Disability and Use of Rehabilitation Services Following Stroke in Rochester, Minnesota, 1975–1979

Mary L. Dombovy, MD, Jeffrey R. Basford, PhD, MD, Jack P. Whisnant, MD, and Erik J. Bergstralh, MS

Medical records of all residents of Rochester, Minnesota, who had a first stroke in 1975–1979 were reviewed to determine level of disability, disposition, and use of rehabilitation services. Of the 292 persons with a first stroke, 251 (86%) (mean age 70 years) survived >1 week. The mean Rankin disability score (Grade 1, no disability, through Grade 5, severe disability) changed from 1.7 before stroke to 2.8 in survivors at hospital discharge; 29% of those discharged required further institutional care. The level of disability in survivors remained relatively constant from 6 months after stroke through 5 years of observation. Of the 112 patients with an admission score of 5, 40 (36%) were alive at 1 year and only 5 of those (13%) improved to relative independence (Rankin scores of 1 or 2). The most common comorbidity contributing to disability was cardiovascular disease (31%). After the first 18 months, the mortality in patients with stroke was similar to that in a normal population having the same age and sex distribution. Of the 251 1-week survivors, 132 (53%) had rehabilitation (physiatrist) evaluations, 127 (51%) received physical therapy, 103 (41%) received occupational therapy, and 33 (13%) received speech therapy. Thirty-four of the 132 patients (26%) referred for rehabilitation evaluations were transferred to the rehabilitation unit. (Stroke 1987;18:830–836)

Once the initial period of high mortality following stroke has passed, survival is good, with 50% of stroke patients living >5 years. Unfortunately, these survivors have a high level of disability; from 30 to 60% are estimated to be dependent in some aspect of daily living. The cost of care and the loss of earnings due to stroke have been estimated to be 7.5–11.2 billion dollars per year. Thus, stroke creates a major social and economic burden, which is likely to increase because of the increasing survival after stroke and the increasing number of elderly people in the population. Therefore, accurate assessment of disability is an important aspect of the natural history of stroke.

Two major deficiencies in studies assessing functional impairment after stroke are limited information about the prevalence and severity of disability after stroke in defined populations, and few attempts to determine the percent of patients receiving or requiring rehabilitation as a rate for a defined population. Concern about cost effectiveness and the allocation of health care services reemphasizes the need for assessment of short- and long-term disability following a stroke.

The purposes of this study were twofold: to determine the distribution of functional dependency before and after stroke for the population of Rochester, Minnesota, and to determine the rate and pattern of use for physical (PT), occupational (OT), and speech (ST) therapies as well as use of the inpatient rehabilitation ward.

Subjects and Methods

The Mayo Clinic medical index and record linkage system, which ensures almost complete case ascertainment for stroke in the population of Rochester, Minnesota, was used in this study. All the medical records for the defined population of Rochester, Minnesota, from the Mayo Clinic and other medical facilities in southeastern Minnesota, as well as the records from the University of Minnesota Hospitals and the Veterans Administration Hospital in Minneapolis, were reviewed for the 5-year period 1975–1979. All patients whose diagnosis was stroke — defined as the sudden onset of a focal neurologic deficit lasting > 24 hours and due to a presumed disturbance in blood supply to the brain — were identified. The criteria used to separate stroke into the various subcategories have been described elsewhere. Only strokes classified as first episodes of cerebral infarction, intracerebral hemorrhage, or subarachnoid hemorrhage were included in this study.

The Rankin classification of dependency (Table 1) was used for functional assessment. This scale has already proved satisfactory in assessing disability after stroke from the medical records at this institution. The scale has additional advantages in that it has been widely used in other studies and is compatible with the dependency classifications used in controlled trials of stroke rehabilitation. The following information was abstracted from the medical records: 1) details on the nature of the stroke;
Table 1. Rankin Disability Scale

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No significant disability; able to carry out all usual duties of daily living.</td>
</tr>
<tr>
<td>2</td>
<td>Slight disability; unable to carry out some previous activities but able to look after own affairs without assistance.</td>
</tr>
<tr>
<td>3</td>
<td>Moderate disability; requiring some help but able to walk without assistance.</td>
</tr>
<tr>
<td>4</td>
<td>Moderately severe disability; unable to walk and to attend to own bodily needs without assistance.</td>
</tr>
<tr>
<td>5</td>
<td>Severe disability; bedridden, incontinent, and requiring constant nursing care and attention.</td>
</tr>
</tbody>
</table>

