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Fewer very old had hypertension (25% versus 34%, \( P = 0.02 \)) and diabetes (14% versus 22%, \( P = 0.01 \)). In adjusted multiple regression models, very old age predicted short-term mortality (OR 2.5; 95% CI 1.5–4.2), and discharge to nursing home or in-hospital mortality (OR 2.7; 95% CI 1.7–4.4). Five years after stroke very old age predicted mortality or nursing home placement (OR 3.9; 95% CI 2.1–7.3), and long-term mortality (HR 2.0; 95% CI 1.6–2.5). However, other factors such as onset stroke severity, pre-existing disability and atrial fibrillation were also significant independent predictors of prognosis after stroke.

**Conclusions**: in this study very old age *per se* was a strong predictor of outcome and mortality after stroke. Apart from very old age, factors such as prestroke medical and functional status, and onset stroke severity should be taken into consideration when planning treatment and rehabilitation after stroke.

**Keywords**: stroke, elderly, prognosis

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**Introduction**

In developed countries the proportion of elderly people reaching advanced age is expected to increase substantially in coming years [1]. Furthermore, it is a widely held notion that very old stroke patients have a poorer prognosis than younger ones simply because of older age.

Few recent studies have focused on clinical characteristics and short-term prognosis of very old stroke patients. In one study of a population-based sample of nearly 1,000 patients it was reported that stroke patients aged 85 years or more had a doubled 30-day case-fatality, and that very old age was a predictor of mortality independent of other clinical characteristics [2]. In another larger European sample of 4,499 stroke patients, old age (≥80 years) was associated with a higher mortality, increased disability and handicap three months after onset [3]. But, in the latter study pre-stroke health, medical condition, and the severity of the stroke appeared to be the major determinants of outcome. Other authors have confirmed the association between older age and a poorer prognosis post stroke [4]. However, in all studies no validated neurological or functional scores were used, and prognosis beyond the first 3 months after onset in the very old stroke patients was not considered.

Previous reports of very old age and long-term outcome after stroke are scant. The Perth Community Stroke Study reported age to be associated with increased long-term mortality, but in this study very old age was not particularly studied [5]. In the Auckland Stroke Study long-term very old (≥85 years) stroke survivors were found to have poorer basic activities of daily living after 6 years when compared with age-matched control subjects [6].

In this study we investigated the influence of very old age on short- and long-term prognosis. In the investigation we adjusted for basic clinical characteristics and stroke severity at onset in order to study the independent influence of very old age on the prognosis after stroke.

**Methods**

We included all patients with acute stroke admitted consecutively during a 25-month period in the years 1991–1993 to the stroke unit at Bispebjerg Hospital, Copenhagen, Denmark. The study is prospective and community-based as has previously been described in detail [7, 8]. Hospital care is free, and a very high proportion (88%) of the stroke patients in the area were admitted to this hospital serving a well-defined catchment area of nearly 240,000 inhabitants in the city of Copenhagen [9]. No selection of patients was performed with regard to age, severity of stroke, or medical condition before admission. All treatment, rehabilitation, and diagnostic procedures were performed within the stroke unit. Patients were not discharged before the rehabilitation team decided that no further in-hospital improvement could be expected. Therefore, no referral to other departments or hospitals for further rehabilitation was necessary.

Stroke was defined according to the World Health Organisation criteria [10]. The study does not include patients with TIAs or subarachnoid haemorrhage. The Scandinavian Stroke Scale (SSS) was used to assess neurological deficit [11]. The SSS evaluates level of consciousness, eye movement, power in arm, hand, and leg, orientation, aphasia, facial paresis, and gait on a total score from 0 (worst) to 58 (best) [12]. The score was recorded on admission, weekly during hospital stay and at discharge by the same neurologist (HSJ). At the visit for long-term follow-up, data were prospectively recorded by another experienced neurologist (LPK) who was blinded to data obtained on admission.

For classification of stroke subtype (haemorrhage or infarction) CT was performed with a Siemens Somatom DR scanner and the same experienced CT-scan reader read the scans.

