

Factors Influencing Stroke Rehabilitation

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Abstract:
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■ Quantitative and semiquantitative methods have been used to evaluate the clinical improvement of 62 patients with completed stroke who were admitted to a rehabilitation hospital.

Improvement in motility and leg strength on the paretic side was minimal and was not influenced by facilitation exercise techniques. Observed changes in strength and motility occurred to about the same degree on both the nonparetic and paretic sides. Patients who had a short interval between onset of stroke and admission to the rehabilitation program improved significantly more on the paretic side than those with a longer interval. Practically no improvement in motility and leg strength was found two months following a stroke.

Hemiplegia and hemiparesis were defined quantitatively on the basis of motility test scores. Patients with hemiparesis showed greater improvement in motility and self-care status in about half the time of hospital stay when compared with patients with hemiplegia. In spite of relatively static neurological deficits, all patients showed evidence of functional improvement as assessed by a self-care rating scale. The poorest functional outcome was seen in patients who had hemisensory losses in addition to hemiplegia. The observations indicate that early, functionally oriented stroke rehabilitation programs offer the best chance of aiding patients. Behavioral and sociological influences on final outcome are important and must be carefully evaluated to insure maximum chances of successes in rehabilitation.

ADDITIONAL KEY WORDS facilitation exercise techniques motility
self-care status behavioral influences hemisensory losses

□ This study was concerned with the delineation of factors which influence outcome in stroke rehabilitation. For the purpose of the study, "stroke" was defined as the neurological

result of an ischemic lesion in the cerebral hemisphere caused by arteriosclerotic or embolic occlusion with resulting hemiplegia or hemiparesis. Cerebral hemorrhage or other causes of hemiplegia were excluded as the natural history of these conditions is different.

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Factors analyzed included: the effect of facilitation exercises, severity of paresis, time interval between onset of stroke and admission to the Burke Rehabilitation Center, and the effect of hemisensory loss on self-care status. The data used came from motility studies,¹ leg strength measurements, sensory testing and a functional status evaluation.

Methods

Data obtained from 62 stroke patients admitted to the Burke Rehabilitation Center in 1968 and 1969 were subjected to further statistical analysis following initial separation of this patient population into two equal groups for the purpose of studying the effects of differing therapeutic exercise regimes.² Since the measures of improvement made by each group were not significantly different, the data were pooled in order to analyze patterns of recovery and certain factors influencing those patterns. The major characteristics of these 62 patients were:

| | |
|-------------------------|----|
| Mean age | 64 |
| Male | 38 |
| Female | 24 |
| Left-sided involvement | 34 |
| Right-sided involvement | 28 |
| Dysphasia | 13 |

DESCRIPTION OF TESTS

Quantitative Testing of Motility Defects (Motility Index)

The details of methodology and results of standardization were described in a previous publication.¹ The apparatus allows the recording of the tapping rate and accuracy of the proximal and distal muscles of upper and lower extremities. This requires eight different subtests. In order to reduce the number of scores from eight to one, a motility index (MI) was developed. In this index a normal score is zero, less than normal motility has a negative score, and greater than normal motility has a positive score. Subindices are computed for each side of the body separately and added to obtain the overall index. The (MI) associated with complete hemiplegia would be about -22, bilateral involvement would score below -22, and complete absence of motility—such as in quadriplegia—would be -44.8. The MI battery was administered upon admission to the rehabilitation center and in weekly intervals thereafter. Only the initial and the final results were analyzed.

Leg Strength Measurements

The strength in foot pounds was measured on the involved and uninvolved lower extremities using a torque dynamometer (CYBEX). Leg strength was defined as the sum of the values obtained for

both knee flexion and extension. Recordings were made upon admission and weekly intervals as well as at discharge. For the purpose of this study, only the values on admission and discharge were used.

