The Effects of Long-term Rehabilitation Therapy on Poststroke Hemiplegic Patients

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Background and Purpose: Rehabilitation therapy is believed to be useful during the first few months after stroke when recovery usually takes place. However, evidence exists that this may not be the rule for all stroke victims. Therefore, we investigated, in a selected group of poststroke patients, the profile of recovery in response to long-term rehabilitation therapy.

Methods: Fifty-one hemiplegic subjects unable to walk 3 months after stroke were enrolled in this study. Patients underwent consecutive periods of rehabilitation up to 2 years after the cerebrovascular accident. Autonomy in daily living activities and the degree of neurological compromise were periodically assessed with the Barthel Index and a neurological scale designed for hemiplegic subjects. The main features of the patients were also evaluated as a possible predictor of outcome.

Results: In a consistent percentage of the patients, significant gains in gait and daily living abilities were observed during the first year and, in individual cases, during the second year after stroke. At the end of the study, 74% of the patients regained their capacity to walk without assistance, and up to 79% had a Barthel Index score above 70. Sphincter function, level of neurological impairments, and capacity in daily living activities are significantly related to the outcome of the patients as a whole but were not useful to anticipate the outcome of each patient.

Conclusions: These results suggest that disabled poststroke subjects may attain significant functional improvements in response to prolonged restorative therapy. However, the possibility of predicting the outcome of individual patients appears the major problem to solve in order to assign to long-term rehabilitation programs only patients who will benefit from the therapy. *(Stroke 1993;24:1186-1191)*

KEY WORDS • hemiplegia • rehabilitation • stroke outcome

Stroke is a major cause of disability in the elderly. Frequently, stroke survivors remain with neurological and functional impairments that significantly limit personal activities in the family and social environments. Although its efficacy is debated,1-3 rehabilitation represents the only therapy that may minimize disability, enhance likelihood of returning home, and reduce social costs.4

Two main factors may reduce the participation of patients in rehabilitation programs. First, it is common opinion that the greatest improvements occur within a few months after brain lesion, and little recovery takes place thereafter.5-7 In addition, rehabilitation is expensive and place availability in the rehabilitation centers is limited. For the above reasons, rehabilitation may be discontinued in stroke patients who do not make documented progresses in a relatively short time. However, evidence exists that some subjects may need prolonged therapy to support recovery that may occur at least up to 2 years after the brain accident.8-11

To test this hypothesis, we selected a group of hemiplegic patients unable to walk 3 months after stroke despite previous rehabilitative efforts. We investigated recovery in the whole group and in subgroups of patients (divided according to the side, the type of stroke, and sphincter function) during a rehabilitation program lasting up to 2 years after stroke. The clinical features of the patients were analyzed as possible predictors of final outcome. Functional and neurological scores at entry into the program (after previous restorative therapy) served as control values.

Subjects and Methods

The study group consisted of 51 patients who were suffering from hemiparesis of the right or left side caused by a single unilateral hemispheric stroke (either hemorrhagic or ischemic). Patients already had been admitted to our or other rehabilitation units and had been discharged or were in process of being discharged because of the little functional gains. Subjects were still unable to walk 3 months after the brain lesion. The main cause of gait inability was motor weakness of the affected limbs, often associated with trunk imbalance. Severe neglect and grave disturbances of comprehension may have contributed to the poor motor recovery in 7 and 13 subjects, respectively. Computed tomography demonstrated large lesions in the territory of the right (13 cases) or left (20 cases) middle cerebral artery, more discrete damage restricted to the right (3 cases) and left (3 cases) frontal lobe, and right (8 cases) or left (4 cases) deep lesions involving the internal capsule.
Subjects were treated up to 2 years after stroke. The rehabilitation program consisted of at least seven consecutive periods of therapy (one every 3 months), lasting 1 to 3 months. Each cycle of treatment was discontinued for 1 to 2 months. During the treatment phase, 1 or 2 hours of individual psychotherapy and 2 hours of occupational therapy were provided 5 days per week. When needed, speech therapy also was administered daily. Individual therapy was aimed to increase strength of the affected limbs, improve balance, and facilitate learning of new motor skills. Bobath describes the major techniques employed. Occupational therapy, including group activities, was used to force the patients to use the learned skills in a variety of environments and to promote socialization.

