Predicting Discharge Status at Commencement of Stroke Rehabilitation

Surya Shah, MEd OTR/L, Frank Vanclay, MSocSci, and Betty Cooper, BAppSc

We discuss the functional ability of all 258 surviving patients with first stroke referred for inpatient comprehensive rehabilitation in Brisbane, Australia, during 1984 and derive an equation to predict the discharge Barthel Index score from characteristics assessed at admission to comprehensive rehabilitation. A boundary condition limiting improvement for patients with high admission Barthel Index scores and the lesser improvement observed for low-scoring patients indicate that the relation between initial and discharge Barthel Index scores is nonlinear. A quadratic equation including initial Barthel Index score and six other independent variables selected by stepwise regression analysis explained 61% of the variance in discharge Barthel Index scores. (Stroke 1989;20:766-769)

Stroke demands much of medical and rehabilitation services. With limited resources, it is important to use those resources for patients who are most likely to benefit from labor-intensive rehabilitation. Therefore, accurate prediction of outcome is highly desirable to identify those patients who are likely to improve the most, to plan for discharge, to judge the success of treatment, and to plan services for stroke survivors.1,2 The critical factor in the discharge disposition of a patient is his or her level of independence in performing the activities of daily living (ADL).1-4 Among the different measures of functional ability, the Barthel Index (BI) is regarded as superior because of its completeness, its sensitivity to change, the ease of statistical manipulation of its results, and its established reliability and validity.2,5-7 We examined the possibility of predicting discharge BI scores of patients with first stroke admitted to comprehensive inpatient rehabilitation from information available from the initial assessment.

Subjects and Methods

The study methodology was a prospective pretest-posttest design based on the population of all patients with first stroke referred for inpatient comprehensive rehabilitation during 1984.

Stroke was defined as a rapidly developed clinical manifestation of a focal loss of cerebral function lasting >24 hours or leading to death within 24 hours.8 The diagnosis was based on neuroradiologic investigations for 52% of the patients. For the other 48%, the diagnosis was based on the clinical impression of the consulting physician and/or a neurologist. Comprehensive rehabilitation was defined as the combined and coordinated use of physical therapy, occupational therapy, and a rehabilitation nurse in a multidisciplinary team, with the services of a speech therapist, a social worker, and a psychologist available as required.

The patients were drawn from the population primarily resident in Brisbane, Australia, which numbered slightly over 1 million in 1984. All seven public hospitals and four private hospitals in Brisbane that admitted stroke patients participated in our study.

There were 2,676 patients admitted in 1984 with a provisional diagnosis of cerebrovascular disease (International Classification of Diseases [ICD] codes 430-437). From these 2,676 patients, 1,342 with stroke were identified by ICD codes 431, 434, 436, and 437.9 Of the 1,342 stroke patients, 265 (20%) died within the first 2 weeks, 98 (7%) with a persistent altered consciousness state were transferred directly to extended-care facilities, and 359 (27%) who were independent in ADL were sent directly home. We did not consider the 68 (5%) with neurosurgical intervention or the 291 (22%) with a second or multiple stroke to minimize potential confounding.

This left 261 patients (19%) who had survived their first stroke in 1984 and who were referred for inpatient rehabilitation following their discharge from
acutely hospitalized. The time from onset of stroke to commencement of rehabilitation ranged from 1 to 79 (mean±SD 17±14.2, median 13) days. Patients were assessed independently on both admission to rehabilitation and on discharge. Three patients died during rehabilitation, leaving 258 patients, the total population of survivors of first stroke who underwent comprehensive rehabilitation during 1984. Discharge from rehabilitation was determined when the team considered that the patient had achieved maximum benefit. Rehabilitation time ranged from 6 to 276 (mean±SD 61±45.1, median 49) days.

Unlike other studies that measured stroke outcome at a specific time, we made our final assessment on discharge from rehabilitation to minimize the potential confounding from nonmedical factors such as discharge disposition and family, social, and cultural influences.

Adaptive recovery was measured as the patient's ability to perform ADL and the patient's improvement in ADL as measured by the BI, and neurologic recovery was measured using the Brunnstrom motor recovery stages.