The following prognostic factors were investigated in the statistical analyses: age groups (<85 years versus ≥85 years), gender, initial stroke severity (SSS), time from stroke onset to admission, diabetes, atrial fibrillation, ischaemic heart disease (IHD), hypertension, claudication, previous stroke or TIA, pre-existing disability, daily alcohol consumption and smoking. The same neurologist (HSJ) assessed all clinical characteristics.

Diabetes was considered present if a patient had known diabetes on admission or if plasma glucose >11 mmol/L on admission or during the hospital stay. Atrial fibrillation was diagnosed if present on admission electrocardiogram. Information concerning other disabling disease was obtained on admission and included disabling diseases other than previous stroke (e.g. amputation, multiple sclerosis, severe dementia, heart failure, latent or persistent respiratory insufficiency).
Ischaemic heart disease was present if a patient had a history of IHD, or had IHD diagnosed during the hospital stay. Hypertension was present if a patient received antihypertensive treatment before admission, or if hypertension was diagnosed during hospital stay by repeated detection of blood pressure $\geq 160/95\, \text{mmHg}$. Smoking was coded if a patient smoked any kind of tobacco on a daily basis. Ex-smokers were coded as non-smokers.

**Follow-up**

A follow-up was performed for all patients at a mean of 7 years after stroke onset. For the patients who had died information on date of death and place of stay 5 years after stroke onset (own home or nursing home) was obtained from the Danish Central Registry of Persons. Through a 10-digit identification code that is unique for the individual person and contains information about birth date, all persons staying in Denmark can be tracked with regard to mortality data and address. The follow-up was performed during the year 1999 ending 29 December (censoring date).

**Outcome**

Short-term outcome and mortality was recorded in two ways: either as death during hospital stay, or the combined outcome discharge rate to nursing home or death during hospital stay. Long-term outcome was recorded as nursing home resident or death 5 years after stroke onset.

**Statistical analyses**

Statistical analyses were performed with the SPSS statistical package [13]. Univariate analyses were performed by non-parametric statistics because not all variables had a normal distribution. The Mann–Whitney $U$ test was used for continuous variables and Fisher’s exact test was used for categorical values.

To find independent predictors of short- and long-term outcome, multiple logistic regression models were used, because very old age was not the only factor being tested [14]. All variables (including age groups) were entered in the initial model and then removed by backward stepwise selection. Removal testing was based on the probability of the Wald statistic. All variables with a $P$ value $>0.10$ were then excluded, and the analyses were then performed again on the new model by the same procedure subsequently leaving a final model. To find independent predictors of long-term mortality a Cox proportional hazard model was built. Again, backward stepwise model selection was used. To assess whether the baseline hazard functions were proportional log-minus-log plots were performed for each variable. The required two-tailed level of significance for all tests was set at 0.05.

The study was approved by the Ethics Committee of Frederiksberg and Copenhagen, approval numbers KF/V.100.2263/91 and KF 01–287/98.

**Results**

This study includes 1,197 patients with completed stroke. Follow-up was performed at a mean of 84 (SD 7.9) months after onset. Data on mortality and date of death were recorded for all patients except for four patients no longer living in Denmark.

**Clinical characteristics**

Table 1 gives the basic clinical characteristics of all patients. Sixteen per cent were 85 years or older at stroke onset. Most of the very old were women, were living alone, had atrial fibrillation, and had pre-existing disabling disease. Patients aged $<85$ years more frequently had a daily intake of alcohol, were daily smokers, had arterial hypertension, and diabetes. In very old patients, strokes were rated as more severe as measured by the SSS score.

**Outcome**

Among the very old, more patients were discharged to nursing homes or died during hospital stay after stroke, 58.6% versus 31.2%, $P<0.0001$. When analysed by adjusted multiple logistic regression, independent predictors of death during hospital stay or discharge to nursing home were very old age (OR 2.7; 95% CI 1.7–4.4, $P=0.0001$), admission stroke
severity (OR 2.7 per 10 point decrease in SSS score; 95% CI 2.3–3.1, \( P < 0.0001 \)) and pre-existing disability (OR 2.1; 95% CI 1.4–3.2, \( P = 0.0006 \)) (Table 2).