The degree of neurological compromission was assessed with the Graded Neurological Scale (Hemiplegic Stroke Scale [HSS]) proposed by Adams et al to evaluate motor, sensory, and higher cortical function deficits secondary to hemispheric stroke. For the purpose of this study, we considered both the total scores (HSS TOTAL), ranging from 0 to 100 (the higher the score, the greater the neurological deficits), and the subscores for motor function (HSS MOTOR) and language (HSS LANGUAGE), ranging from 0 to 40 and from 0 to 20, respectively. The ability to walk was also graded according to the HSS (HSS GAIT). Gait was considered functionally insufficient in patients scoring 4 to 6 and functionally sufficient in those scoring 1 to 3. In this scale, an HSS GAIT score of 3 means that the gait is moderately abnormal and no assistance (other than a simple device, such as a cane) is required, but distance is limited.

Autonomy in activities of daily living (ADL), including personal hygiene, feeding, and dressing, was monitored using the Barthel Index, with scores ranging from 0 to 100 (the higher the score, the greater the independence in ADL).

The HSS and Barthel Index scores were determined for each patient at entry into the study (3 months after stroke) and every 3 months thereafter until the end of the study (24 months after stroke). The Wilcoxon test was used to determine the statistical significance of the differences in Barthel Index, HSS TOTAL, HSS MOTOR, and HSS GAIT mean scores between the different evaluation times, ie, at 3, 6, 9, 12, 18, and 24 months after stroke.

The Mann-Whitney U test was used to evaluate the statistical significance of the differences in Barthel Index, HSS TOTAL, HSS MOTOR, and HSS GAIT mean scores of groups of patients with ischemic or hemorrhagic stroke, or with left or right hemispheric lesion, or of groups of sphincter-continent and -incontinent patients. The criterion of significance was set as $P<.05$.

Discriminant analysis was used to evaluate the prognostic value of different parameters (age, side of stroke; type of lesion; sphincter function; and Barthel Index, HSS TOTAL, HSS MOTOR, HSS LANGUAGE, and HSS GAIT scores) on the final Barthel Index score (either below, equal, or above 70) and the final HSS GAIT score (either below, equal, or above 3) of the patients. Variables with F probability <.1 were considered in the prediction equation.

### Results

The mean±SD age of the patients included in this study was 66.8±10.1 years. There were 28 men and 23 women. Four patients left the program during the first 3 months for reasons unrelated to their disease. Therefore, the statistical analyses were performed using the results from 47 patients.

The mean values of the Barthel Index, HSS GAIT, HSS TOTAL, and HSS MOTOR scores, at the different evaluation times, are depicted in Table 1. At 6, 9, and 12 months after stroke, we observed significant changes with respect to the previous trimester assessments in all tests employed. At the end of the first year after stroke, the mean Barthel Index and the mean HSS GAIT scores improved from values at entry into the study by 65% and 42%, respectively. The HSS TOTAL and HSS MOTOR mean scores improved by 25% and 13%, respectively. No further significant progress in mean values was noticed thereafter.

At the beginning of the study 3 months after stroke, the Barthel Index average score was 47. No patient scored above 60. A total of 25%, 43%, 68%, and 79% of the patients reached a good level of independence on ADL (ie, Barthel Index score of >70) at 6-, 9-, 12-, and 24-month evaluation times, respectively. At these time points, 18%, 36%, 64%, and 74% of the patients regained their ability to walk independently (HSS GAIT score ≤3).

