The Influence of Age on Stroke Outcome
The Copenhagen Stroke Study
Hirofumi Nakayama, MD; Henrik Stig Jørgensen, MD; Hans Otto Raaschou, MD; Tom Skyhøj Olsen, MD, PhD

Background and Purpose This study was undertaken to elucidate whether and how age influences stroke outcome.

Methods This prospective and community-based study comprised 515 consecutive acute stroke patients. Computed tomographic scan was performed in 79% of patients. Activities of daily living (ADL) and neurological status were assessed weekly during hospital stay using the Barthel Index (BI) and the Scandinavian Stroke Scale (SSS), respectively. Information regarding social condition and comorbidity before stroke was also registered. A multiple regression model was used to analyze the independent influence of age on stroke outcome.

Results Age was not related to the type of stroke lesion or infarct size. However, age independently influenced initial BI (−4 points per 10 years, \( P<.01 \)), initial SSS (−2 points per 10 years, \( P<.01 \)), and discharge BI (−3 points per 10 years, \( P<.01 \)). No independent influence of age was found regarding mortality within 3 months, discharge SSS, length of hospital stay, and discharge placement. ADL improvement was influenced independently by age (−3 points per 10 years, \( P<.01 \)), whereas age had no influence on neurological improvement or on speed of recovery.

Conclusions Age independently influences stroke outcome selectively in ADL-related aspects (BI) but not in neurological aspects (SSS), suggesting a poorer compensatory ability in elderly stroke patients. Therefore, rehabilitation of elderly stroke patients should be focused more on ADL and compensation rather than on the recovery of neurological status, and age itself should not be a selection criterion for rehabilitation.


Key Words • aging • rehabilitation • stroke outcome

Advanced age is often considered a limitation for rehabilitation. However, as pointed out in the reviews of both Jongbloed1 and Rusin,2 there is no consensus on the influence of age on stroke outcome. Nine studies3–11 found a negative influence of age on functional status on or after discharge, whereas 2 studies found no influence.12,13 As to the influence of age on functional improvement from admission to the time of assessment, 4 studies showed no influence,7,13–15 2 studies reported a negative influence,8,16 and 1 study showed a negative influence at discharge but no influence 3 months after discharge.18

Furthermore, it is not possible to determine from former studies whether age per se influences stroke outcome or age influences stroke outcome through other factors associated with age.1 To clarify the specific influence of age, other factors such as comorbidity before stroke, marital status, type and size of the stroke lesion, and initial severity of the stroke should be considered.

The purpose of this study was to investigate prospectively in a community-based population the specific influence of age on stroke outcome.

Subjects and Methods

All patients with stroke admitted to Bispebjerg Hospital, Copenhagen, between March 1, 1992, and February 28, 1993, were included in the study (The Copenhagen Stroke Study). The study population was community based, in that (1) Bispebjerg Hospital serves a well-defined area with 239 886 inhabitants in the city of Copenhagen and is the only hospital serving the area; (2) hospital care is free, and a very high proportion (88%) of stroke patients in the community are admitted to the hospital;19,20 and (3) all patients from the community who have an acute cerebrovascular disease that requires admission to the hospital are referred to the neurological department, where acute treatment as well as all stages of rehabilitation take place.

Inclusion and Exclusion Criteria

Included were patients with stroke admitted between March 1, 1992, and February 28, 1993. A total of 515 stroke patients were admitted in the study period (mean±SD age, 74.8±11.1 years; 226 men, 289 women).

Excluded were patients admitted later than 1 week from onset (n=50; mean±SD age, 74.0±11.7 years; 19 men, 31 women) and patients in whom a proper assessment could not be performed (n=47; mean±SD age, 75.6±8.8; 20 men, 27 women; 6 could not cooperate sufficiently because of aphasia, 9 because of disturbed consciousness/disorientation, and 32 because of other reasons). There was no significant difference in age (\( P=1.00 \)) and sex (\( \chi^2=0.66; \) df=1; \( P=0.42 \)) between included and excluded patients. Thus, 418 patients, of whom 93 (22%) had a history of former stroke, were included in the study.

Evaluation of Social and Medical Conditions Before Stroke

To evaluate age-associated changes in social and medical conditions before stroke, we compared the different age groups regarding sex ratio, premorbid conditions (history of former stroke and other disabling disease such as amputation, multiple sclerosis, severe dementia, heart failure, Parkinsonism, etc), marital status (widowed/single or married/cohabitation), and living place before stroke (home or institution).

