Length of stay of stroke rehabilitation inpatients: prediction through the Functional Independence Measure

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Summary. - A model for prediction of length of stay (LOS, in days) of stroke rehabilitation inpatients was developed, based on patients' age (years) and function at admission (scored on the Functional Independence Measure, FIM[SM]). One hundred and twenty-nine cases, consecutively admitted to three free-standing rehabilitation centres in Italy, were analyzed. A multiple linear regression using forward stepwise selection procedure was adopted. Median admission and discharge scores were: 57 and 75 for the total FIM score, 29 and 48 for the 13-item motor FIM subscore, 29 and 30 for the 5-item cognitive FIM subscore (potential range: 18-126, 13-91, 5-35, respectively). Median LOS was 44 days (interquartile range 30-62). The logLOS predictive model included three FIM items ("toilet transfer", TTr; "social interaction"; "expression") and patient's age ($R^2 = 0.48$). TTr alone explained 31.3% of the variance of logLOS. These results are consistent with previous American studies, showing that FIM scores at admission are strong predictors of patients' LOS, with the transfer items having the greatest predictive power.

Key words: stroke, rehabilitation, Functional Independence Measure, functional assessment, length of stay.

Riassunto *(La predizione della lunghezza della degenza riabilitativa dell'emiplegico tramite* Functional Independence Measure*)*. - E' stato realizzato un modello per la predizione della lunghezza della degenza (LOS: *lenght of stay*, in giorni) del paziente con ictus cerebrale in fase riabilitativa, basato sull'età (anni) e sul quadro funzionale all'ingresso (punteggio della *Functional Independence Measure*, FIM). Sono stati analizzati 129 casi ricoverati presso tre centri di riabilitazione italiani. Per l'analisi statistica si è utilizzata una regressione lineare multipla con procedura di selezione progressiva in avanti dei parametri. Le mediane dei punteggi funzionali all'ingresso ed alla dimissione sono risultate: 57 e 75 per la FIM totale, 29 e 48 per le 13 voci della sottoscala motoria della FIM, 29 e 30 per le 5 voci della sottoscala cognitiva (la gamma dei loro valori potenziali è rispettivamente 18-126, 13-91, 5-35; punteggio più elevato indica maggiore autosufficienza). La mediana della LOS è stata di 44 giorni (range 30-62). Il modello predittivo del logaritmo naturale della LOS (logLOS) ha incluso tre voci della FIM ("trasferimento al bagno"; "interazione sociale"; "espressione") e l'età del paziente ($R^2 = 0,48$). La voce "trasferimento al bagno" da sola spiegava il 31,3% della varianza del logLOS. Questi risultati concordano con precedenti studi americani che dimostrano che i punteggi della FIM sono importanti predittori della LOS del paziente, e che le voci attinenti ai "trasferimenti" dispongono del maggior potere predittivo.

Parole chiave: ictus cerebrale, riabilitazione, *Functional Independence Measure*, valutazione funzionale, lunghezza della degenza.

Introduction

The diagnosis related groups (DRG) used to classify and prospectively pay the case-mix of patients admitted to acute care hospitals fail to sufficiently explain the variation in resource consumption for rehabilitation inpatients [1]. Up to 75% of variance of total care costs of these patients is explained by length of stay (LOS) [2, 3]. This in turn, is highly dependent on functional status at admission whatever the etiological diagnosis [2, 4].

Moreover, the LOS prediction can be useful not only for administrative reasons (e.g. to realistically budget resources and to support the development of a classification system aiming at predicting the resource consumption for medical rehabilitation facilities) [1, 4-6], but also for clinical purposes (e.g. to plan the appropriate setting and timing of inpatient rehabilitation programs, counsel the family at an early point, and co-ordinate discharge planning) [7-9].

Recently, two American studies [8, 10] focused on the prediction of LOS in stroke rehabilitation patients. Stroke is one of the most frequent diagnoses for admission to a rehabilitation unit [11, 12]. Both studies reported a good correlation between LOS and scores of several items and sub-scales of the functional independence measure (FIM), as assessed at admission.

