The Effect of Age on Maintenance of Functional Gains Following Stroke Rehabilitation

Sally Borucki, MD, Bruce T. Volpe, MD, and Michael Reding, MD

In order to study the effect of age on the stability of functional improvement following stroke rehabilitation, seventy-one randomly selected patients with ischemic stroke without functionally limiting co-morbid medical problems were followed for two years. Patients were divided into two groups: age ≤ 69 (n = 32, \( \bar{X} = 60 \pm 6 \) years) and age ≥ 70 (N = 39, \( \bar{X} = 77 \pm 6 \) years). Barthel Index (BI) scores were generated for patients on admission and discharge from the inpatient rehabilitation unit and at six, twelve, and twenty-four months thereafter. Intercurrent medical and neurologic illnesses and changes in discharge placement were recorded. There was no difference in sex ratio, interval since stroke, hemisphere involved, or mean rehabilitation hospital admission and discharge BI scores for the younger vs. older patient groups. Life Table Analysis showed no significant difference in BI scores for the two groups over the twenty-four-month follow-up interval. This was true for both groups as a whole and for subgroups matched for extent of neurologic impairment. The frequency of new or progressive disease affecting function was the same for younger (16/32) as for older (20/39) patient groups. Death and skilled nursing facility (SNF) placement during the follow-up interval were more frequent for older vs. younger patients. These data indicate that in the absence of functionally limiting co-morbid medical problems, age is related to death and SNF placement but has no clinically significant effect on maintenance of rehabilitation gains following ischemic stroke. \textbf{Key Words}: Cerebral vascular disorders—Rehabilitation outcome—Aging.

Introduction

We are not aware of any studies that have assessed the effect of age on the maintenance of rehabilitation gains following completion of an inpatient stroke rehabilitation program. Many studies have addressed the effect of age on rehabilitation outcome at the time patients leave the inpatient rehabilitation unit (1–11,13). Only a few of these have isolated age as the independent variable by controlling for age-related co-morbid medical problems or severity of stroke (2,4,5,7).

Advanced age without control for co-morbid medical problems or severity of stroke has a negative effect on functional outcome following stroke (1). Old age may adversely affect functional outcome for several reasons. The aged brain may have less ability to recover from ischemic injury (5). Elderly patients may have a lower level of function before their stroke due to ischemic heart disease, arthritis, or other medical problems (5,6). Stroke severity may increase with age (7).

Four studies have controlled for the presence of co-morbid medical problems (2,4,5,7). Dombovy et al. found a positive correlation between advanced age...
and the number of co-morbid medical problems and degree of disability (4). They did not control for the size of stroke or the extent of neurologic impairment. Three studies by Wade et al., Adler et al., and Reding controlled for co-morbidity and neurologic impairment and found little effect of age on functional outcome up to six months following stroke (2,5,7).

These studies indicate that the more carefully age is isolated from co-morbid medical problems and severity of stroke, the less relevant its effect on rehabilitation outcome. A similar effect of age on maintenance of rehabilitation gains was expected and has prompted the current study.

Methods

All subjects were inpatients on the stroke rehabilitation unit at The Burke Rehabilitation Center and were randomly assigned for serial follow-up as part of a quality assurance audit. Patients had no prior history of stroke and were admitted directly from acute care hospitals in the area. The diagnosis of stroke was based on neurologic history, physical examination, and CT or MRI in each case. Admission criteria require that patients need assistance to ambulate and perform activities of daily living (ADL). Patients with pulmonary, cardiovascular, or musculoskeletal conditions that precluded independent function in the community before the stroke or during the acute stroke phase were excluded. Patients with a history of cognitive impairment antedating their stroke and those with agitation, lack of cooperation, or aggressive behavior following stroke were excluded. All patients were examined by a neurologist (M.R.) on admission to the rehabilitation unit.

Patients with muscle weakness without somatic sensory or visual field deficits were said to have a motor (M) deficit. Patients with hemiparesis and greater than a six-inch error in limb placement task (LPT) response were classified as having motor plus somatic sensory (MS) deficits. Patients with motor plus somatic sensory plus hemianopic vision deficits to confrontation testing were said to have motor, somatic sensory, and vision (MSV) deficits. Such a classification schema has been shown to define clinically significant differences in outcome groups (8).

