Progress Review

Rehabilitation for Stroke: A Review

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SUMMARY Survivors of stroke are often left with severe mental and physical disabilities, which create a major social and economic burden. Many investigators have attempted to assess the role of rehabilitation in reducing such disability. Few controlled studies provide accurate assessment and documentation of benefit. Because of the presence of multiple variables and inadequate measures of outcome, it is difficult to design studies evaluating the effectiveness of rehabilitation for stroke. It is unclear how early rehabilitation should begin and what aspects of rehabilitation are important. Intensive rehabilitation is an expensive and limited resource; thus, the ability to identify the subgroup of patients with stroke who are likely to benefit is a critical issue. Although preliminary guidelines for the selection of patients who are appropriate for rehabilitation are given, no uniform criteria reliably differentiate patients who need rehabilitation from those who will recover spontaneously or do poorly. Controlled studies in the practice of rehabilitation for stroke will provide much useful information for patient management.

CEREBROVASCULAR DISEASE is the third leading cause of death in the United States. Stroke leaves many of its survivors with mental and physical disabilities, which create a major economic and social burden. Many survivors of strokes receive expensive, time-consuming, and intensive rehabilitation in an attempt to improve independence. Although several investigators have studied the role of rehabilitation in the recovery from stroke, few have provided an accurate assessment and documentation of effectiveness. Current concerns about allocation of health-care services and cost-effectiveness have only reemphasized the need for properly designed research of rehabilitation for stroke.

Central issues in rehabilitation for stroke are: How should rehabilitation programs be organized? When should rehabilitation begin? Which patients are likely to benefit from intensive rehabilitation efforts? Where should rehabilitation take place?

The purposes of this article are to review the available information and to provide preliminary guidelines for the selection of patients who are most likely to benefit from intensive rehabilitation programs.

Cause of Stroke and Its Burden on Society

Stroke (cerebral infarction, hemorrhage) is defined as the sudden onset of a focal neurologic deficit due to a presumed local disturbance in the blood supply to the brain. Despite differences in the criteria used to define stroke and in the demographic characteristics of the populations studied, investigators generally agree that in the late 1960s the incidence of stroke was about 1.5 per 1,000 person-years and the prevalence was about 5.0 per 1,000 persons. More recent data based on the population of Rochester, Minnesota, show that the incidence for stroke has decreased almost 50%, to 0.8 per 1,000 person-years during the period 1975-1979, the prevalence has increased 20%, to 6.0 per 1,000 persons.

These observations are expanded on by further epidemiologic data obtained from studies based on the Rochester population from 1945-1979. The initial 30-day case fatality for stroke is high, averaging 38%. Of patients who survive the acute phase, approximately 50% are alive in 7 years. Other studies are in relatively close agreement with this high rate of survival. Recently, Garraway et al reported a 16% increase in the 5-year survival after cerebral infarction when the periods 1945-1949 and 1970-1974 were compared. Soltero et al noted a gradual decline in mortality from cerebrovascular disease since 1960 and a more accelerated rate of decline since 1968; they attributed these findings to the treatment of hypertension.

Residual disability in survivors is difficult to estimate. Variation in subject populations and in the methods used for assessment of disability makes comparison and generalization difficult. Stallones et al estimated that of every 100 survivors of the acute phase of stroke, 10 will return to work without disability, 40 will have "mild" disability, 40 will be severely disabled, and 10 will require institutionalization. Gresham et al reviewed 148 survivors of stroke from the Framingham cohort and compared their function in several categories (for example, vocational function, social function, ability to perform household tasks, mobility, self-care skills, and institutionalization) with that of age- and sex-matched controls. In each area of comparison, a higher percentage of patients with stroke experienced severe disability.

The economic and social impacts of stroke are great. The cost of care plus the loss of earnings due to stroke in the United States is estimated at 7.5 to 11.2 billion dollars per year. In Scotland, it has been estimated that the acute care of patients with stroke alone ac-

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counts for approximately 5% of the national health budget. Feigenson et al reported that the initial hospital costs in New York City for patients with acute cerebral infarction in 1977 ranged from $13,052 to $19,285. Costs for rehabilitation after this acute care ranged from $6,000 to $8,000. They believed that the cost of rehabilitation was justified if it decreased the number of patients requiring long-term institutional care, which they estimated at 18,000 to 36,000 per year. The burden on health-care services that this reservoir of disability from stroke creates is likely to increase because of the increasing survival after stroke and the increasing number of elderly persons in the population.

Efforts at prevention of stroke, other than the treatment of hypertension, have made little impact on disability from stroke. In addition, attempts to improve the prognosis during the period immediately after stroke by providing intensive-care facilities have been largely unsuccessful. Rehabilitation early after stroke to improve functional ability has been suggested to decrease long-term social and economic costs. However, no existing, well-designed, population-based studies adequately address this cost-benefit equation.