Sensory Test Battery

Concomitantly with quantitative evaluations of motility and strength, sensory testing was done in the following manner: (1) *Vibrometry*. For this test a biothesiometer (Model PVD) was used which vibrates at 120 cps in the range from 0 to 50 microns. The test was performed by placing the pad of the index finger on the vibrator with the fingerprint whorl over the center of the vibrator. The subject was first given a recognizable stimulus. Then the amplitude of vibrations was increased gradually from zero by increasing the voltage evenly and slowly. The subject then was asked to report the first perception (threshold of vibration). The amplitude at threshold was then recorded in microns. This procedure was repeated three times and averaged to arrive at a score. The test was performed on both the involved and uninvolved sides. Values ranging between four and six are considered normal. (2) *Two-point versus one-point perception*. For this test a Sweet's two-point compass calibrated in millimeters was used. The test was performed on the index finger of the involved and uninvolved sides. The subject was first given a recognizable stimulus of ten millimeters on the index finger pad at the center of the fingerprint whorl. The stimulus was decreased by one millimeter per trial until the patient gave three consecutive responses of perceiving one point at the same measurement. Normal values are two to four millimeters. (3) *Visual field determination*. To determine the visual field, the Harrington Floecks Field Screener was employed, which presents tachistoscopic visual stimuli covering the entire visual field. Responses were recorded by mapping out omissions indicating the presence of a visual field defect.

These modalities were chosen because of the relative ease of test administration, which, like the previously described measurements, were performed by a nurse technician. Although sensory testing was done at admission, at biweekly intervals, and at discharge, only the final discharge values were analyzed. The methods described by Tourtellotte³ for measuring vibration sense and two-point discrimination were used. He found a high coefficient of variation particularly in vibratory sense in normal college students. Lacking normal values for our stroke population (mean age 64 years), we subtracted the values obtained from the uninvolved sides from those obtained from the involved sides.

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Hemisensory loss was then defined as follows: abnormal two-point discrimination: ≥ 5 mm; abnormal vibration sense a score: ≥ 10 micron units.

Numerical Scoring of Self-Care Status

The Kenny Institute of Rehabilitation Self-Care Evaluation Procedures (KIR Scale) was used as described by Schoening and Iversen.⁴ The KIR Index is based on evaluations of 17 different self-care activities and the subscores are combined to give a single index ranging from 0 to 24. Only values obtained upon admission and at discharge were analyzed. In this study, ranges of self-care proficiency were established as follows: 0 to 15 points = maximal assistance required; 16 to 20 points = moderate assistance required; 21 to 23 points = some assistance required; 24 points = independence in basic self-care activities.

Results

IMPROVEMENT OF MOTILITY

The 62 stroke patients were hospitalized at the Burke Rehabilitation Center for an average period of 59 days. The mean motility indices at admission were -25.8 and at discharge -20.3 , representing a change of 5.5 points. This improvement was not influenced by the utilization of facilitation exercise techniques as described in a previous publication.² The mean improvement in the MI on the involved side of patients in the control group compared with that of the facilitation exercise group was 2.4 and 2.9 respectively. These MI changes represented differences in the initial and final scores. It was also noted that improvement of motility occurred to about an equal degree between the involved and the uninvolved side. The observed mean changes were 2.9 points on the uninvolved side and 2.6 points on the involved side. Of the 34 patients with left-sided involvement the mean improvement in total MI was 4.8 points (median 4.1) as compared to 28 patients with right-sided involvement—patients with a mean improvement of 6.5 points (median 5.8). It was concluded that all observed changes of motility were small indeed and without real clinical importance.

IMPROVEMENT IN LEG STRENGTH

The average values of leg strength on the involved side for the total group were 27 foot pounds at admission and 45 foot pounds at discharge—an average improvement of 18 foot pounds. Again, it was noted that leg strength improved to about the same degree on the

uninvolved and the involved sides but that changes were small.