The FIM[SM] is a disability scale with established validity and reliability [13-15]. It is composed of 13 motor-related items (FIMmot) pertaining to personal care, sphincter control, mobility and locomotion, and 5 cognitive-related items (FIMcogn) pertaining to communication and social/cognitive capacities. A validated Italian version of the FIM has been available since 1993 [16]. Two recent studies [12, 17] pointed out that, at least in stroke, there exists a difference in hierarchy between some Italian and American FIM parameters [11], possibly related to differences in health care organization between the two countries.

Hence, it would appear useful to test the capacity of the FIM to predict LOS in stroke rehabilitation in Italy, with a view to developing a simple model useful both for clinical and administrative purposes.

Materials and methods

Subjects

One hundred and twenty-nine stroke patients, consecutively admitted to three free standing rehabilitation centres, from May 1995 to February 1996, took part in this study. Patients were referred from surrounding acute care hospitals, and were screened for rehabilitation potential by physicians of the acute care hospital or by one of the centres' physiatrists. Patients included in the study: a) were > 18 years of age; b) were conscious at presentation and did not require intensive care; c) had had a first stroke with recent onset (less than 60 days).

Patients underwent on average 450 minutes a week (6 days per week) of physiotherapy, occupational therapy and, where necessary, speech therapy.

Procedure

The FIM was administered to each patient within the first 72 hours of admission. Data were collected by means of direct observation of the patient and, when necessary, by interview with relatives and/or paramedical personnel [16].

The raters, one in each centre, had acquired a FIM competency certificate after attending a course in Italy held by the licensed agency (SO.GE.COM Editrice s.r.l.), partner of the proprietary agency (UB Foundation Activities, Inc., UDS$_{MR}$, State University of New York, Buffalo, NY, USA).

Data analysis

Rehabilitation LOS was transformed by its natural logarithm (logLOS) to cope with positive skewness of the data.

FIM admission raw scores, either cumulative or for single items, were tested with respect to their correlation with logLOS. For each item, scoring was organized hierarchically on a 7-level basis (1 = full dependence; 7 = full independence): 5 levels for non-independence and 2 for independence, either complete or with aids. The 18-item total score (FIMtot) ranged potentially from 18 to 126; the higher the score, the better the performance.

Age (continuous variable) was also taken into account as a potential predictor of LOS [8].

Descriptive statistics were calculated for FIM scores.

In univariate analysis, correlation coefficients were calculated using Spearman's rank method, corrected for ties (r_s). We used the Bonferroni adjustment to correct the significance levels for r_s, taking into account that the number of correlation coefficient between logLOS and FIM scores was 27 (0.05/27 = 0.0018).

In order to better predict logLOS (the dependent variable), a multiple linear regression, using forward stepwise regression with elimination of unnecessary variables was adopted (Statview™ II, Abacus Concepts, Inc.1988). The forward selection procedure is a step by step process which selects as the next variable for the regression model the independent variable with the highest partial correlation with the dependent variable. Essentially, the partial F-ratio associated with each remaining variable is computed on the basis of the insertion of a remaining variable into the existing equation. Of the variables not included in the regression equation, that variable with the largest partial F-ratio is selected for inclusion and then new partial F-ratios are computed. The value 4 is the default for F-to-enter.

Results

The patients (61 males and 68 females) had a mean age of 70.5 years (SD 10.9; range: 38-83).

Eleven percent of the patients were single, 58% married, and 31% widowed or separated. Sixty-seven patients had right hemiparesis, and 62 left hemiparesis. The cause of the stroke was thrombo-embolic in 102 (79%) patients, and hemorrhagic in 27 (21%). Confirmation of the diagnosis was made by a neurologist, according to World Health Organization (WHO) criteria [18], with the aid of CT-scans.

