Stroke in Lund-Orup, Sweden
Improved Long-Term Survival Among Elderly Stroke Patients

Björn Hallström, MD; Bo Norrving, MD; Arne Lindgren, MD

**Background and Purpose**—Several studies report declining early stroke case fatality, but the findings are not consistent across geographic areas. Corresponding changes in long-term survival are less well documented. We recently reported increased stroke incidence among patients aged <75 years and stable incidence among older persons. We now report temporal trends for early and late case fatality among patients with stroke onset during 1983–1985 and 1993–1995.

**Methods**—Patients living within the Lund-Orup, Sweden, hospital district and fulfilling the diagnostic criteria for first-ever stroke during 1983–1985 (n=998) and 1993–1995 (n=1318) were followed up concerning survival status at 28 days, 1 year, and 3 years. Age and sex adjustments were performed. The possible influence of Oxfordshire Community Stroke Project (OCSP) stroke subtypes on survival was also analyzed.

**Results**—Overall survival improved between the study periods (Cox proportional hazards regression: hazard ratio, 0.84; 95% confidence limits, 0.75 to 0.94; P=0.0019). The 28-day case fatality was 15% for stroke patients from both study periods. One-year case fatality was 31% for 1983–1985 patients and 27% for 1993–1995 patients. The corresponding figures at 3 years were 44% and 40%, respectively. In the group aged <75 years, there were no significant changes in overall survival, but survival improved significantly among patients aged ≥75 years beyond 28 days after stroke onset. OCSP stroke subtype was an independent predictor of death (P<0.0001).

**Conclusions**—The recently observed increase in stroke incidence among patients aged <75 years was not accompanied by changing survival in that age group. However, among patients aged ≥75 years, survival improved beyond 28 days after stroke. The causes of this change in survival are unknown but may be related to improved long-term care of elderly stroke patients. (*Stroke*. 2002;33:1624-1629.)

**Key Words:** elderly ■ epidemiology ■ stroke ■ survival ■ Sweden

During the last decades, the mortality of stroke has declined in many countries.1–4 This might be explained by either decreasing incidence of stroke or decreasing case fatality of stroke. We previously reported an increased incidence rate of stroke in Lund-Orup, Sweden, during 1983–1985 and 1993–1995.5 This increase was confined to persons aged <75 years, whereas no significant incidence change was observed for patients aged ≥75 years. This study reports survival with a minimum follow-up of 3 years to determine whether the observed changes in incidence rates were accompanied by changes in survival.

**Subjects and Methods**

**Study Area and Population**
The total population within the hospital district of Lund-Orup consisted of 200 191 inhabitants on December 31, 1983, and 224 126 inhabitants on December 31, 1993, according to official population statistics. The proportion of inhabitants aged ≥75 years was 6.1% in 1983 and 6.6% in 1995. In Lund-Orup 13.8% of the population was ≥65 years in 1995, and in the European Union the corresponding figure was 15.9%.6 The fertility rate was 1.59 (Lund) and 1.85 (Orup) in 1983–1985 and 1.65 (Lund) and 2.02 (Orup) in 1993–1995. During 1983–1985, 31 053 persons moved away and 32 077 moved into Lund-Orup. During 1993–1995, the corresponding figures were 38 898 and 43 181, respectively. Life expectancy figures are similar to those for Sweden in general.

There is only 1 emergency hospital within the area. Acute stroke patients in our hospital district are predominantly treated within the Department of Neurology at Lund University Hospital. There is a strong tradition of in-hospital care of acute stroke patients in Lund-Orup as well as in Sweden in general.7

**Case Ascertainment**
The methods for detecting patients with first-ever stroke have been described previously.8 Stroke was defined according to the World Health Organization stroke definition as rapidly developing signs of focal (or global) disturbance of cerebral function, lasting ≥24 hours or leading to death, with no apparent nonvascular cause.8 Patients aged ≥15 years living within the hospital district of Lund-Orup at the onset of first-ever stroke between January 1, 1983, and December 31, 1985, or between January 1, 1993, and December 31, 1995, were included in the study. The authors retrieved (B.H.) and individually scrutinized (A.L.) the medical records for patients admitted to the departments of neurology, neurosurgery, and internal medicine, with the diagnoses 430 to 438 (according to the *International Classification of Diseases, Ninth Revision*), to determine whether the patients had suffered from first-ever stroke. The diagnoses screened include...
transient ischemic attack (435) and late effects of cerebrovascular disease (438). At the Department of Neurology, where most patients were treated (during 1993–1995: 87.7%), patients were evaluated at least twice: first at admission and then the next day by a senior neurologist. In our institutional-based study we also screened medical records at the departments of pathology and forensic medicine for possible stroke diagnoses. If it was unclear whether the patient had prior stroke, medical records for earlier hospital treatments were scrutinized to exclude that. Only first-ever-in-a-lifetime strokes were included in the study. In total, 4463 patients with possible stroke were screened. There were 998 patients (519 men and 479 women) in 1983–1985 and 1318 (680 men and 638 women) in 1993–1995.5

Survival status of the patients was determined from the Swedish population register during mid-1999. The exact dates of death were unknown for 19 patients who died within 28 days. These patients were randomly assigned a survival time within that time span.