The BI is not sensitive to change as it fails to detect the quality and quantity of the assistance required. We used a modified scoring of the BI, having the same extremes, to increase its sensitivity while maintaining the other qualities of the original BI. In our modified scoring, as in the original BI, patients who were unable to perform a task were coded 1 on the database and received a BI score of 0. Patients who were fully independent were coded 5 and received a BI score as recommended in the original BI. However, patients requiring assistance were further classified as those greatly dependent (coded 4), those requiring moderate assistance and/or supervision to complete a task (coded 3), and those requiring minimal assistance and/or supervision (coded 2). The score for these patients depended on the weight assigned to an item (Table 1). Precise instructions for our modified scoring of the BI and its reliability and validity have been published elsewhere.

### Results

Since our aim was to produce an equation that predicts discharge outcome at the commencement of rehabilitation, only variables for which information is available at admission to rehabilitation or on initial assessment could be used. These variables are presented in Tables 2, 3, and 4. Table 2 indicates that the initial BI score is the single best predictor of discharge BI score (r=0.63). Nominal variables were examined by one-way analysis of variance (ANOVA) for their relation with discharge BI score (Table 4). Three variables (paralysis, discharge BI score, and marital status) were significantly related to discharge BI score. To determine if these variables should be included in the final regression analysis, they were first incorporated into a multiple ANOVA with initial BI score (the single best predictor of discharge BI score) and age (a potential confounding variable). All three nominal variables failed to maintain a significant relation with discharge BI score.

All ordinal/interval, attribute, and nominal variables were available in stepwise regression analysis for potential selection.

The relation between initial and discharge BI scores is not linear (Figure 1). Theoretically, the BI has a boundary condition (a maximum of 100) for discharge score. Patients with high initial BI scores cannot improve to >100; therefore, improvement (the ratio of discharge BI score to initial BI score) diminishes. From Figure 1, it is also obvious that patients with very low initial BI scores tended not to improve greatly, while patients exhibiting the most improvement appeared to be those with initial BI scores of 40–80. This finding has also been reported by Jongbloed.

Therefore, to model the...
linear relation between initial and discharge BI scores, a polynomial function is required. Examination of Figure 1 and analysis of the theoretical issues surrounding rehabilitation reveals that a quadratic equation is appropriate.

The quadratic term chosen was the square of the initial BI score. In stepwise regression analysis, this was the second variable to enter the equation. This quadratic term explained 0.40 to 0.48. In other words, the addition of the quadratic term improved R² equation containing only the initial BI score from 0.40 to 0.48. The final predictive equation (with variables listed in descending order of importance) is: discharge BI score=75.78+1.55 initial BI score-0.010% (initial BI score) ²-0.58 age+3.74 Brunnstrom motor recovery stage (hand)-0.379 onset to admission-0.353 admission to rehabilitation commencement-6.21 myocardial infarction present-5.88 diabetes present. The significance of t for each variable was <0.000, <0.000, <0.000, <0.000, <0.000, <0.000, <0.000, <0.000, 0.003, 0.009, and 0.041, respectively. This equation had a multiple R of 0.78, thus explaining 61% of the variance in discharge BI score.

Discussion

Many studies predicting outcome have been conducted. However, these studies have been criticized for failing to adequately address the issues of methodology, population, and study timing and the role of comorbidity. We considered the weaknesses of previous rehabilitation outcome studies and addressed these criticisms in a prospective population study of all patients with first stroke.

The correlations with discharge BI score (Table 2) indicate that initial BI score is the single best predictor of discharge BI score (r=0.63), which is consistent with other studies reported by Jongbloed. However, inclusion of other variables in the predictive equation increased the amount of variance explained in discharge BI score.

Table 1. Ordinal/Interval Variables Considered in Predicting Discharge BI Score of 258 Patients With First Stroke

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value on initial assessment</th>
<th>Pearson correlation with discharge BI score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge BI score</td>
<td>78.1±26.3</td>
<td>r=0.63, p&lt;0.001</td>
</tr>
<tr>
<td>Initial BI score</td>
<td>44.5±24.5</td>
<td>r=0.47, p&lt;0.001</td>
</tr>
<tr>
<td>Brunnstrom motor recovery stage (hand)</td>
<td>2.8±1.6</td>
<td>r=0.51, p&lt;0.001</td>
</tr>
<tr>
<td>Arm (1-6)</td>
<td>2.6±1.6</td>
<td>r=0.41, p&lt;0.001</td>
</tr>
<tr>
<td>Hand (1-6)</td>
<td>1.5±0.7</td>
<td>r=0.41, p&lt;0.001</td>
</tr>
<tr>
<td>Motor control (upper) (1-3)</td>
<td>69.6±10.8</td>
<td>r=0.28, p&lt;0.001</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>6.5±13.9</td>
<td>r=0.13, p&lt;0.05</td>
</tr>
<tr>
<td>Onset to admission (days)</td>
<td>10.9±9.5</td>
<td>r=0.10, NS</td>
</tr>
<tr>
<td>Admission to rehabilitation commencement (days)</td>
<td>8.4±2.0</td>
<td>r=0.08, NS</td>
</tr>
</tbody>
</table>

BI, modified Barthel Index; NS, not significant.