Evaluation of the Stroke Lesion

Computed tomographic scan was performed with a Siemens Somatom DR scanner. Description included type and size of
the stroke lesion. Lesion size was defined as the largest diameter of the lesion.

Evaluation of Activities of Daily Living and Neurological Status

Activities of daily living (ADL) status was assessed by the Barthel Index (BI).20 It was measured by the nursing and training staff once during the first week after admission, each week during the hospital stay, and at discharge. Neurological status was assessed by the Scandinavian Stroke Scale (SSS).21,22 It was measured on admission, the day after admission, each week during the hospital stay, and at discharge.

Evaluation of Stroke Outcome

Stroke outcome was evaluated by initial ADL and neurological status, mortality within 3 months after stroke, ADL and neurological status at discharge, degree and speed of improvement, length of hospital stay, and discharge placement (home or institution). Survival of discharged patients was confirmed by the national register to calculate mortality within 3 months after stroke. The delay in discharge, ie, days spent for nonmedical reasons (eg, waiting for nursing home, home remodeling, technical aids, etc) was calculated to consider the nonmedical part of the length of hospital stay. The degree of improvement in ADL and neurological status was evaluated by gain in total BI and SSS scores, respectively, from admission to discharge. To minimize the ceiling effect, we calculated percent gain as 100×[(actual gain/optimum gain)]. Optimum gain is the difference between full score and admission score, which is often referred to as rehabilitation potential.11-23 If a patient had a full score throughout the hospital stay, percent gain was set at 100%.

The speed of improvement in ADL and neurological status was evaluated by the time in weeks from admission to achievement of the highest score on the BI and SSS, respectively.

Patients who died during the hospital stay (n=99) were excluded in the analysis of ADL and neurological status at discharge, length of hospital stay, and discharge placement.

Data Analysis and Ethics

Information from all patients was entered into a computerized database and analyzed using the SPSS package.

In univariate analyses, Student's t test was used to compare continuous data, and the χ² test (or Fisher's exact test when appropriate) was used to compare noncontinuous data. Pearson's correlation coefficient was calculated to test the relation between age and infarct size and also to test the univariate relation between age and stroke outcome. To calculate correlation coefficients between age and mortality and home discharge rate, age-specific rates were calculated at intervals of 10 years. The linear multiple regression model was used to determine independent influencing factors for continuous data, and the coefficient was calculated for each significant factor. The logistic multiple regression model was used for binary data, and the odds ratio was calculated for each significant factor. All variables of interest were tested using the backward procedure, and variables that had a probability value below .2 were then entered using the forward procedure to attain as much information as possible. The level of significance was set at P<.05. The study was approved by the ethics committee of Copenhagen.

Results

Subjects

Table 1 shows sex, age, type of stroke, interval between onset and admission, and length of hospital stay in the 418 patients eligible for the study. Ninety-nine patients (24%) died during the hospital stay (95 within 3 months after stroke and 4 later), and 110 patients (26%) died within 3 months after stroke (95 during hospital stay and 15 after discharge).

Age in Relation to Social and Medical Conditions Before Stroke

Table 2 shows social and medical conditions before stroke in relation to age. In elderly stroke patients there were significantly more women (χ²=31, 74; df=4; P<.0001), more elderly were living a widowed/single life (χ²=36, 38; df=4; P<.0001), and fewer of the elderly lived at home before stroke (χ²=12, 60; df=4; P=.01). There was no difference in premorbid condition between age groups (χ²=5.08; df=4; P=.28).

Age in Relation to Type and Size of Stroke Lesion

Computed tomographic examination was performed in 331 (79%) of the patients; median time of computed tomogram from stroke onset was 8 days. There was no significant correlation between age and type of stroke (P=.85) or between age and infarct size (P=.71).