**Table 1. Recovery From Stroke**

<table>
<thead>
<tr>
<th>Time after stroke</th>
<th>Barthel index score</th>
<th>HSS gait score</th>
<th>HSS total score</th>
<th>HSS motor score</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Mo (n=47)</td>
<td>47±9.2</td>
<td>5.5±0.5</td>
<td>48.3±12.3</td>
<td>32.4±5.1</td>
</tr>
<tr>
<td>6 Mo (n=47)</td>
<td>58.3±15.3*</td>
<td>4.6±1.1*</td>
<td>42.7±11.9*</td>
<td>31.4±5.5*</td>
</tr>
<tr>
<td>9 Mo (n=47)</td>
<td>67.3±15.6*</td>
<td>3.9±1.1*</td>
<td>38.8±10.9*</td>
<td>29.8±5.5*</td>
</tr>
<tr>
<td>12 Mo (n=47)</td>
<td>74.4±14*</td>
<td>3.4±1.1*</td>
<td>37.4±10.9*</td>
<td>28.9±5.4*</td>
</tr>
<tr>
<td>18 Mo (n=47)</td>
<td>76.3±13.2</td>
<td>3.2±1</td>
<td>36.2±9.6</td>
<td>28.5±5.3</td>
</tr>
<tr>
<td>24 Mo (n=47)</td>
<td>77.4±11.4</td>
<td>3.2±1</td>
<td>36±9.5</td>
<td>28.3±5.5</td>
</tr>
</tbody>
</table>

n, Number of patients; HSS, Hemispheric Stroke Scale. Values are mean±SD. *P<.05 different from previous assessment score.
and HSS TOTAL mean scores were comparable in all evaluation time points.

Table 3 shows the Barthel Index, HSS GAIT, HSS MOTOR, and HSS TOTAL mean values at 3, 12, and 24 months from 25 patients with left hemispheric stroke (mean±SD age, 66.2±8 years) and 22 patients with hemispheric right stroke (mean±SD age, 67.5±12.1 years). At all evaluation times, the HSS GAIT, HSS MOTOR, and Barthel Index mean scores were comparable between the two groups. The difference in HSS TOTAL mean score between left- and right-side–injured patients was due to the language deficits of the former. In fact, no difference between groups was observed when the HSS LANGUAGE score was subtracted from the HSS TOTAL score (data not shown).

Table 4 shows the Barthel Index, HSS GAIT, HSS MOTOR, and HSS TOTAL mean scores at 3, 12, and 24 months from 27 sphincter-continent (mean±SD age, 66.4±11.4 years) and 20 incontinent patients (mean±SD age, 67.3±8.4 years). At all evaluation times, patients with sphincter disturbances were significantly more compromised than subjects with sphincter control in all scoring tests. The outcome 2 years after stroke was remarkably different between the two groups. All continent patients except one and only 45% of the incontinent patients reached a Barthel Index score of >70. Additionally, 15% of the continent and 40% of the incontinent subjects were still unable to walk independently.

The features of the patients tested as outcome predictors are shown in Table 5. Variables showing an F probability of <0.1 were considered related to the recovery and were kept in the prediction equation. Therefore, three (HSS TOTAL, HSS LANGUAGE, and sphincter control), and six (HSS TOTAL, HSS LANGUAGE, HSS MOTOR, HSS GAIT, sphincter function, and Barthel Index) indexes were used in the prediction equation of HSS GAIT and Barthel Index scores at discharge, respectively. Age, side and type of brain lesion, and sex showed the lowest prediction value. Including in the equation the HSS TOTAL score and sphincter function (the two variables with the lowest F probability) at 3, 6, 9, and 12 months, we were able to correctly classify 70%, 83%, 89%, and 91% of the patients in the final two HSS GAIT groups (HSS GAIT score of ≤3 or >3) and 78%, 85%, 89%, and 94% of the patients in the final Barthel Index groups (Barthel Index score of >70 or ≤70). When we observed the accuracy of the prediction, the percentage of the patients with 95% probability to be exactly classified (P<.05) decreased substantially. At the considered time points, the percentage of patients was 0%, 23%, 26%, and 30%, respectively, in the HSS GAIT groups and 13%, 36%, 38%, and 60% in the Barthel Index groups (Figure). The prediction was not substantially improved by increasing the number of the variables in the equation.