**Issues in Rehabilitation for Stroke**

**General Principles and Problems**

Rehabilitation is defined as the combined and coordinated use of medical, social, educational, and vocational measures for retraining a person to the highest possible level of functional ability. In light of this definition, Peszczynski et al of the Joint Committee for Stroke Facilities summarized the accepted and well-established principles of rehabilitation for stroke as follows: 1) prevent or minimize secondary complications, 2) compensate for sensory and perceptual loss, 3) substitute for lost motor function, 4) provide environmental stimulation, 5) encourage socialization, 6) produce a high degree of motivation, 7) enable independent function and home living, and 8) achieve vocational rehabilitation when feasible.

Although there is general agreement that limited physical therapy should begin as soon as possible to prevent complications such as contractures and bed sores, a basic question remains unanswered: is intensive rehabilitation effective for 1) reducing disability after stroke and 2) decreasing long-term social and economic costs?

Research in the area of rehabilitation is difficult because of the multiple variables that affect selection and outcome. The studies that have attempted to assess the value of rehabilitation for stroke differ in methods and design, and these differences limit their comparability. Some of the problems that limit comparisons are that most studies are descriptive, and many have inadequately matched or ill-defined control groups. In addition, the subjects are often drawn from selected referrals rather than a defined population, and tests of statistical significance are rarely applied.

Another obstacle to evaluating the benefits of stroke rehabilitation is the variability in rehabilitation practice: criteria for patient selection vary among institutions, the interval between the onset of stroke and the commencement of rehabilitation varies both within and between studies, and the duration and type of therapy differ among studies and frequently are poorly described. Finally, measurement of outcome is nonuniform: the variables chosen for assessment differ, multiple indices of functional capacity and activities of daily living are used, and the results are often qualitative or ambiguous.

Most studies that have attempted to address the effectiveness of rehabilitation for stroke for improving function suffer from the above-described problems. The conclusions of these studies differ. Despite these difficulties, if improved functional capacity and disposition are used as end points, these reports suggest that an organized and comprehensive rehabilitation program may be beneficial.

**Timing**

In 1982, Lind reviewed and attempted to compare seven studies of rehabilitation for stroke and concluded that spontaneous recovery accounted for most of the noted improvements in functional ability. Because recovery is greatest during the first month after stroke, spontaneous recovery clouds the effect that rehabilitation may have on functional gains, particularly the effect of early rehabilitation. Feigenson et al attempted to investigate this issue by comparing the outcomes of patients with similar levels of disability but different intervals to the onset of rehabilitation. They found a higher proportion of discharges to home among patients who began rehabilitation early than among the other patients. However, they measured disability at the time of admission to the rehabilitation unit and not at identical intervals after stroke. This finding suggests that the severity of stroke in these two patient groups is not equivalent. Although difficult to interpret, two recent studies cast further doubt about the importance of early rehabilitation and support the conclusion that patients who begin rehabilitation early are likely to be in better health initially.

**Type of Program**

What are the benefits of comprehensive rehabilitation programs in a designated rehabilitation unit compared with efforts in a general medical setting? According to Feldman et al, "the results suggest that the great majority of hemiparetic stroke victims can be rehabilitated adequately on medical and neurological wards [without formal rehabilitation services] if proper attention is given to ambulation and self care activities."

Although Lind's overall conclusion was that comprehensive rehabilitation offered few advantages, he made two very important observations: 1) although functional improvements attributable to comprehensive rehabilitation may be slight, they sometimes make the difference between institutionalization and a return home; and 2) carefully selected patients with "margin-
al functional impairment" may benefit from individualized and comprehensive rehabilitation.

One of the first controlled studies of rehabilitation for stroke, based on the population of Edinburgh, Scotland, lends further support to the hypothesis that intensive rehabilitation may be effective in a select group of patients.2-5 Patients with stroke were randomized within a few days after onset to either a "stroke unit" or to a medical ward. Functional independence was assessed at dismissal and was found to be greater in the patients in the stroke unit despite similar neurologic deficits in the two groups. This finding suggests that some aspect of the stroke unit, rather than spontaneous recovery alone, was responsible for improvement. The length of hospitalization was shorter for the patients in the stroke unit than for those in the medical wards. Patients in the stroke unit received physical therapy earlier but for a shorter period and were more likely to receive occupational therapy and to receive it earlier. Other important differences between the stroke unit and the medical wards were the presence of rehabilitation nursing, a team approach, and a functionally oriented atmosphere that may have encouraged patients to take a more active role and practice their skills more consistently.