In-hospital mortality rate for the very old was 35.6% versus 18.1% for the younger patients, \( P < 0.0001 \). By an adjusted multiple logistic regression model for the dependent variable death during hospital stay we found that the independent predictors were very old age (OR 2.5; 95% CI 1.5–4.2, \( P = 0.0006 \)) and admission stroke severity (OR 2.3 per 10 point decrease in SSS score; 95% CI 2.0–2.6, \( P < 0.0001 \)).

More very old patients were nursing home residents or had died 5 years after stroke onset, 91.6% versus 67.6%, \( P < 0.0001 \). In a multiple regression model, independent predictors for long-term nursing home living or death were very old age (OR 3.9; 95% CI 2.1–7.3, \( P = 0.04 \)), stroke severity on admission (OR 1.9 per 10 point decrease in SSS score; 95% CI 1.7–2.3, \( P < 0.0001 \)), atrial fibrillation (OR 2.2; 95% CI 1.2–3.8, \( P = 0.006 \)), and pre-existing disability (OR 2.8; 95% CI 1.8–4.3, \( P = 0.001 \)).

From Figure 1 it is evident that the mortality among the very old is much higher all through the observation period. The number of survivors is presented for different time points along the \( x \)-axis. In order to adjust for differences in the basic characteristics between the two groups we performed Cox proportional hazard analyses. As given in Table 3, we found that independent predictors of long-term mortality were very old age [hazard ratio (HR) 2.0; 95% CI 1.6–2.5, \( P < 0.0001 \)], stroke severity on admission (HR 1.4 per 10 point decrease in SSS score; 95% CI 1.3–1.5, \( P < 0.0001 \)) and atrial fibrillation (HR 1.3; 95% CI 1.0 to 1.6, \( P = 0.03 \)).

Table 2. Multiple logistic regression analyses (final models) of stroke outcomes and mortality

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Covariate</th>
<th>( P )</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death during hospital stay or discharge to nursing home</td>
<td>Very old age</td>
<td>0.0001</td>
<td>2.7</td>
<td>1.7–4.4</td>
</tr>
<tr>
<td></td>
<td>Stroke severity per 10 point</td>
<td>&lt; 0.0001</td>
<td>2.7</td>
<td>2.3–3.1</td>
</tr>
<tr>
<td></td>
<td>decrease</td>
<td></td>
<td>2.1</td>
<td>1.4–3.2</td>
</tr>
<tr>
<td></td>
<td>Pre-existing disability</td>
<td>0.0006</td>
<td>2.5</td>
<td>1.5–4.2</td>
</tr>
<tr>
<td></td>
<td>Stroke severity per 10 point</td>
<td>&lt; 0.0001</td>
<td>2.3</td>
<td>2.0–2.6</td>
</tr>
<tr>
<td></td>
<td>decrease</td>
<td></td>
<td>1.8</td>
<td>0.8–3.3</td>
</tr>
<tr>
<td></td>
<td>Ischaemic heart disease</td>
<td>0.07</td>
<td>3.9</td>
<td>2.1–7.3</td>
</tr>
<tr>
<td></td>
<td>Stroke severity per 10 point</td>
<td>&lt; 0.0001</td>
<td>1.9</td>
<td>1.7–2.3</td>
</tr>
<tr>
<td></td>
<td>decrease</td>
<td></td>
<td>2.2</td>
<td>1.2–3.8</td>
</tr>
<tr>
<td></td>
<td>Atrial fibrillation</td>
<td>0.006</td>
<td>2.8</td>
<td>1.8–4.3</td>
</tr>
<tr>
<td></td>
<td>Pre-existing disability</td>
<td>0.001</td>
<td>2.1</td>
<td>1.7–3.1</td>
</tr>
</tbody>
</table>

Values of significance, odds ratios, and its confidence intervals are given for covariates, which were in the final models. The value of correct classification for ‘death during hospital stay or discharge to nursing home’ was 88%, for ‘death during hospital stay’ 92%, and for ‘nursing home resident or death within 5 years after stroke’ 79%. Overall chi-squares for all models were <0.0001.