2) the patient's neurologic examination at worst status within 72 hours after the stroke (when available); 3) the patient's Rankin score before the stroke, at the initial examination (onset), at hospital discharge, and at 6 months, 1, 3, and 5 years after the stroke; 4) other potentially disabling conditions the patient had at the same Rankin assessment dates; 5) complications occurring during hospitalization; 6) disposition at the assessment dates; 7) whether the patients received ST, PT, or OT; 8) the time after onset of stroke at which therapy was begun; 9) the total number of therapy sessions; 10) the duration of therapy; 11) whether therapy was received on an inpatient or an outpatient basis; 12) transfer to the rehabilitation ward; and 13) the composition of individual PT and OT sessions.

When necessary, telephone contact was made with patients or families to complete follow-up.

Results

In the interval January 1, 1975, through December 31, 1979, there were 292 cases of first stroke among residents of Rochester, Minnesota (Table 2). The average age at onset was 70.1 years. There were slightly more women than men, and the women were an average of 4.0 years older than the men. More than three quarters of the strokes were thrombotic or embolic infarcts. Over 60% of the cases were confirmed by autopsy or by computed tomographic scan of the head. Forty (13.7%) of the patients were not hospitalized, either because their stroke was mild or because they died without being admitted to the hospital. For the remaining 252 patients (including those who died in the hospital) the mean length of stay was 20.4 days, and the median was 11 days.

Figure 1 compares the survival curve for stroke patients with that of an age- and sex-matched normal population (Minnesota 1970 white population life table). The graphs are plotted on a semilogarithmic scale so that parallel curves indicate equal rates of change. As can be seen, survival of stroke patients parallels expected survival after about 18 months. Of the 225 30-day survivors, 121 (54%) lived to 5 years. At 5 years, 14 patients had been lost to follow-up.

In those surviving the initial stroke, the leading cause of death was cardiac disease (myocardial infarction, congestive heart failure), followed by respiratory infections and subsequent stroke. Although women were, on the average, 4 years older than men at stroke onset, their long-term survival at 5 years was better (51%) than that of the men (39%). The stroke recurrence rate was 4.9% per year over the 5-year period.

Table 3 shows the distribution of Rankin scores before stroke and, in survivors, at onset, dismissal, 6 months, 1, 3, and 5 years after stroke. The mean Rankin scores of survivors were 1.7 before stroke, 3.7 at onset, 2.8 at dismissal, 2.4 at 6 months, 2.3 at 1 year, 2.3 at 3 years, and 2.4 at 5 years.

Because there were age differences between the groups with different Rankin scores at onset (Rankin score 1, mean age 56; Rankin score 2, mean age 66; Rankin score 3, 4, or 5, mean age 72), we compared survival by Rankin score at onset using relative surviv-
al (relative survival = observed/expected survival for groups of the same age and sex distribution). Relative survival at 18 months was best for patients with Rankin scores 1 or 2 (1.0 and 0.93), poorer in those with Rankin scores 3 or 4 (0.75 and 0.73), and worst in those with Rankin score 5 (0.36).

Figure 2 compares Rankin scores over time in 1- and 5-year survivors. The mean Rankin score changed minimally between 6 months and 3 years after stroke. However, by 5 years there was a slight worsening of the scores.

Of the 140 patients who were available for follow-up at 1 year, 90 (64%) maintained their dismissal Rankin score. The remaining 50 patients either improved (31 patients, 22%) or worsened (19 patients, 14%), the number of comorbidities at onset, the worse the disability score at all times of assessment (Table 6).

Figure 2 displays this association for the 1-year survivors.

Both the degree of disability and the number of comorbidities increased with advancing age. To determine the contribution of age alone to disability after stroke, Rankin scores were compared in various age groups; Rankin scores before stroke and comorbidities at the onset of stroke were controlled for. As shown in Figure 4 for patients with no comorbidity, age > 75 years had a significant (p < 0.0005) influence on Rankin scores at 1 year for patients with onset scores greater than 1 or 2. Similar results were also found for patients with 1 or more comorbidities (not shown).

Table 4 shows the relative stability of disability level over time in persons who were survivors of stroke at 1 (○) and 5 years (●).

