Improvement in Motor Performance in Paretic and Paralyzed Extremities Following Nonembolic Cerebral Infarction

BY FLETCHER MCDOWELL, M.D., AND SYDNEY LOUIS, M.D.

Abstract: Improvement in Motor Performance in Paretic and Paralyzed Extremities Following Nonembolic Cerebral Infarction

The problems involved in measuring improvement as well as the conceptual difficulties in considering this phenomenon were considered in general terms. Data on 300 patients with nonembolic cerebral infarction followed from five to nine years are presented, indicating that improvement in function of a paralyzed extremity may occur in the early phase after stroke but was extremely unlikely to continue during long-term follow-up from three months to five years. It was concluded that improvement in function might be determined more by retraining of the nonaffected muscles and particularly of the unaffected side rather than by recovery of the area paralyzed.

ADDITIONAL KEY WORDS stroke recovery
improvement in motor function late recovery

Comment exists in the literature suggesting that substantial improvement in function may occur over many months or years following a stroke. Conversely, it is known that central neural tissue, once destroyed, does not regenerate or recover. Though at first these ideas may appear contradictory, the concepts may not be irreconcilable.

Difficulties exist in studies of improvement following stroke for a number of reasons which merit full recognition and discussion prior to the presentation of data. In the early phases following a stroke there are certain inherent difficulties which complicate the interpretation of improvement. Clinically, cerebral ischemia cannot satisfactorily be distinguished by any test from cerebral infarction. An inference is made that when improvement in neurological function is rapid and marked, the patient probably suffered ischemia. The degree of infarction, the amount of ischemia peripheral to an infarct, the amount of collateral circulation, and the quantity of edema surrounding an infarct will all determine the reversibility or irreversibility of the initial symptoms and signs and hence the improvement potential.

If, as in the present study, the initial period of hospitalization is regarded separately, there remain other difficulties in studying long-term improvement. For instance, there is no evidence of the ability of uninvolved neural tissue to compensate for a loss of function. The significance of bilateral innervation or innervation of lower motor neurons from two separate areas of brain may or may not play a part in determining the potential for recovery. Once again, no studies are available to determine the importance of these points in the study of improvement. Another point in such studies is that care must be taken to separate improvement in the function of the paretic extremities from improvement in overall function of the...
TABLE 1
Criteria for Evaluating Improvement of Motor Performance After Discharge from Hospital

<table>
<thead>
<tr>
<th>No motor deficit</th>
<th>No weakness detected on examination. Little or no defect of gait.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild to moderate motor deficit</td>
<td>Paresis on formal neurological testing. Defective gait but able to walk alone without support, braces, etc.</td>
</tr>
<tr>
<td>Severe motor deficit</td>
<td>Complete paralysis of leg. Severe weakness resulting in necessity of braces, crutches or assistance on walking.</td>
</tr>
</tbody>
</table>

Improvement was noted when a patient changed category, particularly insofar as lower extremity function and gait were concerned.

Improvement in the early phase was defined as improvement in motor performance of the affected extremities in the inpatient phase, a period of one and one-half months to three months. It was defined in clinical terms as marked, moderate or slight return of use of weakened or paralyzed extremities. As discussed in the introductory remarks, we were fully aware that the influence of many factors including alteration in the patients' general health might modify our clinical impression in this phase. For these reasons, no efforts were made to produce an impression of precision. Early improvement was, therefore, judged clinically as being markedly, moderately, slightly or not at all improved by comparing motor performance at discharge with that on admission.

Late improvement in function was determined primarily by the patient's ability to use his affected extremities during formal neurological testing and rested especially heavily on improvement of lower extremity function in walking. A simple grading system was utilized with the patients being classed as having no disability or mild, moderate, or severe disability (table 1). It is appreciated that changes may well occur within one of these categories which would not be evident in the final analysis. The patients' ability
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to walk normally, with slight, moderate, or severe difficulty or not at all, was used extensively in determining in which category a patient should be placed. Most of the examinations, particularly the latter ones, were carried out by Drs. Ellen McDevitt, Sydney Louis, and Fletcher McDowell.

**Results**

**THE PHASE IN HOSPITAL**

As may be seen from table 2, some improvement occurred in the use of the involved extremities in just over half of the patients during hospitalization. Marked improvement occurred in 16.7% and moderate improvement in 20%.

**THE POSTHOSPITALIZATION PHASE**

Figures 1 and 2 show what late improvement occurred in those patients classed as mild to moderate or as severely disabled at the time of discharge. As may be seen, a very small, but constant, proportion of patients were found to show improvement during the five years of follow-up. The patients classed as mildly to moderately disabled showed a slightly higher proportion of improvement during the first year than the severely disabled patients. Figures 1 and 2 also show the number of surviving patients.

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**TABLE 2**

Improvement in Motor Function on Physical Examination Contrasting Status on Admission with that at Discharge

<table>
<thead>
<tr>
<th>Improvement</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marked</td>
<td>16.7</td>
</tr>
<tr>
<td>Moderate</td>
<td>20.0</td>
</tr>
<tr>
<td>Slight</td>
<td>14.3</td>
</tr>
<tr>
<td>None</td>
<td>11.7</td>
</tr>
<tr>
<td>Died</td>
<td>34.0</td>
</tr>
</tbody>
</table>

**FIGURE 1**

The fate of 53 patients, having mild or moderate motor deficit at the time of stroke, is shown. The follow-up period is from the time of discharge to five years or death.
The fate of 75 patients, having severe motor deficit at the time of stroke, is shown. The follow-up period is from the time of discharge to five years or death.

Mortality Rate in Each Time-Period of Follow-Up

<table>
<thead>
<tr>
<th>Severity of paresis</th>
<th>6 months</th>
<th>1 year</th>
<th>5 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild or moderate at discharge</td>
<td>9%</td>
<td>21%</td>
<td>58%</td>
</tr>
<tr>
<td>Severe at discharge</td>
<td>8%</td>
<td>20%</td>
<td>64%</td>
</tr>
</tbody>
</table>

FIGURE 3

The percentage mortality in the mild to moderate group of patients with nonembolic cerebral infarction is compared with the severely paralyzed group over the five-year follow-up.

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Improvement in performance in paresis following stroke

Discussion
Mortality rates for those surviving the initial hospitalization were approximately equal in the severe and in the mild to moderate strokes. This tends to suggest, as has previous work by us, that mortality is related more to associated diseases than to the stroke and its sequelae. Moreover, it is evident from the similarity of mortality rates, that mortality in these two groups could not have affected the proportions showing or not showing improvement.

It is evident from our data that improvements in motor function are to be expected in just about half of the patients during the very early phases following a stroke. The reasons for this improvement and problems with interpreting this information have been dealt with and are determined by the reversibility or irreversibility of damage in and around an area of infarction. It is also apparent that beyond the period of hospitalization, despite adequate physical therapy, encouragement and frequent close, friendly supervision, improvement in paralysis occurred in an insignificantly small number of patients. This does not imply that patients failed to return to work or to become increasingly independent. Such improvement occurred mainly because of increasing use of the remaining musculature, particularly on the intact side, and usually could not be attributed to a return of function in the paralyzed extremities.

References
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