An historical prospective study of prediction of improvement and final disposition of 105 patients with a stroke was carried out over a 2-year period in the rehabilitation service of a hospital providing long-term care. Patients were referred a mean of 37.8 days after the stroke, and were evaluated for total function and for mental status, perception, communication and motor ability at the time of admission and every 2 to 3 weeks thereafter. At the time of admission 26% of the patients were able to care for themselves; at the time of discharge 59% were able to do so, but 44% of these could not return home, primarily because of unfavourable social and environmental circumstances. In contrast, 35% of the patients unable to care for themselves went home because their families were willing to provide extra care. Neither the total function score nor the neurologic subtest scores at the time of admission predicted improvement. The presence of sphincter control and a lower age were the only significant predictors of improvement.

In the past few years the rapid increase in the cost of hospital care for acute conditions has created renewed interest in the development of functional prognostic criteria to help clinicians decide on the best timing and type of rehabilitation program for stroke patients. In a previous article in the Journal the work described that was designed to relate the overall functional ability of the stroke patient (Table I) to scores on four subtests — those assessing mental status, perception, communication and motor ability. These functions were scored on a seven-point scale based on verbal descriptions of decreasing deficit in each area. The total function score was postulated to be equal to the poorest score on any of the subtests. In practice we have found this scoring system to give an overall index of function that agrees well with an independent assessment of overall social performance in any environment.

In the following study we sought indicators of a successful outcome in a rehabilitation program. The study was designed to determine the following (Table II): (a) the correlation between the total function score at the time of admission and certain variables (age, sex, marital status, cause, associated medical conditions, sphincter control at the time of admission, whether there had been a previous stroke, the interval between the stroke and the initiation of the rehabilitation program, and the duration of treatment) and the subtest scores at that time; (b) the value

Table I—Overall functional ability of stroke patient*

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Totally unable to function.</td>
</tr>
<tr>
<td>1</td>
<td>Dependent socially and for self-care.</td>
</tr>
<tr>
<td>2</td>
<td>Socially dependent; requires assistance or supervision in self-care.</td>
</tr>
<tr>
<td>3</td>
<td>Socially dependent; self-care independent.</td>
</tr>
<tr>
<td>4</td>
<td>Socially and self-care independent; employable only in sheltered situation.</td>
</tr>
<tr>
<td>5</td>
<td>Socially and self-care independent; can undertake part-time or modified employment.</td>
</tr>
<tr>
<td>6</td>
<td>Able to return to former lifestyle, including employment.</td>
</tr>
</tbody>
</table>

*Reproduced from Jimenez and colleagues.1

Table II—Correlations studied

<table>
<thead>
<tr>
<th>Variables</th>
<th>Subtest scores at time of admission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total function score at time of admission</td>
<td></td>
</tr>
<tr>
<td>Total function score at time of discharge</td>
<td></td>
</tr>
<tr>
<td>Duration of rehabilitation treatment</td>
<td></td>
</tr>
<tr>
<td>Placement at time of discharge</td>
<td></td>
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</tbody>
</table>

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of the variables and of the subtest and total function scores at the time of admission in predicting improvement in the total function score at the time of discharge; (c) the correlation between the duration of rehabilitation treatment and the variables, the subtest scores at the time of admission, the total function score at the time of discharge and the placement at the time of discharge; and (d) the correlation between placement and the total function score at the time of discharge, age and marital status.

Methods

The charts of all 105 patients with complete hospitalization for a stroke admitted during a 2-year period to a hospital providing a long-term rehabilitation program (Baycrest Hospital, Toronto) were reviewed. Their admission had been agreed to by an admission committee according to the general and routine hospital policy; the authors were not members of the committee. All patients received an initial assessment and were re-evaluated every 2 to 3 weeks according to the criteria established in the previous article.1 Each assessment was done by one of the authors (J.J.) with the assistance of three therapists. Improvement was defined as any increase in the total function score. Sphincter control was defined as the ability to evacuate the bowels and bladder in the usual manner.

The data were analysed with the use of an IBM computer and the Statistical Package for the Social Sciences,2 which includes cross-tabulation, Pearson’s partial correlations and comparison of means.

Nearly two thirds of the patients were women, 64% were over the age of 70 years and 42% were married; this distribution is fairly typical of the patients at Baycrest Hospital. The mean interval between the onset of the stroke and referral to the hospital was 37.8 days, but the range and variance were great; 26% of the patients had not been referred until at least 40 days after the onset of the stroke. Most of the strokes (75%) were described as caused by thrombosis, 14% were considered to have been caused by embolism and the remainder were ascribed to hemorrhage; however, the diagnosis of thrombosis was usually made by inference or exclusion. The left hemisphere alone was affected in 55% and the right alone in 42%; in only 3% were both hemispheres affected. In 19% there was a history of a previous stroke, and most of those strokes had been on the same side. The diastolic blood pressure was elevated, usually mildly, at the time of admission in 30%.

