3% of the length of stay variability and 66.4% of the total FIM™ at discharge variability.**

Conclusion: **The compound variable is a reliable tool because of its reproducibility in predicting the functional level at hospital discharge in hemiparetic patients.**

Key words: cerebrovascular accident, functional gain, Functional Independence Measure, stroke assessment, rehabilitation, prediction model.

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INTRODUCTION

A prediction model must fulfil certain requirements, such as having clinical credibility, being precise, and showing evidence of generalized application and of clinical effectiveness (1). A systematic review has revealed many prognostic models in patients with stroke to have methodological errors, limited generalization or lack of correct validation (2).

In a previous study, a predictive model that includes only the Functional Independence Measure (FIM™) and the trunk control test (TCT) measured at admission of the patient with stroke to a rehabilitation ward, predicts 60% of the variability of the length of stay (LOS) and 66.5% of the variability of the functional level at discharge (FIM™) (3). In spite of having good clinical credibility, this model has certain limitations, such as its reduced sample size (n =28), and its reproducibility has not been demonstrated in a different group of patients.

The purpose of our study was to validate the compound variable (FIM™+TCT) at admission as a model for predicting the functional condition on discharge (FIM™) and the LOS in a rehabilitation ward in a larger sample of stroke patients.

PATIENTS AND METHODS

This is a retrospective study of a cohort of 245 patients admitted to our department in the period January 1, 2001 to December 31, 2004.

The inclusion criteria were: (*i*) hemiplegia secondary to cerebrovascular accident (CVA) in the 4 weeks prior to admission; (*ii*) no previous history of disabled gait; (*iii*) absence of medical complications during stay that would interfere with rehabilitation treatment; and (*iv*) absence of cognitive impairment that would prevent the patients from following the instructions required to complete the tests and rehabilitation treatment.

An analysis was made of a total of 537 computer-based clinical records whose main diagnosis was hemiplegia (ICD-9-CM); of these 221 were eliminated because of lack of data, 28 for presenting a period of progress of the CVA at admission of more than one month, 15 for suffering medical complications during admittance and 28 for presenting previous gait disorders; resulting in a final sample of 245 patients.

All these patients followed a standard program of rehabilitation while admitted to the rehabilitation department of an acute hospital.

The variables included were:

1. Independent variables:
   - TCT (4): performed by the rehabilitation clinician within the first 24 hours after admission.
   - Total FIM™ at admission: applied by the rehabilitation clinician within the first 24 hours after admission.
   - Compound variable (CV): created by using principal component analysis, using the 2 standardized variables (FIM™+TCT): $\text{compound variable} = \left(\frac{\text{TCT}-76.4}{24.03} + \frac{\text{FIM admittance}-84.0}{24.38}\right) * 0.561$
2. Dependent variables:
   - Total FIM™ at discharge: applied by the rehabilitation clinician at discharge.
   - LOS: days of admission in the rehabilitation department.

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3. Other variables: age, sex, type of CVA (ischaemic or haemorrhagic), laterality of the hemiplegia, days since the CVA until admission to our department and destination on discharge (home or healthcare centre).

Statistical analysis was performed using the SPSS statistics package for Windows. The means of quantitative variables were compared between 2 groups using Student's t-test. When the data did not follow a normal distribution the non-parametric Mann–Whitney U test was used. Qualitative variables were compared using the χ^2 test. The correlation between quantitative variables was analysed using Pearson's correlation index (r). The level of significance was established as $p \geq 0.05$.

RESULTS

The characteristics of the sample of 245 patients were: mean age 65.79 years (SD 12.32), 153 men, 92 women and mean time from CVA to admission to our department of 13.93 days (SD 6.17). The type of CVA was ischaemic in 202 cases and haemorrhagic in 43, the laterality of the hemiplegia being left in 128 cases and right in the remaining 117. The 245 patients presented a mean FIM™ of 70.38 (SD 21.84) at admission and 94.01 (SD 20.39) at discharge. The median of the TCT was 74 [49–100]. The mean of the CV was –0.53 (SD 1.11). The mean LOS was 20.12 days (SD 7.13) and 182 patients were discharged at home and 63 patients were institutionalized.

In the analysis of the correlations, the TCT was negatively correlated ($r = -0.52$, $p < 0.001$) to the LOS and positively ($r = 0.69$, $p < 0.001$) to the FIM™ at discharge. The regression analysis showed that the TCT predicts 27% of the variability of the LOS and 48% of the variability of the FIM™ at discharge ($p < 0.01$). The correlation with the LOS was statistically significant for the CV ($r = -0.59$) although less so than for the FIM™ at discharge ($r = 0.82$). The regression analysis showed that the CV predicts 34.3% of the variability of the LOS and 66.4% of the variability of the FIM™ at discharge ($p < 0.001$).

As the correlation between the CV and the LOS was less than expected (in the model of the year 2002 the CV predicted 60% of the variability in the LOS), we divided the patients into 2 groups depending on the destination on discharge, home (CVh) or institutionalization (CVi). The correlation of CVh with the hospital stay was statistically significant ($r = 0.68$) and with a coefficient of determination $r^2 = 0.46$. No significant correlation ($p = 0.12$) was found between CVi and the LOS (Fig. 1). As to the discharge FIM™ prediction, the correlations of CVh and CVi were not different: $r = 0.76$ and $r = 0.80$ ($p < 0.001$). The characteristics of these 2 groups are compared in Table I.