![Mean Rankin scores over time in persons who were survivors of stroke at 1 (○) and 5 years (●).](image-url)
Table 5. Symptomatic Associated Diseases (Comorbidities) at Onset of Stroke

<table>
<thead>
<tr>
<th>Disease</th>
<th>Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiovascular</td>
<td>89</td>
</tr>
<tr>
<td>CNS degenerative</td>
<td>39</td>
</tr>
<tr>
<td>Arthritis</td>
<td>38</td>
</tr>
<tr>
<td>Peripheral vascular</td>
<td>27</td>
</tr>
<tr>
<td>Severe COPD</td>
<td>17</td>
</tr>
<tr>
<td>Metastatic cancer</td>
<td>10</td>
</tr>
<tr>
<td>Uncontrolled diabetes</td>
<td>7</td>
</tr>
<tr>
<td>Trauma</td>
<td>6</td>
</tr>
</tbody>
</table>

CNS, central nervous system; COPD, chronic obstructive pulmonary disease.

*Percent of the 284 patients for whom comorbidity status was known.

When multiple regression analysis was used to adjust for age and prior Rankin scores, there was no significant difference in disability between men and women.

At discharge, 29% of the survivors required further institutional care. This rate decreased to 18% at 1 year. The percent of patients requiring institutional care increased with advancing age (Figure 5) as well as with worsening Rankin scores. Specifically, rates of institutionalization at discharge were as follows: Rankin score 1 or 2, 0%; Rankin score 3, 11%; Rankin score 4, 69%; and Rankin score 5, 100%.

As noted, all patients with discharge scores of 1 or 2 returned home, whereas none of the patients with scores of 5 did so. Patients living with a spouse before stroke who had discharge scores of 3 or 4 were more likely to return home at discharge than were patients with the same discharge scores who were living alone (91% compared with 46%; p < 0.0001). However, those living with a spouse were considerably younger (mean age 64 years) than those living alone (mean age 77 years). In patients with discharge scores of 3 or 4, 50% of the women and 40% of the men living alone before stroke returned home. For patients living with a spouse before stroke, the proportion returning home was 85% for women and 96% for men (difference was not significant).

Of the 251 1-week survivors, 132 (53%) had a rehabilitation medicine consultation, at a median of 5 days following the stroke; 127 (51%) received PT, 103 (41%) received OT, and 33 (13%) received ST. The median delay was 5 days to the beginning of PT and 8 days to OT. The median number of sessions for PT was 16 over 17 days. For OT, the median was 8 sessions over 12 days. For those who received ST, only the number of sessions was available, the median being 24.

Thirty-four patients were eventually transferred to the rehabilitation unit. This figure represents 12% of 292 incidence cases of stroke, 14% of the 251 1-week survivors, and 26% of the 132 rehabilitation medicine consultations. The median delay from stroke onset to rehabilitation unit admission was 17 days. The median length of stay following transfer was 31.5 days.

For a comparison of outcome, the rehabilitation unit patients were compared with the remaining 7-day survivors with onset Rankin scores of 3, 4, or 5 (Table 7). The rehabilitation unit patients were younger and had better prestroke and slightly worse admission Rankin scores than those of comparable disability at onset of stroke who were not transferred to the unit. Mean Rankin scores were also slightly worse in rehabilitation unit patients at 1-year follow-up owing to more deaths of patients with onset scores of 5 among those not admitted to the rehabilitation unit (14 compared with 2). However, when one looks at differences between onset and dismissal Rankin scores as well as

Table 6. Effect of Number of Comorbidities at Onset on Mean Rankin Scores in Survivors at Onset, Dismissal, and 1 and 5 Years After Stroke

<table>
<thead>
<tr>
<th>Number of comorbidities at onset</th>
<th>Onset MRS</th>
<th>Onset Pts</th>
<th>Dismissal MRS</th>
<th>Dismissal Pts</th>
<th>1 Year MRS</th>
<th>1 Year Pts</th>
<th>5 Years MRS</th>
<th>5 Years Pts</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3.19</td>
<td>121</td>
<td>2.23</td>
<td>86</td>
<td>1.77</td>
<td>83</td>
<td>1.93</td>
<td>67</td>
</tr>
<tr>
<td>1</td>
<td>3.96</td>
<td>101</td>
<td>3.08</td>
<td>72</td>
<td>2.69</td>
<td>54</td>
<td>2.81</td>
<td>36</td>
</tr>
<tr>
<td>2</td>
<td>4.15</td>
<td>52</td>
<td>3.50</td>
<td>34</td>
<td>3.24</td>
<td>17</td>
<td>3.60</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>4.00</td>
<td>10</td>
<td>3.00</td>
<td>5</td>
<td>4.25</td>
<td>4</td>
<td>4.50</td>
<td>2</td>
</tr>
</tbody>
</table>

MRS, mean Rankin scores. Table includes only patients for whom Rankin scores and comorbidity status were available. Pts, number of patients.
FIGURE 5. Percent of patients institutionalized before stroke, at dismissal, and 1 year after stroke according to age.