**Discussion**

The present study evaluated the recovery during long-term rehabilitation therapy in a homogeneous group of patients with severe physical impairment due to a single-ever hemispheric stroke. To this end, we used a valid and reliable scoring instrument that rates the degree of compromised neurological status secondary
to hemispheric stroke.13-16 The autonomy in ADL was monitored with the Barthel Index, a simple and reliable test frequently used in stroke studies.17-20 In this regard, Granger et al13 reported that stroke patients reaching a Barthel index score of ≥60 move from dependency to assisted independence. However, in the present study, recovery in ADL was considered satisfactory when patients achieved a Barthel Index score of >70, which in our opinion better depicts a good level of capacity in self-care. At entry into the study, subjects were unable to walk and had a mean value exceeding 50% in compromised ADL abilities. Prolonged rehabilitation produced significant gains in gait and daily living activities up to 1 year after the brain accident. At the end of the study, 74% of the patients regained their capacity to walk without assistance, and up to 79% scored >70 in the Barthel Index test. About 10% of the patients achieved these objectives during the second year of therapy. These observations support and extend previous evidence from the literature. Several authors demonstrated that functional recovery can occur in response to rehabilitation programs started 6 months to years after stroke.9,11,21 Katz and colleagues have shown that improvements in ADL and walking abilities can occur up to 2 years after stroke.9 However, the patients evaluated in the study by Katz et al were less compromised than ours: About 2 months after the brain lesion, 51% of the patients were able to walk.

As measured by HSS TOTAL score, the neurological recovery paralleled functional recovery determined by Barthel Index score. However, 1 year after stroke, the former improved by 25% from baseline values, whereas the latter ameliorated by 65%. The discrepancy between improvements in neurological performances and functional index may be explained by the rehabilitation therapy that forces patients to learn new skills, allowing a more successful adaptation to the neurological deficits.23

The results from this study cannot solve the question of whether the functional improvements are related mainly to the rehabilitation or to the spontaneous course of recovery from the brain lesion. However, it should be pointed out that our patients were severely compromised and destined to remain bedridden in institutions for disabled people; thus, they would have had neither the stimuli to promote the “relearning” phenomena related to recovery nor the consistent support to practice them. In addition, it is common experience that spontaneous recovery does take place soon after stroke, but it is unlikely to occur 6 or more months thereafter.10 Furthermore, Tangeman et al11 showed that 1 month of an intensive rehabilitation program produced significant functional gains in patients 3 years after stroke. Together, these observations favor the hypothesis of a central role of rehabilitation in producing late recovery from stroke.

The final outcome of the patients with hemorrhagic infarction was not different from that of the patients with ischemic lesion. However, at 3 and 12 months, the Barthel Index score of the hemorrhagic stroke patient group was significantly higher compared with subjects with ischemias. This phenomenon may be due to a more rapid recovery of the former as previously suggested.24 However, the lack of testing scores earlier than 3 months after stroke does not allow definitive conclusions.

We did not find differences in outcome between patients with right- and left-side stroke in accordance

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**Table 5. Predictors of Stroke Outcome by Discriminant Analysis**

<table>
<thead>
<tr>
<th>Variable</th>
<th>HSS gait score at discharge</th>
<th>Barthel index score at discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F value</td>
<td>F probability</td>
</tr>
<tr>
<td>HSS total score</td>
<td>7.3</td>
<td>0.009</td>
</tr>
<tr>
<td>Sphincter control</td>
<td>4.0</td>
<td>0.051</td>
</tr>
<tr>
<td>HSS language score</td>
<td>3.4</td>
<td>0.069</td>
</tr>
<tr>
<td>HSS motor score</td>
<td>2.3</td>
<td>0.137</td>
</tr>
<tr>
<td>Barthel index score</td>
<td>2.1</td>
<td>0.157</td>
</tr>
<tr>
<td>HSS gait score</td>
<td>1.7</td>
<td>0.196</td>
</tr>
<tr>
<td>Side of lesion</td>
<td>1.2</td>
<td>0.288</td>
</tr>
<tr>
<td>Age</td>
<td>0.9</td>
<td>0.337</td>
</tr>
<tr>
<td>Type of lesion</td>
<td>0.7</td>
<td>0.675</td>
</tr>
<tr>
<td>Sex</td>
<td>0.2</td>
<td>0.675</td>
</tr>
</tbody>
</table>