### Stroke Classification

Patients fulfilling the diagnostic criteria for first-ever stroke were classified into main stroke types as having cerebral infarction (CI), intracerebral hemorrhage (ICH), subarachnoid hemorrhage (SAH), or undetermined pathological type.5 Patients with CI, ICH, or undetermined pathological type were classified according to the Oxfordshire Community Stroke Project (OCSP) classification system, as having lacunar syndrome (LACS), total anterior circulation syndrome (TACS), partial anterior circulation syndrome (PACS), or posterior circulation syndrome (POCS).5,9 For patients with medical records that were incomplete to determine the OCSP subtype, the subtype was classified as unknown.

### Statistical Methods

Case fatality at 28 days, 1 year, and 3 years was calculated in relation to sex, age group, main type of stroke, OCSP stroke subtype, and study period. Day 0 was defined as the day of stroke onset. A Kaplan-Meier graph was calculated to show the cumulative survival up to 3 years after stroke onset for both study periods and also for the groups aged <75 years and ≥75 years. The cutoff point at 75 years was chosen because this represents approximately the median age for the stroke patients in our study.5 The log-rank test was used to examine whether there were survival differences between the 2 periods. To test whether the estimated difference in the risk of dying after stroke was confounded by different distributions of age group (15 to 34, 35 to 54, 55 to 74, 75 to 84, and ≥85 years), sex, and OCSP subtype, we performed a Cox proportional hazards regression analysis, stratifying for those factors. Hazard ratios with 95% confidence limits (CL) were shown. The \( \chi^2 \) test was used for comparison of survival outcome for categorical variables. The Statistical Product and Service Solutions (SPSS) software package was used for statistical analysis. A value of \( P<0.05 \) was considered statistically significant.

### Results

Three years after stroke onset, 408 of the 936 patients (44%) having stroke during 1983–1985 and 525 of 1318 patients (40%) with stroke during 1993–1995 had died. The case-fatality at 28 days, 1 year, and 3 years in relation to different variables are shown in Table 1. The 28-day case fatality was unchanged between the periods, but the case-fatality at 1 year and 3 years declined somewhat. The Cox proportional hazards regression analyses are shown in Table 2. One main finding was that the survival after stroke improved significantly for patients having stroke during 1993–1995. Women had higher survival than men did. As expected, the survival was worse in the older age groups, and it differed between the

### Table 1. Case Fatality at 28 Days, 1 Year, and 3 Years in Relation to Different Variables (1983–1985 and 1993–1995)

<table>
<thead>
<tr>
<th>Variable</th>
<th>28 d</th>
<th>1 y</th>
<th>3 y</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>151/1199</td>
<td>12.6</td>
<td>289/1167</td>
</tr>
<tr>
<td>Women</td>
<td>205/1117</td>
<td>18.4</td>
<td>351/1087</td>
</tr>
<tr>
<td>Age group, y</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;75</td>
<td>100/1075</td>
<td>9.3</td>
<td>173/1050</td>
</tr>
<tr>
<td>≥75</td>
<td>256/1241</td>
<td>20.6</td>
<td>467/1204</td>
</tr>
<tr>
<td>OCSP subtype (SAH excluded)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TACS</td>
<td>225/543</td>
<td>41.4</td>
<td>321/532</td>
</tr>
<tr>
<td>PACS</td>
<td>45/771</td>
<td>5.8</td>
<td>161/753</td>
</tr>
<tr>
<td>LACS</td>
<td>7/569</td>
<td>1.2</td>
<td>54/566</td>
</tr>
<tr>
<td>POCS</td>
<td>35/301</td>
<td>11.6</td>
<td>64/301</td>
</tr>
<tr>
<td>Unknown</td>
<td>16/40</td>
<td>40.0</td>
<td>7/10</td>
</tr>
<tr>
<td>Main type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CI</td>
<td>152/1421</td>
<td>10.7</td>
<td>302/1398</td>
</tr>
<tr>
<td>ICH</td>
<td>73/237</td>
<td>30.8</td>
<td>95/231</td>
</tr>
<tr>
<td>SAH</td>
<td>28/92</td>
<td>30.4</td>
<td>33/92</td>
</tr>
<tr>
<td>UND</td>
<td>103/566</td>
<td>18.2</td>
<td>210/533</td>
</tr>
<tr>
<td>Period</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1983–1985</td>
<td>154/998</td>
<td>15.4</td>
<td>290/936</td>
</tr>
</tbody>
</table>