ADL performance was measured using the Barthel Index (BI). The BI score varies from 0 to 100, with 0 representing total dependence and 100 being independence in ADL and mobility function (9,10). The BI has been previously validated for both in-person and phone evaluation. The test-retest reliability of this instrument at our institution is 0.98 (p < 0.001) (11).

Study personnel blinded to the patient's previous BI scores and neurologic impairments contacted patients or their caregivers and generated follow-up BI scores at six, twelve, and twenty-four months after discharge from the rehabilitation unit. Any intercurrent medical problems or change in discharge placement were noted.

A fifteen point decline in follow-up BI score was chosen as a cutoff limit indicating clinically significant deterioration. Patients whose twenty-four-month follow-up BI scores were fifteen or more points below their discharge level were said to have shown deterioration. Those with transient deterioration at six- or twelve-month follow-up intervals were not scored as showing functional deterioration if their twenty-four-month follow-up scores recovered to within fourteen points of their discharge score.

Patients who died or were lost to follow-up were censored during the time interval in which the event occurred.

Patients were divided into two age groups, sixty-nine years or less (n = 32) and seventy years or more (n = 39). Seventy years of age was selected because it was close to the median age of our study sample and gave two groups of similar size.

The probability of maintaining the discharge BI score at six, twelve, and twenty-four months was measured using Life Table Analysis. Life table curves for the two groups were compared using the Mantel-Haenszel Log Rank Method (12). Mean BI scores were assessed using student's t test. The extent of neurologic impairment, sex ratio, and side of lesion were all assessed using the Chi square statistic.

Results

The demographic features of the two age groups were similar. There was no significant difference in sex ratio, hemisphere involved, mean admission and discharge BI scores, or time interval since stroke. (See Table 1.)

There was no significant difference between age groups in mean BI scores at six, twelve, or twenty-four months. Both age groups showed a seven point decline in mean BI scores from discharge to twenty-four months (P = NS). (See Figure 1.)

A total of thirty-six patients (sixteen in the younger and twenty in the older age group) had intercurrent medical problems during the two-year follow-up interval that could have caused a decline in ADL-mobility function. These problems included recurrent stroke, epilepsy, congestive heart failure, myocardial infarction, cardiac arrhythmia requiring hospitaliza-
Table 1. Demographics

<table>
<thead>
<tr>
<th></th>
<th>Young (N = 32)</th>
<th>Old (N = 39)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age ± standard deviation</td>
<td>60.3 ± 6.5 yrs</td>
<td>76.8 ± 6.0 yrs</td>
</tr>
<tr>
<td>Sex (F/M)*</td>
<td>13/19</td>
<td>20/19</td>
</tr>
<tr>
<td>Mean admit BI score†</td>
<td>31.56 ± 20.26</td>
<td>29.6 ± 19.5</td>
</tr>
<tr>
<td>Mean discharge BI score†</td>
<td>61.88 ± 27.93</td>
<td>53.08 ± 30.34</td>
</tr>
<tr>
<td>Interval from onset† to discharge from Burke (days)</td>
<td>93.75 ± 36.11</td>
<td>92.74 ± 35.18</td>
</tr>
<tr>
<td>Interval from onset† to admission to Burke (days)</td>
<td>41.75 ± 20.27</td>
<td>35.54 ± 16.69</td>
</tr>
<tr>
<td>Side of stroke R/L*</td>
<td>7/8</td>
<td>8/8</td>
</tr>
</tbody>
</table>

*Using Chi Square Contingency Tables, P = N.S. For all values
†The mean ± standard deviation, P = N.S. Student’s t test.

Figure 1. Mean Barthel Index Score Versus Time
(All Patients N = 71.)