The number of deaths (Table 8), the rehabilitation unit patients fare much better than the no-treatment group and somewhat better than the PT or OT group. Tests of statistical significance could not be applied because of differences in age and death rates and lack of randomization.

Discussion

Stroke survival in this study was similar to that noted in previous studies. However, two additional observations deserve particular note. First, the probability of survival for stroke patients was similar to that for an age- and sex-matched normal population by 18 months after stroke. Second, 54% of the 30-day stroke survivors were still alive at 5 years. Katz et al. noted that survival was similar to that in a normal population after 24 months, but because that study was based on 159 rehabilitation referrals, some mild strokes may have been excluded. Other studies are in relatively close agreement with this high rate of survival.

Cardiac disease was the most common cause of death in patients who survived the initial stroke, accounting for 23% of all subsequent deaths. This finding is in agreement with those of previous studies. The higher rate of survival in women may be related to their lower prevalence of cardiac disease. The stroke recurrence rate was 4.9% per year over 5 years, and recurrent stroke accounted for only 11% of subsequent deaths. Kotila et al. noted a similarly low stroke recurrence rate — 5.2% — in the first year, although Ahlsio et al. and Sacco et al. noted much higher rates; 23% over 2 years and 33% over 5 years. The reasons for these differences are not evident. Although the patients in the study by Kotila et al were, on the average, 10 years younger than those in the study by Ahlsio et al, the mean ages of the patients in the current study and in that by Sacco et al were approximately the same as in the study by Ahlsio et al (69–71 years).

The mean age of 70.1 years at stroke onset is at the upper end of the range (59–71) found in other studies. Some of these studies are based on selected rehabilitation referrals, which may have excluded elderly patients. This problem is less likely to occur in the present study because of the way medical care and medical records are organized in Rochester. Comparison of survival, disability, institutionalization, and comorbidity following stroke in different studies is difficult for a number of reasons. The patients vary from selected rehabilitation referrals to all those known to have had strokes in a population over a given period. The average age at the time of stroke varies, and this variation affects outcome. In addition, times of assessment and criteria vary widely. All these factors make generalization from these studies difficult, if not impossible. Additionally, most studies are not population-based, and thus few conclusions can be drawn about disability rates and requirements for rehabilitation services.

Previous studies noted rates of dependency at hospital discharge ranging from 29 to 50% and at 1 year ranging from 17 to 49%. The present study noted the following rates of dependency (Rankin scores of 3–5) in survivors: 20% before stroke, 75% at stroke onset, 57% at hospital dismissal, 40% at 6 months after stroke, 34% at 1 year, 33% at 3 years, and 37% at 5 years. These numbers provide a population-based estimate of dependency after stroke.

The percent of patients requiring institutional care also varies widely among studies — from 11 to 27%. The rates of institutionalization, 29% at dismissal and 18% at 1 year, found in this study are within this range. As did Kotila et al, we found a positive correlation between a spouse and return home for patients with moderate to moderately severe disabil-

Table 7. Rehabilitation Unit Patients Compared With the Remaining 7-Day Survivors Having Onset Rankin Scores of 3, 4, or 5

<table>
<thead>
<tr>
<th>Patients not in rehabilitation unit</th>
<th>Patients not in rehabilitation unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rehabilitation unit patients</td>
<td>Received PT or OT</td>
</tr>
<tr>
<td>Patients, no. 32</td>
<td>84</td>
</tr>
<tr>
<td>Mean age, yr 66</td>
<td>74</td>
</tr>
<tr>
<td>Mean Rankin score</td>
<td>1.2</td>
</tr>
<tr>
<td>Prestroke</td>
<td>4.5</td>
</tr>
<tr>
<td>Admission</td>
<td>3.3</td>
</tr>
<tr>
<td>Dismissal</td>
<td>3.2</td>
</tr>
</tbody>
</table>

PT, physical therapy; OT, occupational therapy.