<table>
<thead>
<tr>
<th>TABLE 2. Social and Medical Conditions Before Stroke</th>
<th>Age Group, y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>≤54 (n=27)</td>
</tr>
<tr>
<td>Male sex</td>
<td>19</td>
</tr>
<tr>
<td>Premorbid condition*</td>
<td>9</td>
</tr>
<tr>
<td>Marital status†</td>
<td>12</td>
</tr>
<tr>
<td>Home living†</td>
<td>26</td>
</tr>
</tbody>
</table>

*No. of patients with a history of stroke or other disabling disease.
†No. of widowed/single patients.
‡No. of patients living at home before stroke.
Table 3. Mortality Within 3 Months After Stroke

<table>
<thead>
<tr>
<th>Age Group, y</th>
<th>No. of Patients</th>
<th>Dead Within 3 mo</th>
<th>Mortality Within 3 mo, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤54</td>
<td>27</td>
<td>2</td>
<td>7.4</td>
</tr>
<tr>
<td>55-64</td>
<td>40</td>
<td>4</td>
<td>11.1</td>
</tr>
<tr>
<td>65-74</td>
<td>96</td>
<td>23</td>
<td>24.0</td>
</tr>
<tr>
<td>75-84</td>
<td>184</td>
<td>53</td>
<td>28.8</td>
</tr>
<tr>
<td>≥85</td>
<td>71</td>
<td>28</td>
<td>39.4</td>
</tr>
</tbody>
</table>

Influence of Age on Mortality

Table 3 shows age-specific mortality within 3 months after stroke. Mortality increased significantly with age (r = .97, P < .01) (Table 4). However, the logistic multiple regression analysis showed that age had no significant influence on mortality independent of sex, premorbid condition, initial ADL, and neurological status (P = .13) (Table 5). According to the discriminant analysis of this model, the goodness of fit (dead/alive) was 83%.

Influence of Age on Initial Activities of Daily Living and Neurological Status

Table 4 shows a significant negative correlation between age and initial ADL status (BI) in the univariate analysis (P < .01). The linear multiple regression analysis also showed that age had a significant influence on initial ADL status independent of sex, premorbid condition, and initial SSS score (P < .01) (Tables 5 and 6). Table 4 also shows a significant negative correlation between age and initial neurological status (SSS) in the univariate analysis (P < .01). However, in the linear multiple regression analysis age had no significant influence on discharge neurological status independent of sex, premorbid condition, and initial SSS score (P = .73) (Table 5). A 10-year increase in age resulted in a 3-point decrease in discharge BI score but did not influence discharge SSS score.

Influence of Age on Activities of Daily Living and Neurological Status at Discharge

Table 4 shows a significant negative correlation of age with discharge ADL status (BI) in the univariate analysis (P < .01). The linear multiple regression analysis also showed that age had a significant negative influence on discharge ADL status independent of sex, premorbid condition, initial BI score, and initial and discharge SSS scores (P < .01) (Tables 5 and 6). Table 4 also shows a significant negative correlation of age with discharge neurological status (SSS) in the univariate analysis (P < .01). However, in the linear multiple regression analysis age had no significant influence on discharge neurological status independent of sex, premorbid condition, and initial SSS score (P = .73) (Table 5). A 10-year increase in age resulted in a 3-point decrease in discharge BI score but did not influence discharge SSS score.

Influence of Age on Activities of Daily Living and Neurological Improvement

Table 4 shows no correlation of age with ADL improvement (gain on BI) in the univariate analysis (P = .97). However, the linear multiple regression analysis showed that age had a significant influence on ADL improvement independent of sex, premorbid condition, initial BI, and initial and discharge SSS scores (P < .01) (Tables 5 and 6). Table 4 shows no correlation of age with neurological improvement (gain on SSS) in the univariate analysis (P = .27). The linear multiple regression analysis also showed that age had no significant influence on neurological improvement independent of sex, premorbid condition, and initial SSS score (P = .73) (Table 5).

To minimize the ceiling effect, percent gain (percentage of actual gain against optimum gain) was calculated. Age had a significant negative correlation with percent gain on BI in the univariate analysis (P < .01) (Table 4). The linear multiple regression analysis also showed that age had a significant influence on percent gain on BI independent of sex, premorbid condition, initial BI, and initial and discharge SSS scores (P < .01) (Tables 5 and 6). In contrast to percent gain on BI, age had no correlation with percent gain on SSS in the univariate analysis (P = .15) (Table 4). The linear multiple regression analysis also showed that age had no significant influence on percent gain on SSS independent of sex, premorbid condition, and initial SSS score (P = .17) (Table 5). A 10-year increase in age resulted in a 7% decrease in percent gain on BI, whereas it did not influence percent gain on SSS.