Figure 2. Mean Barthel Index Score Versus Time*
*Only patients without intercurrent medical problems, N = 35.
Table 2. Number of neurologic impairments vs. age

<table>
<thead>
<tr>
<th>Neurologic deficit</th>
<th>Young (N = 32)</th>
<th>Old (N = 39)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor only</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>Motor + sensory</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>Motor + sensory + vision</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>39</td>
</tr>
</tbody>
</table>

*Using a 2 × 4 Contingency Table, Chi Square = 8.9, P = <0.05

There was a significant difference between age groups in the extent of their stroke-related neurologic impairments. Younger patients had a disproportionate number of pure motor deficits, while older patients had more motor, sensory, and visual impairments. (See Table 2.)

There were eight patients originally discharged to a skilled nursing facility, two in the younger group and six in the older group. By twenty-four months, one patient in the younger age group who had originally been in a SNF went home, and one patient was moved from home to a SNF. An additional eight patients in the older group were placed in a skilled nursing facility during this interval (Chi square = 5.6, P < 0.05). (See Table 3.)

Survival tended to be worse for older patients. Four of thirty-two patients in the younger and twelve of the thirty-nine patients in the older group died during the 24-month follow-up interval (Chi square = 3.4, P = N.S.).

Discussion

This study confirms previous reports of functional improvement measured by BI scores for both younger and older patient groups during inpatient stroke rehabilitation. The change in Barthel Index score from admission to discharge was similar in both younger and older patients. The probability of maintaining the rehabilitation hospital discharge BI score was likewise

Table 3. Discharge disposition

<table>
<thead>
<tr>
<th>SNF at Discharge</th>
<th>SNF by 24 mos.</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥70 yrs</td>
<td>6</td>
</tr>
<tr>
<td>&lt;69 yrs</td>
<td>2</td>
</tr>
</tbody>
</table>

*Using a 2 × 2 Contingency Table Chi Square = 5.6, P < 0.05
similar for both age groups. These observations underline the value of rehabilitation services for selected older stroke victims.

The study population is selected by our admission criteria. The most important age-related medical exclusions are the presence of "functional limitation" due to cardiopulmonary and rheumatologic problems antedating the stroke. Many patients have a diagnosis of ischemic heart disease indicating prior myocardial infarction or angina pectoris. The diagnosis itself is not as relevant for rehabilitation outcome as the degree to which it limits exercise tolerance. Cognitive impairment antedating stroke or agitated-aggressive behavior following stroke indicate impaired higher integrative function and are expected to adversely affect rehabilitation outcome.

Application of the above mentioned exclusion criteria define a group of older stroke victims who will improve as much as their younger counterparts. They will also maintain their gains equally well following discharge from the rehabilitation unit.

Most patients who were unable to maintain functional gains had intercurrent medical illness that could explain the decline. It was beyond the scope of this study to provide re-evaluation and supplementary rehabilitation services. Perhaps such intervention may have reversed the deterioration in self-care and mobility function that were observed.

Patients with discharge BI scores \( \geq 60 \) irrespective of age were more likely to show functional decline over the twenty-four-month follow-up interval than those with scores \( \leq 59 \). This probably reflects the non-linearity of the BI scale and suggests that a fifteen point decline in score represents different degrees of functional loss at its upper vs. lower limits. Another possible explanation is that functional decline is harder to define in patients who already require physical assistance.

Older patients tended to have more extensive strokes as judged by their number of neurologic impairments. This supports previous observations concerning age and its effect on size of stroke (7). This emphasizes the importance of controlling for the size of stroke or extent of neurologic impairment when studying functional outcome following stroke.

Older patients were more likely to transfer from home to a skilled nursing facility over the follow-up period than were younger patients. Of the nine patients admitted to SNF facilities, only five showed deterioration in BI scores indicating a deterioration in patient function since discharge. The remaining four presumably required SNF placement for social or economic reasons. The linkage between age and SNF placement has been noted by others (13). The fact that the age effect remains even after controlling for age-related co-morbid medical problems indicates that SNF placement is often dictated by factors extraneous to the patient, such as the death of a spouse or "significant other."

As expected, older patients had a higher death rate during the twenty-four month follow-up interval than the younger group. There was no clear relationship between the Barthel Index scores or extent of neurologic impairments and death.

Acknowledgment: This work was funded in part by the Winifred Masterson Burke Relief Foundation.

References


J NEURO REHAB. VOL. 6, NO. 1, 1992 5