Two additional recent population-based controlled trials6-7 compared the clinical outcome of patients in a special stroke rehabilitation unit with that of patients who received therapy on general medical wards. At both 3 and 12 months after stroke, the percentage of patients living at home was greater for the group who received rehabilitation in a specialized setting. However, differences in independence for activities of daily living were small. Similar to the findings in the Edinburgh study, neither of these two studies could discern what aspects of the stroke rehabilitation ward accounted for the differences in outcome. Also, differences in the methods of patient selection among these trials limit direct comparison of the results.

Smith et al.41 in a controlled study of outpatient stroke rehabilitation, found that the degree of improvement correlated strongly with the amount of intensity of therapy. They also found that only a few patients (11% of 1,094 patients admitted to a hospital for stroke) were suitable for intensive outpatient rehabilitation. However, they believed that the treatment was effective and realistic in this selected group.

In a recent trial of home-care services for patients with acute stroke, Wade et al.82 noted functional recovery equal to that of patients who received hospital care. There did not appear to be greater stress on families, despite severe initial disability in 27% of the patients managed at home. The suggestion that outpatient rehabilitation and home care are feasible alternatives to hospital rehabilitation may have implications in terms of the future structure of rehabilitation services.

Duration of Benefit

Only a limited number of studies have studied stroke patients for prolonged periods to assess long-term maintenance of independence. Coughlan and Humphrey83 noted rather severe degrees of disability in the patients they surveyed, but they provided no data about their status at dismissal. Garraway et al.84 noted a disappearance of the differences in functional status between patients treated in the stroke unit and those treated in the medical unit at 1 year after dismissal, but Strand et al.87 noted maintenance of these gains. Both authors believed that family education was responsible for the difference. Other studies85, 89, 90 have also suggested that functional capacity remains relatively stable over time. Further research is needed to determine if functional status is maintained for prolonged periods after rehabilitation in survivors of stroke to be able to assess its effectiveness in reducing long-term social and economic costs.

Rehabilitation Potential

Although the functional benefits and cost-effectiveness of comprehensive rehabilitation have not been determined, comprehensive rehabilitation may be superior to limited rehabilitation in a subgroup of patients with stroke. Numerous studies have addressed this issue by attempting to identify prognostic indicators for success or failure in rehabilitation programs.23, 39, 40, 46-50, 56-59, 67-68 Controversy surrounds many of the symptoms, deficits, and other data that have been studied in terms of their usefulness for predicting prognosis after stroke (table 1).

However, three recent studies86-88 attempted to develop prognostic indicators or a predictive equation for death and disability after stroke. Allen86 examined patients 24 hours after stroke and included death as a negative outcome. Thus, many of the indicators may not be applicable in terms of predicting functional outcome. The study by Sheikh et al.87 used retrospective and often incomplete data, and the equation developed by Wade et al.88 was only 55% accurate in predicting functional recovery. These studies have not provided a clinically useful tool to select patients with stroke who are likely to benefit from rehabilitation.

The development of clinical criteria to select early (within 7 to 10 days) after stroke the patients who are

<table>
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<th>Negative predictors</th>
<th>Possibly negative predictors</th>
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<tr>
<td>Coma at onset</td>
<td>Hemisensory deficit</td>
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<tr>
<td>Incontinence 2 wk after stroke</td>
<td>Left hemiparesis</td>
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<td>Poor cognitive function</td>
<td>Homonymous hemianopsia</td>
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<td>Severe hemiparesis or hemiplegia</td>
<td>Advanced age</td>
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<td>No motor return within 1 mo</td>
<td>Language disorder</td>
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<tr>
<td>Previous stroke</td>
<td>Low premorbid intelligence</td>
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<tr>
<td>Perceptual-spatial deficit</td>
<td>Lack of spouse or close family</td>
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<td>Neglect or denial syndrome</td>
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<td>Significant cardiovascular disease</td>
<td>Low socioeconomic class</td>
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<tr>
<td>Large or deep lesion on computed tomogram</td>
<td>30 days from onset of stroke to admission</td>
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<td>Multiple neurologic deficits</td>
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most likely to benefit from comprehensive rehabilitation would have considerable practical value in patient management. The Edinburgh stroke study\(^4\), \(^89\), \(^96\) made preliminary steps toward this goal by using a selected subgroup of patients who were conscious and had an established or developing hemiplegia (approximately 25\% of all patients with stroke). Patients with a poor prognosis for life and independence and patients who were likely to recover with little or no therapy were excluded. The investigators attempted to refine selection further and administered a clinical examination to the patients at various intervals and classified them into three categories (good, intermediate, or poor) on the basis of prognosis for successful rehabilitation. They noted that care in the stroke unit offered the greatest advantage over care on the medical wards for patients in the intermediate group.

