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FUNCTIONAL SHORT-TERM RECOVERY FACTORS IN PATIENTS WITH STROKE: A RETROSPECTIVE OBSERVATIONAL COHORT STUDY

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ABSTRACT

Background: The potential for early functional recovery in stroke patients is the basis for treatment choices and drives the rehabilitation. In this study we aimed to determine the predictive factors for short-term functional recovery in stroke patients admitted in a rehabilitation clinic.

Methods: We conducted an analytical, observational, retrospective cohort study on 108 stroke patients at Campolongo Hospital for Rehabilitation. The short-term functional recovery of stroke patients has been studied by the Motricity Index (MI) and the Trunk Control Test (TCT) in respect of motor recovery, and the Functional Independence Measure (FIM) scale about disability. The influence of predictors on short-term functional recovery has been studied by Chi square test.

Results: All patients showed a good functional recovery at discharge. Statistically significant correlations have been found between patient's age and the lack of trunk control at discharge ($p = 0.0305$), between patient's age and the value of the Motricity Index at discharge ($p = 0.0093$), between the presence of aphasia and the severity of motor deficit at discharge ($p = 0.0397$), between the presence of neglect and the severity of motor deficit at both entry and discharge ($p = 0.0051$ and $p = 0.0031$).

Conclusion: Our experience suggests that a predictive model of the short-term functional prognosis in early stroke patients allows for the optimization of the treatment and the rehabilitation taking charge. The final result will be an improvement of the patient's satisfaction and a rationalization in the use of available resources.

Keywords: stroke, functional recovery, predictors, short term recovery.

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INTRODUCTION

Nowadays the correct identification of early prognostic factors in ischemic stroke represents a topic of great interest both in clinical management and research, as the definition of the potential for functional recovery is the basis of therapeutic choices and rehabilitation. Kalra[1] has shown that the achievement of a predictive model of the functional prognosis after stroke would allow for the optimisation of the treatment and rehab taking charge; this, of course, would turn into an increasing of the appropriateness and effectiveness of the therapy, also with a view to better plan care and a rationalization in the use of available resources. Different variables have been linked with the outcome of ischemic stroke; the consensus in this regard was not yet achieved due to the difficulty in comparing the studies for the differences between the patients enrolled, the techniques of intervention, the intervals of evaluation, the criteria for the definition and measurement of the outcomes.[2] Nevertheless we have identified some prognostic indicators (pre/post stroke event), on which there is agreement in the Literature. [3]

One of the indicators of greatest interest is the patient's age at the time of the stroke, which has always been considered the bearer of poor motor outcome: recent evidence has shown that, although more slowly, even older people may recover.[4] Advanced age, therefore, does not represent in itself a limit to the possibility of post-stroke functional recovery, if not associated with other parameters with negative predictive values. Regarding sex, however, it was reported that in women the recovery of impairment and disability is less than in men.[5,6] Even those with a low level of premorbid autonomy present a risk of developing a disability three times higher, and seven times higher for the handicap. The functional outcome does not seem to be related to the brain damage suffered. The presence of comorbidity has a negative impact on mortality, but does not reduce the extent of functional recovery.

Among the indicators relating to the post stroke, large infarcts in the anterior circulation (TACI) correlate with increased risk of mortality at one month (approximately 35%) and have a disability that requires institutionalization at discharge (65%).[7,8] The severity and complexity of the clinical onset (measured using clinical scales as the *Scandinavian Stoke Scale* or *National Institutes of Health Stroke Scale*), significantly affect survival. The severity of the motor deficit of the limb affected, evaluated in the acute phase (seven days after stroke), predicts the segmental functional recovery.[9] Among the indicators of negative predictive value with respect to the recovery of autonomy, also notable are: trunk control [10], the persistent loss of sphincter control, [11] muscle tone disorders (severe spasticity or flaccidity), the coexistence of attention deficits such as neglect,[12] severe aphasia.[13] The presence of dysphagia increases the risk of mortality and morbidity and is associated with a lower benefit obtained after rehabilitative intervention and a greater risk of institutionalization.[14] As for the functional status at admission, measured by the FIM scale, it seems to positively predict functional status at discharge; in particular intermediate degrees of loss of autonomy (37-72 / 126 FIM) are associated with greater effectiveness of rehabilitation treatment.[15,16] However, since the duration of hospitalization can vary from hospital to hospital, as well as between patients in a single hospital, it is more correct to consider the time between stroke and entry to physiotherapy as *marker* of functional recovery.[17] Several works, in fact, have shown that begining rehabilitation few days after diagnosis means having the possibility of a more favourable functional outcome.[18] However, this relationship is affected by the fact that since the recovery after stroke occurs more rapidly in the early months, the patients studied earlier show further modifications in functional status compared to those evaluated at a later stage.[17] The relationship between the early entry into rehabilitation and better functional outcome, therefore, may actually reflect the normal pattern of recovery after stroke, rather than being the result of early treatment. The presence of depression, finally, negatively influences the rehabilitative activity and the quality of life of the patient, increasing the risk of dependence on ADL from 2 to 3 times. The aim of this study is the identification of prognostic factors of the functional recovery in stroke patients, verifying their reliability and effectiveness.