FUNCTIONAL IMPROVEMENT (KIR SCALE)

The mean values at admission were ten and at discharge 19, representing an improvement of nine points on this 0 to 24 scale. The mean improvement of patients with left-sided involvement was eight points and of right-sided involvement 11 points.

On first glance these improvement values appear impressive, but in reality they are not. Only five patients gained complete independence in the activities of daily living by reaching 24 points. Thirty-five required still some assistance (21 to 23 points). Eight patients required moderate assistance (16 to 20 points), and 14 patients continued to require maximal assistance (3 to 15 points).

FACTORS AFFECTING FUNCTIONAL IMPROVEMENT

Severity of Involvement

The differentiation of hemiparesis from hemiplegia is an arbitrary one. In this study complete hemiplegia was defined as a MI of -23.3 on the right side and -21.5 on the left side. Hemiparesis was defined as an MI of at least four points above the above value.

In comparing 22 hemiplegic patients with 18 hemiparetic ones, the following results were obtained: The number of days from onset of stroke to admission to Burke Rehabilitation Center was the same, but the mean change of motility of the hemiparetic patient was about twice that of patients with complete hemiplegia.

The initial functional status as assessed by the KIR Scale was significantly better in the hemiparetic group. Mean improvement was somewhat less but final functional outcome was better as compared to the hemiplegic group. Finally, the length of stay of a hemiplegic patient was about twice that of a hemiparetic one. The results are summarized in table 1.

Time Interval Between Onset of Stroke and Admission to Rehabilitation Center

The time interval between the onset of a stroke, length of stay in a general hospital, and eventual transfer to a rehabilitation center is subject to great variation, the nature of which was not analyzed specifically. In our patient population the onset-to-admission time was independent of the severity of hemiplegia

TABLE 1
Hemiplegia and Hemiparesis Compared

| | Number of patients | Days, onset to admission | Length of stay | Improvement of MI (involved side) | Initial KIR index | Improvement KIR index |
|--|--------------------|--------------------------|----------------|-----------------------------------|-------------------|-----------------------|
| | | Median | Mean | Mean | Mean | Mean |
| Complete hemiplegia (MI: 21.5-23.3) | 22 | 30 | 73.3 | 1.4 | 7.7 | 9.2 |
| Hemiparesis (MI 4 pts. above minimal MI) | 18 | 30 | 40.9 | 2.7 | 14.9 | 6.4 |

TABLE 2
Short and Long Interval: Onset to Admission Compared

| | Number of patients | Improvement of MI (involved side) | Improvement of leg strength (torque) | Initial KIR index | Improvement of KIR index |
|---|--------------------|-----------------------------------|--------------------------------------|-------------------|--------------------------|
| | | Mean | Mean | Mean | Mean |
| Short interval onset to admission (≤ 24 days) | 14 | 1.8 | 20.1 ft. lbs. | 8.8 | 9.5 |
| Long interval onset to admission (≥ 58 days) | 14 | 0.9 | 10.7 ft. lbs. | 11.3 | 6.8 |

TABLE 3
Functional Outcome and Hemisensory Loss

| Self-care index (KIR scale) | Number of patients | 1 | 2 | 3 | 1,2 | 2,3 | 1,2,3 | No hemisensory loss | % of patients with hemisensory loss |
|-----------------------------|--------------------|---|---|---|-----|-----|-------|---------------------|-------------------------------------|
| 3-15 | 14 | | 1 | | 6 | 1 | 2 | 4 | 71 |
| 16-20 | 8 | 1 | 1 | 1 | 1 | | 1 | 3 | 62 |
| 21-23 | 35 | 4 | 3 | 2 | | | 1 | 25 | 29 |
| 24 | 5 | | 1 | | | | | 4 | 20 |

Heading codes: 1 = two-point discrimination deficit; 2 = vibration deficit; 3 = homonymous hemianopia.
Legend: Hemisensory losses were found predominantly in patients with poor functional outcome.