The median of the interval between the acute episode and admission (onset to admission delay, OAD) was 32.5 days (interquartile range, IQR: 21-43) and that of the LOS 44 days (IQR: 30-62; 10th percentile 22 and 90th percentile 90 days).

Table 1. - Percentile distribution of the FIMmot (13 motor-related items of functional independence measure, FIM), FIMcogn (5 cognitive-related items of FIM), and FIMtot (FIMmot + FIMcogn) scores at admission and discharge

Percentiles	Admission					Discharge				
	10°	25°	50°	75°	90°	10°	25°	50°	75°	90°
FIMmot	14	19	29	43	64	21	33	48	71	80
FIMcogn	11	16	29	34	35	14	21	30	34	35
FIMtot	26	39	57	74	98	38	58	75	104	111

Eighty-eight percent of the patients (no. = 113) went home after rehabilitation, 9% (no. = 12) were discharged to a nursing home, 3% (no. = 4) were transferred to an acute care hospital. No patient died.

The percentile distribution of the FIMmot, FIMcogn and FIMtot scores, at admission and discharge, is reported in Table 1.

The positive skewness of the LOS (index value 0.989, with value zero corresponding to symmetric distribution) was corrected by transformation into its natural logarithm, logLOS (index value - 0.293).

A significant negative correlation was found between logLOS and FIMtot and FIMmot scores, as well as with 9 FIM items (Table 2): a) five pertaining to personal care: "grooming" (item B), "bathing" (C), "dressing-upper body" (D), "dressing-lower body" (E), and "toileting" (F); b) three related to transfers: "mobility/transfer bed, chair, wheelchair" (I) "mobility/transfer toilet" (J), "mobility/transfer tub or shower" (K); c) one pertaining to locomotion: "locomotion/walking or wheelchair" (L). The logLOS was also found to correlate with the subscores in the categories "self care" (items A-F), "mobility/transfer" (items I-K) and "locomotion" (items L-M), but showed no correlation with FIMcogn scores (Table 2).

The items concerning "mobility/transfer toilet" (J), "social interaction" (P), and "expression" (O), together with age, showed with stepwise regression that they were capable of predicting 47.5% of the variance in logLOS.

The linear regression model was: logLOS = 5.97 - 0.20 J - 0.13 P - 0.05 O - 0.01 age, with R = 0.69. The item "mobility/transfer toilet" alone explained 31.3% of the variance in logLOS, while "social interaction", age, and "expression" explained a further 8.2%, 5.9%, and 2.1% of the variance, respectively.

For clarity's sake, we report as an example of LOS prediction the two patients of our sample with the lowest and highest FIM values respectively: 1) C.B. 69 years, male. At admission, FIMmot 13, and FIMcogn 11. LOS as predicted by the model was 86 days; the actual LOS

Table 2. - Correlation between logLOS and FIM scores at admission, calculated by Spearman's correlation coefficients (r_s). The 6 subscales, FIMmot, FIMcogn and FIMtot scores are in bold type. The negative value indicates that the LOS decreases with an increase in the functional ability

Independent variables	r_s
Self care (A-F)	**-.413** *
A - Eating	-.252
B - Grooming	-.332 *
C - Bathing	-.448 *
D - Dressing - Upper body	-.482 *
E - Dressing - Lower body	-.496 *
F - Toileting	-.465 *
Sphincter control (G-H)	**-.257**
G - Bladder	-.209
H - Bowel	-.270
Mobility (I-K)	**-.519** *
I - Transfer bed-chair-wheelchair	-.491 *
J - Transfer toilet	-.543 *
K - Transfer tub-shower	-.402 *
Locomotion (L-M)	**-.480** *
L - Walk, wheelchair	-.473 *
M - Stairs	-.271
Communication (N-O)	**-.065**
N - Comprehension	-.098
O - Expression	-.052
Social cognition (P-R)	**-.088**
P - Social interaction	-.160
Q - Problem solving	-.019
R - Memory	-.151
FIMmot (A-M)	**-.444** *
FIMcogn (N-R)	**-.089**
FIMtot (A-R)	**-.340** *

* significant at p < 0.05 (experimentwise type I error probability). LOS: lenght of stay; FIM: functional independence measure; FIMmot: motor-related items of FIM; FIMcogn: cognitive-related items of FIM; FIMtot: FIMmot + FIMcogn.

was 92 days; 2) A.C. 73 years, female. At admission, FIMmot 68, and FIMcogn 34. LOS as predicted by the model was 18 days; the actual LOS was 16 days.