METHODS

We conducted a descriptive and correlation study of a cohort of 108 hemiplegic patients admitted under intensive rehabilitation in the Department of severe brain injury clinic "Campolongo Hospital" in Eboli (Salerno). All procedures on patients were compliant to Helsinki Declaration, and all patients gave the informed consent before to start the study. The inclusion criterion was the presence of hemiplegia, while all subjects with different outcomes (monoplegia, quadriplegia), as well as patients who died during hospitalization or resigned before the end of the trial were excluded. All patients concerned have practiced a

rehabilitation protocol consisting of two daily sessions of neuromotor rehabilitation, according to the Bobath method, and one session of occupational therapy per day aimed at the recovery of the manipulation-prehension, for the duration of hospitalization, about two months.

For the purpose of describing our study, the age, sex, level of cerebrovascular risk, the type of stroke (ischemic / hemorrhagic), the site and extent of the injury, the side affected, the severity of the clinical picture and the extent of motor damage were recorded for each patient. In particular, the referenced cerebrovascular risk factors were those described by the main guidelines for the prevention of stroke risk.[19] To simplify the analysis, three risk bands, "low", "intermediate" and "high", have been arbitrarily defined respectively, on the basis of the presence of none, one or more than one risk factors, more than two risk factors and/or previous cerebrovascular event, and/or diabetes mellitus in anamnesis. As for the age, also for the analysis, patients were divided into four bands: ≤ 45 years, 46-60 years, 61-75 years and > 75 years.

All patients were evaluated at the start, which occurred in the immediate post-acute phase (from 7 to 10 days after the cerebrovascular event) and at hospital discharge, which occurred after about 60 days, by administration of:

- A clinical-anamnestic card, detailing the demographic variables (age and sex), the type of stroke (ischemic /hemorrhagic), the location / extension of the lesion (OCSP classification), the presence of cerebrovascular risk factors, any associated diseases and the most frequent complications of the stroke patient (dysphagia, sensitivity disorders, aphasia, neglect), and the physiatric evaluation of functionality at entrance and discharge;
- The *Motricity Index (MI)*,[20] designed to study the motor impairment resulting from the injury of the upper motor neuron; is considered a valid, reliable and sensitive tool [21,22] and is fast to perform, requiring no more than 5 minutes to complete, and it does not require special training of the examiner. It also shows a strong correlation with parameters such as patient survival after stroke, the recovery of the ability to walk and the functional level of the patient.[23,24]
- The *Trunk Control Test* (TCT), as a further index of motor impairment: control of the trunk is a parameter that takes on a predictive value in respect of the level of recovery of the hemiplegic patient.[25,26] TCT is also a valid, reliable and sensitive tool.[22,27]
- The *FIM (Functional Independence Measure) scale* for the assessment of functional status and disability. [28,29] The FIM is a rating scale of disability ,[30,31] divided into 18 *items* within six functional areas (personal care, sphincter control, mobility, locomotion, communication, cognitive skills-relational) measured on an ordinal scale consisting of seven levels of functional performance. It is a valid, reliable and sensitive scale[32,33,4] and is extensively validated in stroke. Compared to other ADL scales such as the Barthel Index, it is more extensive regarding the functions discussed, considering also cognitive-relational functions.