Age had no influence on the speed of ADL recovery in the univariate analysis (P = .51) (Table 4). The linear multiple regression analysis also showed that age had no significant influence independent of sex, premorbid condition, initial and discharge BI, and initial and discharge SSS scores (P = .51) (Table 5). Age had no influence on the speed of neurological recovery in the univariate analysis (P = .42). The linear multiple regression analysis also showed that age had no significant influence independent of sex, premorbid condition, and initial and discharge SSS scores (P = .56) (Table 5).

Influence of Age on the Length of Hospital Stay

In the univariate analysis age had a positive correlation with both length of hospital stay and delay in discharge (P < .01) (Table 4). However, the linear multiple regres-
TABLE 5. Multiple Regression Analysis of Stroke Outcome

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Method</th>
<th>Age</th>
<th>Sex</th>
<th>Premorbid Condition</th>
<th>Initial Neurostatus (SSS)</th>
<th>Discharge Neurostatus (SSS)</th>
<th>Initial ADL Status (Bl)</th>
<th>Discharge ADL Status (Bl)</th>
<th>Marital Status</th>
<th>Home Living</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death within 3 mo</td>
<td>Logistic</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>S</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Initial Bl</td>
<td>Linear</td>
<td>S</td>
<td>NS</td>
<td>NS</td>
<td>S</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Initial SSS</td>
<td>Linear</td>
<td>S</td>
<td>NS</td>
<td>S</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Discharge Bl*</td>
<td>Linear</td>
<td>S</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>S</td>
<td>S</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Discharge SSS*</td>
<td>Linear</td>
<td>NS</td>
<td>NS</td>
<td>S</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Bl gain*</td>
<td>Linear</td>
<td>S</td>
<td>NS</td>
<td>NS</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>% Gain on Bl*</td>
<td>Linear</td>
<td>S</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>S</td>
<td>S</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>SSS gain*</td>
<td>Linear</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>% Gain on SSS*</td>
<td>Linear</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Speed of ADL recovery*</td>
<td>Linear</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>S</td>
<td>S</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Speed of neural recovery*</td>
<td>Linear</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>S</td>
<td>NS</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Hospital stay*</td>
<td>Linear</td>
<td>NS</td>
<td>NS</td>
<td>S</td>
<td>NS</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>Delay in discharge*</td>
<td>Linear</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>Home discharge*</td>
<td>Logistic</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>S</td>
<td>S</td>
<td>NS</td>
</tr>
</tbody>
</table>

Neuro indicates neurological; SSS, Scandinavian Stroke Scale; ADL, activities of daily living; Bl, Barthel Index; NS, nonsignificant; S, significant; and ..., not studied. Sex was coded as 1 = male, 0 = female. Premorbid condition was coded as 1 = history of former stroke or other disabling disease, 0 = no history of former stroke or other disabling disease. Marital status was coded as 1 = widowed or single, 0 = married or cohabitation. Home living was coded as 1 = home living before stroke, 0 = institutionalized before stroke.

*Dead patients were excluded.
†Percentage of actual gain against optimum gain.
‡Time in weeks from admission to achievement of highest score.

Influence of Age on Discharge Placement

In the univariate analysis age failed to show any significant correlation with home discharge rate (P = .11) (Table 4). Likewise, the linear multiple regression anal-