Discussion

This study shows that in stroke patients there exists a significant negative correlation between logLOS and the level of independence in items and categories of the motor domain of the FIM, in line with previous American observations [11, 16]. Other authors have pointed out that functional status at admission is strongly associated with rehabilitation LOS [2, 19] and charges [20].

A different statistical approach, based on classification and regression trees (CART) [21], also confirmed the central role of functional status in predicting LOS in stroke rehabilitation patients, namely the role of the variables related to transfer skills [5] and the act of toileting [7].

The development of predictive models of LOS on the basis of functional status has been enhanced with use of the 18-item, 7-level FIM [4, 5, 8, 10], which compares favourably with other less precise ordinal scales (such as the 10-item, 3-level Barthel Index) [2, 19], irrespective of whether multiple linear regression or CART is applied.

In the present study the three highest correlations between logLOS and FIM items were obtained in descending order with "mobility/transfer toilet", "dressing-lower body" and "mobility/transfer bed, chair, wheelchair": the first item has already been shown in the literature to be one of the principal predictive factors of favourable stroke outcome [7], while the third item was the single strongest determinant of LOS in another study [10]. As in other papers [4, 15], raw scores were statistically managed as true interval measures, because it has been shown that the FIM has linear metric properties, except for obvious floor-ceiling effects in the close vicinities of extreme scores, which were not recorded in our sample.

Transfer skills represent a complex human activity, involving a series of motor and cognitive-perceptual behaviours, and have an important functional, as well as social, significance. Their pivotal role in determining LOS is not surprising.

Being able to get on and off the toilet explains alone approximately one third of the variance in logLOS, followed (in descending order) by "social interaction", age, and "expression".

This study thus confirms that certain motor functions are a strong predictor of rehabilitation LOS (making it the first choice for outcome assessment within the context of resource use) [4, 5, 19], whereas the weak correlation between LOS and cognitive FIM scores

(Table 2) indicates that high-order cognitive abilities play only a complementary role in determining LOS of stroke rehabilitation inpatients.

Age explains a limited, though significant, additional percentage of variance and showed a negative correlation with logLOS; other studies have shown that older persons have shorter LOS than younger patients [12, 22], particularly when there is severe disability [5, 19, 22], as was the case with our sample.

We decided to predict LOS only on the basis of functional status (FIM scores) and age for two main reasons: a) these parameters have been frequently reported as two of the most significant predictors of rehabilitation LOS [23], and are readily available to care providers of the rehabilitation team at admission; b) we intended to develop a clinically meaningful tool that was simple enough for routine use, and independent of biomedical evaluation.

The percentage of variance of logLOS explained by our model is only slightly inferior to that explained by Galski et al. (57%) [8], and by Bohannon and Cooper (69%) [10], despite the fact that our sample size was greater and that the other studies were conducted on patients admitted to a single rehabilitation unit.

The high agreement between the results of the present study and those of the two preceding studies [8, 10]:

a) suggests that the FIM is quite robust as regards cross-cultural transplantation, in spite of the marked differences in national health care systems and lifestyles [24-26];

b) confirms that the functional independence evaluation enables prediction of a high percentage of LOS variance in stroke rehabilitation inpatients.

In conclusion, the ability of some FIM items, together with age, to predict the logLOS in stroke patients confirms, also in Italy, the usefulness of this functional status measure for several important purposes, namely planning stroke programs according to specific patient characteristics, optimizing allocation of human resources during the early stage of functional recovery, and planning discharges.

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