Table 2. Nominal Variables Considered in Predicting Discharge BI Score of 258 Patients With First Stroke

<table>
<thead>
<tr>
<th>Variable</th>
<th>One-way ANOVA with discharge BI score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paralysis</td>
<td>F=12.000, NS</td>
</tr>
<tr>
<td>Employment</td>
<td>F=2.905, NS</td>
</tr>
<tr>
<td>Marital status</td>
<td>F=2.699, NS</td>
</tr>
<tr>
<td>Occupational classification</td>
<td>F=1.595, NS</td>
</tr>
<tr>
<td>Site of lesion</td>
<td>F=1.496, NS</td>
</tr>
<tr>
<td>Occupational prestige</td>
<td>F=0.759, NS</td>
</tr>
<tr>
<td>Handedness</td>
<td>F=0.719, NS</td>
</tr>
<tr>
<td>Arterial distribution</td>
<td>F=0.711, NS</td>
</tr>
<tr>
<td>Etiology</td>
<td>F=0.354, NS</td>
</tr>
</tbody>
</table>

BI, modified Barthel Index; NS, not significant.
In predicting improvement in functional ability, the discharge BI score as they are comparable measures in the equation should be considered in predicting a patient's recovery. The inclusion of the quadratic term takes into account the small improvement of patients with low initial BI scores and the small improvement of patients with high initial BI scores. In predicting improvement in functional ability, the squared initial BI score is also significant.

In stepwise regression analysis, the third variable to enter the equation was age. Age is clearly associated with discharge outcome; every 10 years of age reduces the predicted discharge BI score by 6 points.

While the role of associated illnesses is considered absolutely vital, the only variables to have a significant effect on discharge BI score were myocardial infarction and diabetes (Table 3), each reducing the predicted discharge BI score by 6 points. These associated illnesses were not significantly correlated with age. Therefore, it is clear that age affects stroke outcome independent of its effects on associated illnesses.

As shown in Table 2, Brunnstrom motor recovery stages and motor control are highly correlated with discharge BI score as they are comparable measures of stroke severity. The fact that hand control was included in the stepwise regression as a predictor of discharge BI score indicates that neurologic recovery and adaptive recovery are related. Therefore, it is imperative to consider not only the BI score, but also some measure of neurologic recovery.

Both the time from onset of the stroke to acute-care hospital admission and the time from admission to commencement of rehabilitation were included in the stepwise regression. As shown by the final predictive equation, delays at either stage contribute equally to a poor discharge BI score, which indicates the value of early rehabilitation. The issue for further research is whether the reduction in discharge BI score caused by a lengthy acute-care hospital stay is due to medical practice or the nature of stroke recovery.

Our predictive equation explains 61% of the variance in discharge BI score. This predictive equation is likely to better estimate outcome and possible discharge dispositions and is likely to help the rehabilitation team, family, and patient to assess the effectiveness of rehabilitation and to plan for the future. With 61% of the variance explained, the remaining variance may be the natural variance that can never be explained. However, further research into the correlates of the multisymptom complex of hemiplegia may reveal other significant factors that will account for some of this currently unexplained variance.

References


KEY WORDS • Australia • cerebrovascular disorders • prognosis • rehabilitation

Figure 1. Improvement in Barthel Index (BI) score for 258 patients with first stroke. —— discharge BI = initial BI; —— discharge BI = 48.0 + 0.68 initial BI.
Predicting discharge status at commencement of stroke rehabilitation.
S Shah, F Vanclay and B Cooper

Stroke. 1989;20:766-769
doi: 10.1161/01.STR.20.6.766

Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 1989 American Heart Association, Inc. All rights reserved.
Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://stroke.ahajournals.org/content/20/6/766

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Stroke can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Stroke is online at:
http://stroke.ahajournals.org//subscriptions/