As for the organization of data for statistical analysis:

1. MI scores were divided into three bands[34] :No deficit (score 100), moderate deficit (MI 99-50), severe deficit (MI < 50).
2. However, data regarding literary stratification scores TCT was not revealed, so, for the sole purposes of description, in this paper we have divided our patients into three subgroups (score < 35/100; 35-70 / 100 ; > 70 / 100), representing severe, moderate and slight impairment respectively.
3. As for the FIM values, finally, patients were divided into three subgroups (score < 40/126; 40-80 / 126 ; > 80/126), respectively, indicating a severe, moderate, and mild disability.[35]

The results of the rating scales administered were expressed both as a final score at discharge and as the difference between the final scores and the initial ones (Delta-IM, TCT-Delta, Delta-FIM) both absolute and relative (Delta Relative). The MI has also been considered both separately for the upper and the lower limbs, and globally throughout the emibody hit.

Statistical processing

To study the effect that these variables could have on the recovery, and therefore their predictive values with respect of *the outcome* an analysis of data linkage was created in partnership with the Department of Statistics of the University of Salerno. They used chi-square tests and the correlation index of Pearson to study the linear covariance and correlation bonds. The level of significance chosen was 95%, valid for p values < 0.05.

RESULTS

Sex		
Male	69	64%
Female	39	36%
Type of stroke		
Ischemic	81	75%
Hemorrhagic	27	25%
Affected emibody		
Right	65	60%
Left	43	40%
Linked disorders		
Aphasia	52	48%
Neglect	13	13%
Sensory disorders	20	18%
Dysphagia	12	11%
No disorders	11	10%
Cerebrovascular risk		
Low	15	14%
Medium	33	31%
High	60	55%

Table I: Baseline clinical characteristics of the cohort (numeric value and percentage)

ILLUSTRATIONS

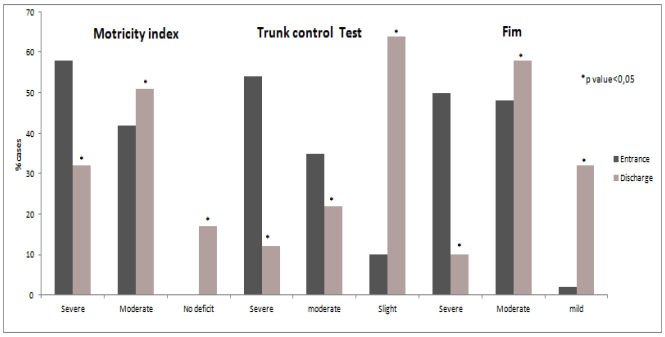

Figure 1: Recovery indices (Motricity Index, Trunk control test, Fim) scores at entrance and at discharge. Statistical significance of observed differences (p value < 0,05) was indicated by an asterisk.

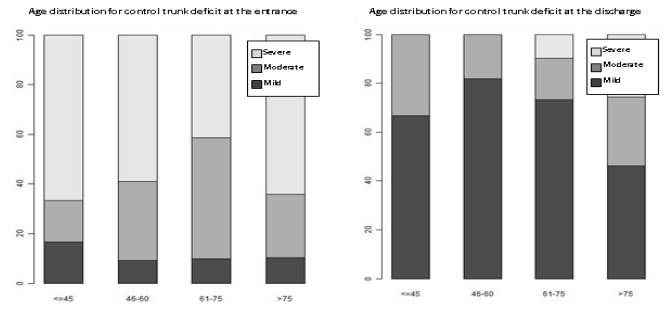

Figure 2: prediction of age on trunk control deficit (TCT score). The comparison between entrance and discharge data showed that, although starting from a homogeneous damage in all age-groups, younger patients (<45 years old; 45-60 years old) had a better recovery; for older patients, instead, a greater impairment remained at the end of the study. Statistical association between age and TCT score at discharge was confirmed by chi-square test and Pearson test (p= 0,0305).

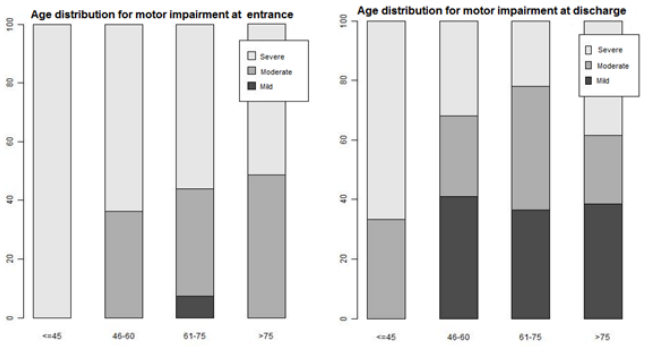

Figure 3: prediction of age on motor impairment (MI score). As well as for trunk control, also here patients between 45-60 years old had a better recovery, while older ones showed a higher residual deficit at the end of the study. Statistical association between age and MI score at discharge was confirmed by chi-square test and Pearson test (p= 0,0093).