TABLE 6. Linear Multiple Regression Analysis of Stroke Outcome

<table>
<thead>
<tr>
<th>Variable</th>
<th>Covariate</th>
<th>Coefficient (b)</th>
<th>SE (b)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Bl</td>
<td>Age</td>
<td>-0.39</td>
<td>0.12</td>
<td>.0012</td>
</tr>
<tr>
<td>(R^2 = .57)</td>
<td>Initial neurological status</td>
<td>1.83</td>
<td>0.09</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
<td>17.73</td>
<td>10.30</td>
<td></td>
</tr>
<tr>
<td>Initial SSS</td>
<td>Age</td>
<td>-0.17</td>
<td>0.07</td>
<td>.01</td>
</tr>
<tr>
<td>(R^2 = .06)</td>
<td>Premorbid condition</td>
<td>-6.18</td>
<td>1.70</td>
<td>.0003</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
<td>56.59</td>
<td>5.16</td>
<td></td>
</tr>
<tr>
<td>Discharge Bl</td>
<td>Age</td>
<td>-0.30</td>
<td>0.07</td>
<td>.0001</td>
</tr>
<tr>
<td>(R^2 = .78)</td>
<td>Initial ADL status</td>
<td>.30</td>
<td>0.03</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td></td>
<td>Discharge neurological status</td>
<td>1.54</td>
<td>0.10</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
<td>5.32</td>
<td>7.02</td>
<td></td>
</tr>
<tr>
<td>Bl gain</td>
<td>Age</td>
<td>-0.30</td>
<td>0.07</td>
<td>.0001</td>
</tr>
<tr>
<td>(R^2 = .58)</td>
<td>Initial ADL status</td>
<td>-0.70</td>
<td>0.03</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td></td>
<td>Discharge neurological status</td>
<td>1.54</td>
<td>0.10</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
<td>5.32</td>
<td>7.02</td>
<td></td>
</tr>
<tr>
<td>% Gain on Bl</td>
<td>Age</td>
<td>-0.69</td>
<td>0.16</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>(R^2 = .42)</td>
<td>Initial ADL status</td>
<td>.26</td>
<td>0.07</td>
<td>.0004</td>
</tr>
<tr>
<td></td>
<td>Discharge neurological status</td>
<td>1.41</td>
<td>0.23</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
<td>32.14</td>
<td>15.22</td>
<td></td>
</tr>
</tbody>
</table>

Bl indicates Barthel Index; SSS, Scandinavian Stroke Scale; and ADL, activities of daily living.
Discussion

Although many studies have investigated the influence of age on stroke outcome,3-18 no consensus has been obtained, mainly because of the following methodological problems.1-2 First, most of the former studies4,5,7,9-10,18 were not community based. Second, different score systems were used to evaluate the functional outcome. Seven studies3,6,8,12,15,17 used their own scales, 5 studies used the BI,6,9-11,13 and 4 studies used validated scales other than the BI.5,14,16,18

Third, outcome measures were different among former studies. Four studies used discharge ADL status,4,5,11,12 7 studies used ADL status at different times after stroke,5,6,8,10,13,16 5 studies used improvement from admission to discharge,4,5,11,12,16 1 study used improvement from admission to 6 months after stroke,13 and 1 study used improvement from admission to 3 months after discharge.18

Fourth, half of the studies did not consider any other influencing factor related to age such as initial severity, premorbid condition, marital status, and type and size of the stroke lesion.5,7,12-15,17 Initial severity was considered only in 7 studies;8,4,11,13,16 Premorbid condition was considered in only 1 study.9 Type and size of the stroke lesion were considered in only 2 studies.3,4

Fifth, the number of patients was relatively small in most studies. Only 2 studies included more than 400 patients,9,11 and most of the studies included fewer than 200 patients.4,5,7,8,10,13-17

To overcome these problems, this study was designed as follows: (1) The study population was community based; (2) widely used validated score systems were used to evaluate ADL (BI) and neurological status (SSS) to make our study comparable to other studies; (3) both ADL and neurological status were assessed in all patients weekly during the hospital stay, and the degree and speed of improvement from admission to discharge were also evaluated; (4) influencing factors for stroke outcome other than age were also considered; and (5) the study population was large (n=418).

Our finding that elderly stroke patients are more likely to be women living a widowed/single life is consistent with the results of Wade and Hewer.9 Like others,6,24 we found no difference between the type of stroke lesion in the young and the elderly. There was no correlation of age with infarct size. This finding suggests that the poor ADL and neurological status on admission and at discharge in elderly stroke patients might be attributable to a poor compensatory capacity rather than to the stroke lesion per se.

The influence of age on mortality after stroke found in the univariate analysis of this study is consistent with other studies.2,14-16 However, age did not have an independent significant influence on mortality when severity of stroke was also considered. This finding suggests that the influence of initial severity of stroke was so great that the independent influence of age per se disappeared in the logistic regression model when these factors were considered.

Our findings show that initial ADL status is influenced by age. This is consistent with the results of Wade and Hewer,9 who found a lower initial BI score in elderly stroke patients in a community-based study. We also found an influence of age on initial neurological status. Wade and Hewer,9 however, found no such correlation. The difference may be explained by the fact that they assessed only about half of their patients within the first week after stroke, and they analyzed each neurological finding separately instead of using a score system similar to SSS.

The poor discharge ADL status in elderly stroke patients found in this study is consistent with other community-based studies.3,5,9 Age has an independent negative influence even when poor initial ADL and neurological status in the elderly were considered. Our finding disagrees with the finding of Feigenson et al12 that age was unrelated to discharge ADL function. A direct comparison is difficult, however, because their study population was not community based and a validated ADL score system was not used.