Results

Total function score at time of admission

At the time of admission 78 patients (74%) were unable to care for themselves (Fig. 1); of these, 8 died at Baycrest Hospital. One patient able to provide self-care also died. The admission scores on the subtests of mental status, perception and motor ability as well as sphincter control showed significantly independent correlation with the total function score at the time of admission (Table III). In addition, poor sphincter control at the time of admission was inde-
pendently correlated with a low score in motor ability ($P = 0.001$). The communication scores did not show a significant correlation with the total function scores at that time.* Age was not independently related to the total function score at the time of admission. (Once the relation between age and mental status, perception, motor ability and sphincter control had been taken into account there was no independent relation between age and the total function score; in other words, older patients had lower function scores not because of their age but because they tended to have a greater neurologic deficit following the stroke.) Older patients were referred significantly sooner after the onset of the stroke than younger patients.

**Total function score at time of discharge**

At the time of discharge the total function score had improved in 49 patients, had remained the same in 46 and had worsened in 1. Nine patients died in hospital.

Forty-one percent of the 78 patients who were unable to care for themselves at the time of admission were able to do so at the time of discharge (Fig. 1). These 78 patients' total function scores improved less than those of the patients able to care for themselves at the time of admission, but the difference was not statistically significant.

Sex, marital status, whether there had been a previous stroke, location of the stroke, cause, blood pressure at several times during the hospital stay and whether medical complications, including pain in the shoulder, occurred did not show a statistically significant correlation with improvement in the total function score at the time of discharge.

Using the partial correlation method we found that the initial score on any subtest and the initial total function score did not predict either the final total function score or whether that score would be improved. The only two variables found to have a positive correlation with improvement in the total function score at the time of discharge were lower age (0.20, $P = 0.031$) and the presence of sphincter control at the time of admission (0.37, $P = 0.001$).

*Because the independent variables are highly interrelated, the correlations are expressed in terms of Pearson's partial coefficients derived from a matrix showing the relation between any two of the following: age, sphincter control at the time of admission, improvement and the four subtest scores. In this matrix the relation between any two variables is given independently of the relation between either of those two variables and any of the other variables in the matrix.

**Duration of rehabilitation treatment and length of hospital stay**

The amount of rehabilitation treatment received was studied by counting the number of days on which such treatment was given; a mean of 84.6 days of rehabilitation treatment was given during a mean of 121 days in hospital. The amount of such treatment given was not related to any of the independent variables at the time of admission or to outcome (improvement in the total function score and placement at the time of discharge).

**Placement at time of discharge**

Of the 96 patients discharged 54 (56%) went home; the remainder went to an institution.

The ability to provide self-care at the time of discharge was a strong predictor that the patient would go home rather than to an institution: close to 75% of the patients with this ability went home, as compared with only 35% of those without this ability (Table IV). Those older than 69 years were more likely to be placed in an institution (Table V).

Widowed and single patients went to an institution more frequently than married patients, independently of age and total function score at the time of discharge. In fact, 80% of the married patients went home, while only 39% of the unmarried patients were able to do so.

**Discussion**

It is always difficult to compare the results of different studies because of the different methodologies used, but it is clear that the amount of rehabilitation treatment received during hospitalization is related to the improvement in function at discharge.
different studies when the populations and methods of evaluating patient disability and function vary so greatly. Some studies have dealt with age- and sex-selected groups, while in others the rehabilitation program was carried out during the original hospitalization. In most instances motor power, activities of daily living and sphincter control have been used as measures of function and also as predictors of outcome. But some studies have included mental status and psychologic evaluation as measures and predictors of outcome, finding that apathetic behaviour and disordered thinking were of negative predictive value; the gross motor-perceptual losses are an indication of less likely improvement but are without individual statistical predictive value. The presence of associated medical conditions does not seem to correlate with improvement, but we question the inclusion of spasticity and sphincter control under this heading.

In the light of our own findings and those in the literature we conclude that functional scores are not as useful as predictors of outcome. They only represent remaining abilities or disabilities, which do not necessarily point to a specific central lesion; they are a description of the "peripheral dysfunction" rather than of the "central brain damage". Our own subtests — which, in fact, were clinical neurologic evaluations — failed to have any predictive value for this reason. Similarly, the "neuropsychiologic syndromes in stroke" described by Gordon and colleagues did not show any definite statistical predictive value. At present, age and the presence of sphincter control are the only variables correlated with improvement. The correlation we found between poor sphincter control and poor motor ability raises the practical point of the importance of early bladder care for stroke patients as some of them may be incontinent only because their mobility is seriously affected. Our results fully support Anderson and Kottke's conclusion regarding the critical need to re-examine and reconsider the principles and attitudes in stroke evaluation and research.

In our study we found that the length of stay in hospital was not correlated with improvement, in contrast to the reports of others, but the improvement in total function score continued with time (Fig. 1); thus, the question of spontaneous recovery is again raised.

Social factors are known to play an important role in rehabilitative outcome. In our population study marital status was not correlated with improvement, but it was a definite determinant of final placement. Marital status, age and total function score at the time of discharge play similar roles in determining whether the patient returns home or is placed in an institution; therefore, "social independence" must be included in all functional evaluations.

In conclusion, it seems advisable to refer for rehabilitation all patients with a stable medical condition after a stroke. However, rehabilitation is a learning process in which goals should be defined for different levels of independence in each case; therefore, assessment of mental status and the ability to learn is mandatory before any goals are established.

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