In addition, a new prediction model was developed from the present sample:

$$\text{compound variable} = \left(\frac{\text{TCT} - 68.32}{28.51} + \frac{\text{FIM admittance} - 70.38}{21.84}\right) * 0.548$$

The correlation with the discharge FIM™ ($r = 0.82$) was exactly equal to the previous model.

DISCUSSION

This study verified the reproducibility of the CV regarding predicting the functional state at discharge from rehabilitation of patients with stroke, as the same results were obtained as those observed in the original study (3). It is important to stress that this predictive model only uses 2 independent variables (TCT and FIM™ at admission) and this gives it greater statistical power (5) and makes it easy to use in daily clinical practice. We have found only one other model (6) that also uses 2 variables: it explains the 44.3% variability of the functional state of the patient at 100 days (measured by the Barthel index) using the age of the patient and the National Institute of Health Stroke Scale (NIHSS) during the first few hours after the CVA. Our model predicts 66.4% of the variability of the functional level at discharge, although its application is not so early.

The reproducibility of the prediction of the LOS has not been demonstrated. This could be explained by the fact that the stay in the rehabilitation department is conditioned by various factors: it is not only influenced by the clinical and functional

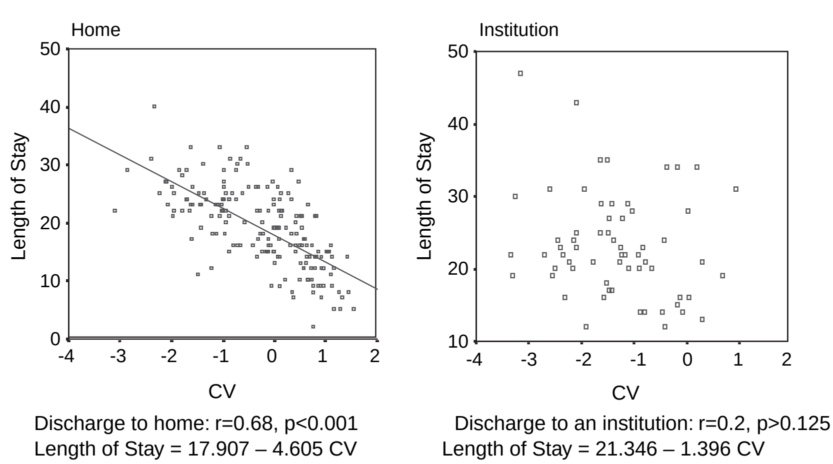

Fig. 1. Correlation of the compound variable (CV) with the stay depending on destination on hospital discharge (home or institution).

Table I. *Comparison of the characteristics in the group of patients who went home at discharge with those in the group of institutionalized patients*

	Home	Institution
Age (years) Mean (SD)	65.57 (12.38)	66.51 (12.23)
FIM™ at admittance	75.35 (20.67)	56.05 (18.66)*
FIM™ at discharge	100.42 (16.28)	75.49 (18.84)*
Time of evolution (days)	13.50 (5.62)	15.16 (7.44)
Stay	19.05 (6.80)	23.22 (7.20)*
Compound variable	−0.25 (1.00)	−1.34 (1.01)*
TCT (median)	81 [61–100]	49 [25–74]
Sex (*n*)		
men	114	39
women	68	24
CVA type (*n*)		
ischaemic	153	49
haemorrhagic	29	14
Laterality (*n*)		
left	93	35
right	89	28

* $p < 0.001$.
TCT = trunk control test; CVA = cerebrovascular accident; FIM™ = Functional Independence Measure.

condition of the patient, but also by social and economic factors. For this reason we divided the sample into 2 groups depending on the destination on discharge (home or institution). When analysing these 2 groups separately, it was noted that there is no correlation between the CV and LOS for institutionalized patients, whereas this was significantly increased for patients who returned home. We must bear in mind that in our sample institutionalized patients presented a worse FIM™ and TCT at admission and this could be a confounding factor when analysing the results. This should be verified by a stratified analysis. Although the prediction of the variation of the stay for non-institutionalized patients was significantly lower than that observed in the original model, it is similar to the one obtained in other models that included a larger number of independent variables (7).

We should also point out some of the limitations of this study. In the first place, the sample is comprised of patients admitted to our department and so it excludes patients that did not require intensive rehabilitation treatment. This causes a selection bias that limits generalization of the model to all patients who have suffered a CVA.

Neither do we know whether this model predicts functional results in the long term. Another of the limitations is that the data has been obtained in a retrospective manner. Although we believe that this does not overly affect our study because the variables are numerical and the TCT or FIM™ was not estimated from the medical records, it would be necessary to verify that the precision of the variables is not reduced when they are collected retrospectively.

In conclusion, we have verified the reproducibility of the compound variable (FIM™ + TCT) at admission, as a model for the prediction of the functional condition at discharge (FIM™). However, the prediction of the variation in the hospital stay is less precise than that found in the original study. We believe that the compound variable is a tool that can help when taking decisions regarding patients with hemiplegia caused by a CVA, although future studies are required to complete this validation.

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