We also found that discharge neurological status correlated significantly with age in the univariate analysis. But when the influence of initial neurological status was considered in the multiple regression model, age did not have an independent influence. This indicates that elderly stroke patients have a poor discharge neurological status because their initial neurological status is poor.

This study shows that age influences discharge ADL status but not discharge neurological status. Neurological status evaluated by SSS is considered to reflect recovery from the stroke lesion itself, whereas ADL status evaluated by BI is considered to reflect not only recovery from the stroke lesion itself but also compensation by the nonaffected side. Considering this selective influence of age on ADL status and the fact that age was not related to the type of stroke lesion or infarct size, this discrepancy between ADL status and neurological status suggests that elderly stroke patients have a poor compensatory ability.

In the univariate analysis, no correlation was found between age and ADL improvement during hospital stay. This is consistent with most non-community-based studies.7,13,15 However, age had a significant negative influence on ADL improvement when sex, premorbid condition, initial BI, and initial and discharge SSS scores were also considered. This is in accordance with other studies16,17 that considered influencing factors for stroke outcome other than age. In contrast to ADL improvement, age had no influence on neurological improvement. This has not been previously reported.

The ceiling effect might obscure the influence of age on improvement.7 If a patient has a high initial score, the optimum gain is limited by the full score. To minimize this effect, percent gain (percentage of actual gain against optimum gain) was introduced in this study. In our study age had a negative significant correlation with percent gain on BI. This finding is consistent with other studies.11,20 In contrast, age had no influence on percent gain on SSS. This has not been previously reported. This discrepancy between ADL and neurological improvement, which corresponds to the discrepancy between ADL and neurological status at discharge, emphasizes that elderly stroke patients might have a poor compensatory ability.
This study found no influence of age on the speed of improvement. Shah et al. used the rate of BI improvement per hospital day to evaluate the speed of improvement and showed a negative influence of age. Because elderly stroke patients remain in the hospital longer partly because of social factors, it is possible that their results were influenced by those factors.

The influence of age on the length of hospital stay shown in the univariate analysis is consistent with the finding of Wade and Hewer. This influence was not found in the multiple regression model in which the influence of initial and discharge ADL and neurological status, marital status, and living place before stroke were also considered. This finding indicates that elderly stroke patients may have some delay in discharge not because of age per se but because of social factors and a poor ADL status.

In the univariate analysis home discharge rate tended to be lower with increasing age. But this tendency, which is consistent with other community-based studies, failed to be significant (P = .11). However, when discharge ADL and marital status were also considered, age did not have an independent influence on home discharge rate (P = .75). This indicates that elderly stroke patients were discharged to a nursing home because of poor ADL and marital status but not because of age per se.

Conclusions

Although age is not related to the type and size of the stroke lesion, it influences several aspects of stroke outcome, mostly in ADL-related aspects: initial ADL and neurological status, discharge ADL status, and improvement in ADL status. According to our analysis, a 10-year increase in age results in a 4-point decrease on initial SSS, a 3-point decrease on discharge BI, a 3-point decrease in BI gain, and a 7% decrease in percent gain on BI. However, other aspects are not influenced by age: discharge neurological status, improvement in neurological status, speed of recovery, length of hospital stay, delay in discharge, and discharge placement.

This study shows that age influences initial stroke severity and ADL recovery but does not influence neurological recovery, suggesting a poor compensatory ability in elderly stroke patients. Considering the importance of ADL function, we propose that the rehabilitation of elderly stroke patients should be focused more on ADL and compensation rather than on recovery of neurological status, and age itself should not be a selection criterion for rehabilitation.

Acknowledgments

This study was supported by grants from the Danish Health Foundation, the Danish Heart Foundation, Ebba Celinders Foundation, and the Gangsted Foundation.

References

The influence of age on stroke outcome. The Copenhagen Stroke Study.
H Nakayama, H S Jørgensen, H O Raaschou and T S Olsen

Stroke. 1994;25:808-813
doi: 10.1161/01.STR.25.4.808

Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 1994 American Heart Association, Inc. All rights reserved.
Print ISSN: 0039-2499. Online ISSN: 1524-4628

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/25/4/808

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Stroke can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Stroke is online at:
http://stroke.ahajournals.org/subscriptions/