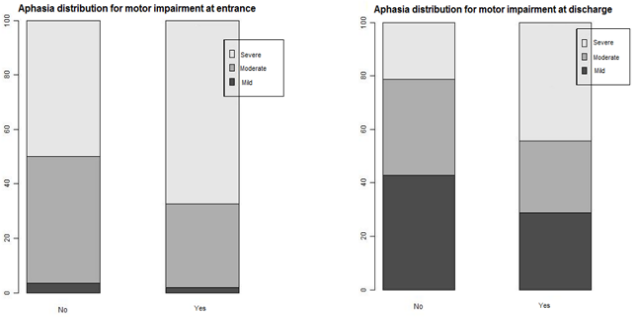

Figure 4: prediction of aphasia on motor impairment (MI score). The comparison between entrance and discharge data showed that patients without aphasia had a better recovery, also starting from a similar condition to aphasic ones. Statistical association between aphasia and MI score at discharge was confirmed by chi-square test and Pearson test (p= 0,00397).

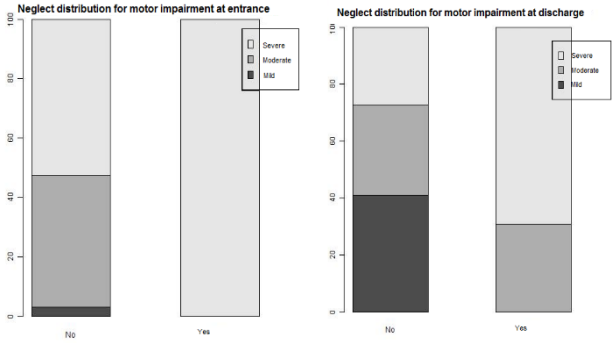

Figure 5: Prediction of neglect on motor impairment (MI score). Collected data, at entrance and at discharge, showed that patient with neglect diagnosis started by a worse clinical condition; they were all classified as "severe damage", and only a little of them had a recovery to moderate damage". Statistical association between negative and MI score at entrance and at discharge was confirmed

by chi-square test and Pearson test (p= 0,0051 and p= 0,0031).

Table I shows the main characteristics of patients included in the study, recognized at the time of entrance: among the most interesting data, the prevalence of right hemiplegia (60% of patients), aphasia (48%) and a profile of tendentially high cerebrovascular risk (55%); this risk profile was higher in men, and in those who had already developed an ischemic event. As for the overall assessment of disability through the FIM scale, most of the patients studied (98%) had a medium / high starting level of disability and dependency by care giver.

As a result of the rehabilitation program, as shown in Figure 1, there was an improvement in both of the indices of impairment and in the disability of patients: first, the index of motor skills showed deficits to be absent in 17% of cases (none at the time of entrance), moderate in 51% (42% at the entrance) and continued to be severe in 32% (compared with 58% initial) cases. In particular, stratifying the scores for upper and lower limb, the level of motor recovery of the first, expressed by the increase (Delta IM AS), was on average lower than that of the second, especially in the case of the left limb. However, the deficit of trunk control at discharge showed a marked improvement, with 65% of patients showing a slight deficit (10% at the entrance), 22% a moderate deficit (35% initial) and only 13% a severe deficit (55% at the entrance). Finally, disability at discharge (FIM) remained severe in only 10% of cases (initially 50% of the patients showed severe deficits), moderate in 58% of cases (48% at entry), mild in 32% (2% at start). All variations of the IM-TCT- FIM scores were statistically significant in the chi-square test (p <0.05).