Figure 1. Kaplan-Meier cumulative survival plots for months after stroke onset. Vertical axis gives cumulative survival, horizontal axis gives number of months after stroke onset. Age groups: patients ≥85 years (broken line); patients <85 years (solid line); \( P < 0.001 \) (Log rank test). Numbers in brackets denote the number of survivors.
were significant that the frequencies of hypertension, diabetes, and smoking much in line with previous studies women comprised a shift from stroke caused by hypertensive arterial disease in the very old [2]. In accordance with our explanation for more severe strokes among the very old pre-existing disability. Hypertension and diabetes were less severe strokes, being female, having atrial fibrillation, and severity by a widely used and well-validated score system.

The life expectancy in the developed countries will increase in the years to come and the elderly will constitute a still larger part of the population. Hence, it will be still more important to be able to predict prognosis in the elderly stroke population.

Very old age was found to be associated with more severe strokes, being female, having atrial fibrillation, and pre-existing disability. Hypertension and diabetes were less often seen in the very old. The higher frequency of atrial fibrillation, a possible source of large emboli, may be one explanation for more severe strokes among the very old [15]. In accordance with our findings one study suggested that the more severe strokes among the very old were due to a shift from stroke caused by hypertensive arterial disease in the young towards cardioembolic strokes in the very old [2]. Much in line with previous studies women comprised a larger proportion of the very old in this study [3]. We found that the frequencies of hypertension, diabetes, and smoking were significantly lower among the very old stroke patients. This is most probably explained by a selection of patients without these risk factors reaching advanced age.

In the present study we measured short-term outcome in two different ways: discharge rate to nursing home, and in-hospital mortality. Very old age was a strong independent predictor of both outcomes. Apart from very old age other factors contributed to poor short-term outcome in this cohort of stroke patients. Factors such as onset stroke severity and pre-existing disability appear to be equally as important. These results are to some extent much in line with previous findings that the reasons for the poorer short-term prognosis in older stroke patients appear to be pre-stroke dependence and the severity of stroke rather than just older age per se [2–4]. In the Framingham study population that did not exclusively investigate very old aged, acute survival was influenced negatively as age increased when corrected for stroke type and severity [16]. Similar results for age specific short-term mortality were later found in other population-based studies [17, 18].

We found only one study of long-term mortality and very old age years after stroke in the existing literature [19]. In the Oxfordshire Community Stroke project older patients had a worse absolute survival, but the results were not adjusted for other basic characteristics. The Perth Community Stroke Study found age to be associated with increased mortality in a final multivariate model for death from any cause [5]. In the present study almost 10% of the patients aged ≥85 years were still alive and living in their own home 5 years after stroke onset. Furthermore, other factors such as onset stroke severity, atrial fibrillation, and pre-existing disability also seem to be independent predictors of long-term outcome. When looking exclusively at long-term mortality, the survival curve for the very old patients continued to have a steeper slope. But this is not just because of very old age per se. After adjustment for all factors, long-term survival also depends on onset stroke severity, and atrial fibrillation; findings that are much in line with those reported by Jamrozik et al. [5].

One major limitation of the present study is that we did not monitor factors such as recurrent strokes or other cardiovascular events between inclusion and follow-up. Second, we were not able to detect causes of mortality for those who died. And third, even though the total number of patients included was large, only 16% of our patients were ≥85 years at the time of stroke onset.

Overall, very old age is a strong and independent predictor of both short- and long-term prognosis. But the prognosis for very old aged stroke patients also depends largely on their pre-stroke medical condition and some may be as likely to benefit from treatment as the younger. The prognosis for the very old after stroke is not uniformly dismal; focus on the treatment of other factors may improve prognosis.

### Key points
- Clinical characteristics and risk factor profile among very old stroke patients.
- The prognostic significance of being ‘very old’.
- Short- and long-term prognosis for very old stroke patients.

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Effects of ageing on gastrointestinal motor function

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Abstract

Background: existing data on the effect of ageing on gastrointestinal motility are few. In this study, we assessed the propulsive effect of all main segments of the gastrointestinal tract in a group of healthy older people.

Methods: 16 healthy volunteers (eight women, eight men) of mean age 81 years (range 74–85 years) participated in the study. Gastric emptying and small intestinal and colonic transit rates were determined by gamma camera technique. The

References


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