Assessment of Outcome

As noted, one of the obstacles to developing selection criteria for rehabilitation from stroke is the lack of a uniform and well-defined means of measuring outcome. Generally, measures of functional ability rather than abnormalities on neurologic examination are preferred because patients with similar neurologic findings may perform at different functional levels.\(^5\), \(^36\), \(^55\), \(^66\) Donaldson et al\(^91\) and Granger\(^92\) believed that outcome scales for rehabilitation must 1) provide an objective description of functional status, 2) be sensitive to allow detection of changed functional status, 3) be simple and reproducible so they can be administered reliably by different professionals, and 4) be standardized to improve communication and evaluation of treatment programs.

Functional independence in performing the activities of daily living is measured by many scales, including the Barthel index,\(^93\)\(^-\)\(^95\) the Katz index,\(^96\) Kenny Self-Care Evaluation,\(^97\) Donaldson Unified Activities of Daily Living Evaluation form,\(^98\) Pulses Profile,\(^98\) and Patient Evaluation Conference System.\(^99\) Additionally, many authors devise their own scales to assess the outcome for rehabilitation. The results of studies are not directly comparable because different scales are based on a patient’s ability to perform combinations of different activities. Additionally, the same numerical weight may not be given to a particular activity. Of the three most frequently used scales (Barthel, Katz, and Kenny), the Barthel index seems to have the following advantages: completeness, sensitivity to change, and ease of statistical manipulation.\(^100\)

The Rankin classification of dependency\(^48\) has been widely used in the United Kingdom and Europe. It has proved satisfactory for the assessment of dependency after stroke in studies that use medical reviews and is compatible with the more objective assessments used in controlled trials of rehabilitation for stroke.\(^90\), \(^102\) Compared with the Barthel index, the major advantage of the Rankin scale is its relative simplicity and ease of both application and data retrieval. However, the Rankin scale lacks the detail necessary to detect small changes in function.

Guidelines for Selecting Patients

No uniform criteria based on controlled studies reliably differentiate the patient with stroke who is likely to benefit from intensive rehabilitation from the patient who is likely to do poorly or to recover spontaneously. Yet, rehabilitation is both a limited and an expensive resource that requires such a decision.

On the basis of the available data from the above studies, some general comments can be made: 1) decreased alertness, inattention, poor memory, and an inability to learn new tasks or to follow simple commands imply that a patient is not ready or not appropriate for intensive rehabilitation; 2) because of their inability to recognize their deficits and their carelessness toward the neglected side, patients with severe denial or neglect are often difficult to motivate in therapy; 3) significant associated medical problems, particularly cardiovascular disease and degenerative joint disease, may limit a patient’s participation in therapy; 4) language difficulties (aphasia) and the degree of weakness may have less of an impact on independence and the return home; 5) the presence of a caring and able spouse may be one of the most significant positive factors in the outcome of rehabilitation; 6) other social and economic factors play important but difficult to define roles; and 7) education of family members may be equally as important as rehabilitation of the patient.

Most importantly, when considering rehabilitation, the physician must view the patient with all medical, neurologic, and psychosocial problems as a whole and must not base the decision on the presence or absence of specific deficits. Consultation with a physiatrist or a neurologist specializing in rehabilitation prior to embarking on prolonged, intensive rehabilitation efforts may be helpful in making this determination. When feasible, a short trial of rehabilitation enables one to make a more complete and accurate assessment of a patient’s rehabilitation potential.

Conclusions

The central issue in rehabilitation for stroke remains: does early intensive rehabilitation by reducing functional dependency act to decrease long-term social and economic costs? From this question stem several other important questions: 1) which patients are likely to benefit from intensive rehabilitation and can they be preselected? 2) when should rehabilitation begin? 3) where should rehabilitation take place? and 4) how should rehabilitation programs be organized?

Designing controlled studies to evaluate a healthcare service such as rehabilitation is difficult.\(^35\) Valid criteria for outcome need to be established in a setting where multiple variables are interacting. A compromise must be reached to select a limited number of variables to be measured that reflect different areas of outcome. These variables may vary in importance and an “end result” of rehabilitation may be difficult to establish. The sample size needed to reach statistical significance should be determined and subjects drawn from a defined population. Because most rehabilitation centers have primarily a referral practice and may...
not have adequate medical record systems, such population-based studies are difficult to implement.

Unlike a controlled trial to evaluate the effectiveness of a new drug, controlled studies of rehabilitation for stroke have limitations in inference and generalization. This difficulty arises because of differences in staff, rehabilitation methods, and social and economic settings. General conclusions would be justified only if similar results were found in several studies in different locations.

If these problems are to be solved, studies must be designed that include the following criteria: 1) strict definitions and characteristics of specific populations, sample groups, and controls; 2) information concerning timing, duration, quantity, and type of therapy; 3) uniform assessment of patients with measures that have proven validity and reliability; and 4) adequate numbers of comparable patients and controls.

Properly designed controlled studies that adhere to clinical and epidemiologic principles in the practice of stroke rehabilitation will provide much useful information about patient care and the organization and delivery of rehabilitation services.

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