Variables with an F probability of <0.1 were considered related to recovery.

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*Bar graph shows percentage of patients exactly classified (P<.05) by discriminant analysis in final Hemiplegic Stroke Scale (HSS) gait score groups (■) and final Barthel Index score groups (■). The variables considered in the prediction equation were HSS total score and sphincter control at the specified evaluation times.*
with previous findings. However, some authors reported that lesions in the right hemisphere had a more ominous outcome than left-side hemispheric injuries. The cognitive deficits (such as constructional apraxia and spatial neglect) due to right hemisphere lesion may hamper rehabilitation more than language disturbances caused by left hemisphere lesions. Together these observations suggest the need to examine recovery in relation not only to the side of the lesion but also with regard to the presence and gravity of related neuropsychological deficits.

Sphincter incontinence on admission is an unfavorable sign of outcome. About 40% of the incontinent patients compared with 15% of the continent subjects were unable to walk at discharge from after participating in the program for 2 years. These observations agree with the data of the literature. For instance, Wade and Langton Hewer reported that among moderately or severely disabled patients, 80% of the patients with urinary incontinence and 43% of the incontinent patients recover almost completely. In this study, patients with sphincter disturbances were neurologically more compromised than continent patients according to the HSS TOTAL and HSS MOTOR scores. This observation may agree with the speculation of Jimenez and Morgan that incontinent patients have a less favorable outcome because of the associated more pronounced motor deficits.

Predicting outcome of stroke patients is aimed at optimizing the choice of patients to be treated, excluding subjects who probably will not benefit from rehabilitation. In this study, we observed that the HSS MOTOR, HSS GAIT, Barthel Index scores and/or the HSS TOTAL, HSS LANGUAGE scores, and sphincter control were significantly related to outcome. Age, sex, and side and type of lesion had a low predictive value. However, using a combination of the above features (in particular the HSS TOTAL score and sphincter function) in the prediction equation and setting the probability of the prediction at P<0.05, we were able to allocate only a low percentage of patients into the final Barthel Index or HSS GAIT groups. At best, we were able to anticipate 12 months after stroke the correct final Barthel Index outcomes of 60% of the subjects. These conclusions agree with previous reports. A correlation has been demonstrated between the Barthel Index score, language disturbances, severity of the motor impairment, sphincter function, and outcome. Conversely, factor analysis studies using a combination of the above and other variables did not produce predictive formulas useful for clinical decisions in individual patients.

In conclusion, a consistent percentage of patients with severe disability 3 months after stroke may attain functional independence in response to long-term rehabilitation therapy. Independence in gait and ADL activities should be expected up to 1 year and in some cases up to 2 years after stroke. Unfortunately, the lack of the possibility to predict outcome in individual cases would imply that all disabled patients have to be treated. By contrast, rehabilitation is a costly and limited resource. Therefore, more research is needed to improve accuracy of prediction to exclude from long-term rehabilitation programs those subjects who will take minimum advantage of the therapy.

Acknowledgments

We wish to thank Professor Paul Bach-y-Rita for his suggestions in preparing this manuscript and his help in the rereading of the English text, and the physical and speech therapists for their contributions to this study.

References

The effects of long-term rehabilitation therapy on poststroke hemiplegic patients.
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Stroke. 1993;24:1186-1191
doi: 10.1161/01.STR.24.8.1186
Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0039-2499. Online ISSN: 1524-4628

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