Coming to the objective of our investigation, it is remarkable that a number of significant correlations have emerged between some of the predictors chosen and the characteristics of the patient at discharge. The execution of the tests mentioned above, in fact, showed statistically significant correlations between:

- Patient age and the values of TCT (p = 0.0305) and MI (p = 0.0093) at discharge; in particular it emerged that patients aged between 45 and 60 years recover better in terms of motor impairment (and consequently of residual disability); this was showed in figure 2 and figure 3
- The presence of aphasia and severity of motor deficit at discharge (p = 0.0397), as showed in figure 4;
- The presence of neglect and severity of motor deficit both at entry and discharge (respectively p = 0.0051 and p = 0.0031), as showed in figure 5.
- The increase in MI in the upper limb (Delta MI UL) compared to the increase of FIM (p = 0.0307)
- The increase in MI in the lower limb (Delta MI LL) compared to the increase of FIM (p = 0.0071).

The further investigation of correlations showed no significant correlation ties (p value > 0.05).

DISCUSSION AND CONCLUSION

The findings from our sample confirmed, in principle, what already exists in the Literature about the subject in question. First, the net recovery of patients following an intensive period of physiotherapy, shown by the constant trend of IM-TCT-FIM scores from important gravity conditions to modest conditions, seems to be in accordance with the SPREAD guidelines [36] for the execution of rehabilitation following a stroke; there remains, however, a limitation with respect to the method of work. While, in fact, in our study we applied the Bobath method, which has evidences in its favour, [37] the guidelines cited[36] also propose alternative techniques, such as the application of functional electrotherapy and muscle strengthening. Literature also suggests the use of computerized gait training to improve mobility recovery in stroke patients.[38] Regarding the analysis of predictive values of recovery, we must emphasize first of all that patients aged between 40 and 65 have recovered better than older patients; this would seem to support the hypothesis that age limits the patient's recovery.[4] At the same time, however, we find no acknowledgment of the literary fact that only coexisting of an important comorbidity justifies a negative prediction of advanced age at the time of stroke. [39] Regarding sex, however, in agreement with the findings in the Literature, women in our sample appear to recover less than their male peers, with the persistence of motor impairment and disability being of greater magnitude.[5,6] Patients with motor weakness of the limbs at entry showed a general trend to improvement, evidenced by the parallel and significant decrease of the disability; this recovery, however, has generally been more rapid and complete for the lower limb. This prediction is in good agreement with recently published evidence.[40]

Another interesting detail is the role of the deficit proceed from the stroke in predicting motor recovery (MI-TCT), including special attention

deserved by aphasia and neglect. As for patients with aphasia, a significant correlation with more serious scores of motricity and disability is shown, defining a value of prediction for worse outcomes. [15] A stackable condition occurred in the presence of neglect, where the motor-deficit framework of the patients was on average the worst, in analogy with what was defined by other scholars. [14] We have not found, however, a significant correlation between severity scores of patients and other consequences of stroke, such as dysphagia.

The aim of rehabilitation in stroke patients is to enable the greatest possible functional recovery, associated with a good level of physical and psychological wellbeing. In most patients the goal is to obtain a level of functional autonomy that allows the return home and the integration in the life of the community. For this reason, doctors are required to reliably predict the outcome, in the early stage of post-stroke functional recovery of the patient, based on the presence of predictors; this allows to facilitate the rehabilitation process and to use the resources available in the most appropriate way possible. However, there still remains an important gap between prognostics and rehabilitative practice. Therapists and doctors must formulate their functional goals as precisely as possible. This requires proper knowledge of the characteristics and the patient's illness, things that determine the functional outcome. Formulating a prognosis is something much more complex than a simple application of a prediction model and involves clinical decision-making and clinical reasoning, which is based on the cornerstones of the recovery, such as balance in sitting position, maintaining of the erected position and the ability to walk. Although adherence to the principles of methodology in research is a prerequisite for the achievement of an internal validity and statistics, the heterogeneity of the population of ictus remains a serious threat to the external validity of predictive models. Therefore stratification of patients based on demographic data and diagnostics has been recommended in order to increase the accuracy of forecasting models. The purpose of applying predictive models in more specified subsets of patients with stroke is to find a balance between precision and generalisability. In order to obtain a more efficient use of stroke services, it is important to identify predictors that discriminate between patients with good prognoses and those with bad. Differences within and between post-stroke studies with respect to the timing of the measurements for the prediction reduces the external validity of existing predictive models. Strict adherence to the dictates of the clinical trials (restrictive selection criteria and repeatable measurements over time) can contribute to a better understanding of post-stroke recovery in general and of patient characteristics that allow an early and reliable prediction of the final result.

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