(table 1). Thus, separate analyses of these variables were justified. Two equal groups of patients were selected for comparison. The first represented the shortest interval (less than 24 days) and the second the longest interval (58 days or more) between onset of stroke and admission to rehabilitation. The patients whose admission time fell in between these extreme values were not analyzed. The groups differed considerably in their improvement of motility and strength. The patients with a short interval of onset to admission improved significantly more on the involved side than those with the longer onset to admission intervals. The results are summarized in table 2.

The Effect of Hemisensory Loss

Table 3 summarizes the results of sensory testing as described in relationship to functional outcome as measured by the KIR Scale. It became evident that hemisensory losses were found predominantly in patients with poor functional results, particularly those whose sensory deficits consisted of a combination of all three modalities examined.

Discussion

Controversy exists as to the final outcome of patients in stroke rehabilitation. Optimistic reports state that 90% of "CVA" patients become independent in basic self-care activities

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and 50% can be taught to do gainful work.⁵ However, there are also growing numbers of pessimistic reports such as Feldman,⁶ who expressed surprise and disappointment at the poor results obtained particularly in vocational rehabilitation.

Most outcome studies have a common problem in that all possible vascular causes for adult neurological deficits are lumped together as "CVA's," and that results are either descriptive or based on criteria which defy comparison. Our study shows that there was no significant change in neurological deficits after patients with completed stroke, as defined, were transferred from a general to a rehabilitation hospital. Psychiatrists who observe patients in either setting are aware of the considerable number of patients who improve spontaneously and return to their prior mode of living under combined medical and psychiatric management. The patients in this study obviously did not belong in this category. Yet improvement in self-care function was noted in spite of their relatively static neurological condition. The improvement values as assessed by the KIR Scale seem to compare very favorably with those obtained in a study by Ellwood.⁷ In a group of 48 hemiplegics, his admission scores were about 13 points and at discharge 16 points as compared to a mean score of ten points at admission and 19 points at discharge in this study.

Diller⁸ stated that a "self-care activity consists of the most common functional motor skills which are part of the normal behavior necessary for an individual to function independently in society." He also states that in stroke rehabilitation the patient is not taught a motor skill but that he is taught to walk, to dress and to wash himself, etc. The results of our study clearly support Diller's view that self-care function is correlated to motor acts but that there is no congruence with motor deficits. Our observations support the idea that functional outcome in stroke patients is influenced by a variety of behavioral factors. Hyman,⁹ who studied our stroke population sociologically, found that feelings of stigma impair motivation and functional improvement. He concluded that stroke rehabilitation "must aim not at the elimination of impairment, but rather at the preparation of the patient for renewed social participation despite

it." Lorenze and Cancro¹⁰ found that disturbances of visual perception were negatively related to self-care function.

Our study showed that elaborate and expensive rehabilitation methods do not offer more benefits for the stroke patient than simple, functionally oriented programs which should begin as soon as a definitive diagnosis has been established and the general medical condition is stable. The prudent utilization of properly supervised auxiliary treatment personnel should have an impact on health care costs without impairing the quality of stroke rehabilitation.

Conclusion

The analyses of data obtained from our stroke population are summarized as follows: (1) Improvement in motility and leg strength on the involved side is generally small and usually without clinical significance. (2) Facilitation exercises do not significantly influence this improvement. (3) The observed improvement in motility occurred to about the same degree on both the involved and uninvolved sides. (4) Improvement in self-care function occurred to varying degree: the poorest functional outcome was observed in patients with hemisensory loss in addition to motor deficit. Hemiparetic patients achieved a higher level of self-care function in about half the time of hospital stay compared with patients with hemiplegia. (5) There was practically no improvement of motility and leg strength observed two months after a stroke. Evidence of neurological and self-care improvement is substantially greater in patients whose onset of stroke was three weeks or less prior to admission.

The observations made in this study are in support of early rational and functionally oriented stroke rehabilitation programs, bearing in mind the importance of behavioral and sociological influences on final functional outcome.

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