Table 8. Change in Rankin Scores of Rehabilitation Unit Patients Compared With the Remaining 7-Day Survivors Having Onset Rankin Scores of 3, 4, or 5

| Patients, no. 32                  | 84                  | 65                  |
| Dismissal status, % of patients   | 84                  | 63                  | 32                  |
| Improved* Rankin scores           | 13                  | 26                  | 28                  |
| Same or worse* Rankin scores      | 3                   | 11                  | 40                  |

PT, physical therapy; OT, occupational therapy. *Compared with admission Rankin scores.
ability (Rankin score of 3 or 4). Because the rates for both dependency and institutional care after stroke in this study are population-based and because the severity of stroke has changed little over the years, these numbers should be useful in health care planning.

In this study, increasing levels of disability were associated with both advancing age and an increasing number of comorbidities. The effect of age on disability after stroke has received much discussion in the literature but remains controversial. Some studies found that age had slight to no influence on outcome, whereas others found a stronger correlation. Because comorbidity had such a prominent effect on disability and because the number of comorbidities increased with advancing age, we assessed the effect of age on disability, controlling for the number of comorbidities. Age was found to have a significant positive correlation with worsening Rankin scores. After controlling for age, gender was found to have no significant influence on disability or disposition among patients with similar Rankin scores at onset.

The effect of other diseases on stroke outcome is not clear. Katz et al found a higher death rate in patients with comorbidities. Gresham et al found that stroke patients had a higher rate of cardiovascular disease than controls and estimated that this could account for up to 50% of the disability these patients experienced. Conversely, Andrews et al found that cardiovascular disease did not influence disability but that physical impairments such as arthritis did.

Some of these differences can be explained by the different criteria used for considering a disease a comorbidity. In the present study, a disease was considered to be a comorbidity only if it was symptomatic and appeared to cause disability at the time of assessment. We found a strong correlation between a greater number of comorbidities and more severe disability.

One of the most striking findings of the present study was the relative stability of disability (that is, functional ability) from 6 months through 3 years after stroke. Other population-based studies followed stroke patients for up to 2 years after stroke and also found very little change in functional ability after the first 3–6 months. Andrews et al found improvement in only 6.5% of stroke survivors between 6 months and 1 year after stroke. Ahsis et al found that approximately 9% of survivors improved between 6 months and 2 years, and the corresponding finding by Kotila et al was 13% between 3 months and 1 year. Katz et al noted that only 5.8% of stroke patients improved after 1 year but also noted that functional ability was well maintained for >2 years. We found a slightly increasing disability level and increasing rates of institutionalization at 5 years when these results were compared with those at 1 or 3 years after stroke. This finding may be due to the effects of age and comorbidity. It is possible that continued recovery occurs but is not detected because of the inability of commonly used measurements to detect changes in patients with mild degrees of impairment.

These findings have important implications. Since the level of function spontaneously changes very little after the first 3–6 months after stroke, these patients are suitable for controlled trials assessing the effects of specific rehabilitation techniques or programs. Such studies assessing the importance of specific aspects of rehabilitation, beginning 6 months after stroke, would lessen the effects of spontaneous recovery and would be easier to design.

In this study, only 34 of the 251 1-week survivors (13.5%) were transferred to the rehabilitation unit. A much larger number of patients were seen in consultation by rehabilitation medicine (52% of the 1-week survivors), and most of these patients received PT, OT, or both. (At the Mayo Clinic and affiliated hospitals, all patients are evaluated by rehabilitation medicine physicians before therapy is begun.) These patients were seen promptly, at a median of 5 days after stroke, and therapy was begun shortly thereafter. This timing may be important because some reports suggest that rehabilitation is more effective if begun soon after stroke. The delay to rehabilitation unit admission, with a median of 17 days, was influenced by medical and surgical care needs as well as by the availability of rehabilitation beds.

Rehabilitation unit patients improved somewhat more than patients who were not transferred to the unit (Table 8), but, as previously noted, statistical significance could not be determined. This important area, of course, requires careful prospective investigation.

This population-based study does not allow direct comparison of outcome between groups of patients. However, the detail of the medical records and careful follow-up allowed us to obtain a full picture of disability and use of rehabilitation services after stroke in the Rochester, Minnesota, population. Such information can aid in the planning of rehabilitation and other health care services as well as form a basis for future studies to assess stroke disability and the effects of specific rehabilitation treatments.

References

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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/18/5/830