UND indicates undetermined pathological type; No., number of deaths/total number of patients.
Sixty-two patients were lost to follow-up at 1 year and 3 years.
different OCSP subtypes, with significantly worse prognosis in the TACS group.

Figure 1 shows a Kaplan-Meier graph estimating the cumulative survival during the first 3 years after stroke onset for patients from both study periods. The survival was better during the latter period ($P=0.0013$, log-rank test). The improvement of case fatality noted between the 2 time periods was also statistically significant after adjustment for age, sex, and OCSP subtype of stroke, as shown in Table 2.

We also made Kaplan-Meier graphs for the 2 groups aged $<75$ years and $\geq 75$ years (Figure 2), showing that the improved survival was confined to the elderly patients ($P=0.0018$, log-rank test in the group aged $\geq 75$ years; $P=0.29$, log rank test in the group aged $<75$ years). The change among patients aged $\geq 75$ years remained statistically significant after adjustment for age, sex, and OCSP subtype (hazard ratio, 0.80; 95% CI, 0.70 to 0.92; $P=0.001$, Cox proportional hazards regression), whereas for patients aged $<75$ years the corresponding hazard ratio was 0.95 (95% CI, 0.77 to 1.17; $P=0.65$). The change in survival among patients aged $\geq 75$ years was confined to the period beyond 28 days after stroke onset (data not shown).

Sixty-two patients were lost to follow-up during the first study period and excluded from the case fatality analyses beyond 28 days, although they were included in Cox proportional hazards regression analyses. These patients with first-ever stroke during 1983–1985, whose personal code numbers were not registered, constituted 6.2% of the patients during 1983–1985. Among these patients, 31% had died within 28 days (median age, 82 years; range, 60 to 94 years; 3 patients aged $<75$ years and 16 patients aged $\geq 75$ years). The 43 patients surviving at 28 days had a median age of 74 years, ranging from 56 to 88 years.

### Main Types of Stroke in 1993–1995

The proportion of patients undergoing CT, MRI, or autopsy was 57% during 1983–1985 and 90% during 1993–1995. The 28-day case fatality in 1993–1995 was 11% for CI, 29% for ICH, 32% for SAH, and 22% for undetermined pathological type. At 1 year the corresponding figures were 22%, 41%, 37%, and 41% and at 3 years 35%, 53%, 41%, and 61%, respectively. In a univariate analysis, the case fatalities differed significantly between the different main types of stroke ($P<0.0001$, $\chi^2$ test).

### OCSP Subtypes and Case Fatality

There were no significant changes among the OCSP stroke subtypes in case fatality between the 2 study periods except

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**TABLE 2. Cox Proportional Hazards Regression Analysis on Survival for the 2316 Patients Included in the Study**

<table>
<thead>
<tr>
<th>Hazard Ratio</th>
<th>95% CI</th>
<th>$P^*$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td>0.012</td>
</tr>
<tr>
<td>Men</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>0.87</td>
<td>0.78 to 0.97</td>
</tr>
<tr>
<td>Age group</td>
<td></td>
<td>$&lt;0.0001$</td>
</tr>
<tr>
<td>15–34</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>35–54</td>
<td>2.29</td>
<td>0.54 to 9.56</td>
</tr>
<tr>
<td>55–64</td>
<td>4.02</td>
<td>0.98 to 16.4</td>
</tr>
<tr>
<td>65–74</td>
<td>11.0</td>
<td>2.72 to 44.2</td>
</tr>
<tr>
<td>75–84</td>
<td>18.2</td>
<td>4.52 to 73.1</td>
</tr>
<tr>
<td>$\geq 85$</td>
<td>34.8</td>
<td>8.61 to 140.2</td>
</tr>
<tr>
<td>OCSP subtype and SAH</td>
<td></td>
<td>$&lt;0.0001$</td>
</tr>
<tr>
<td>TACS</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>PACS</td>
<td>0.46</td>
<td>0.40 to 0.52</td>
</tr>
<tr>
<td>LACS</td>
<td>0.32</td>
<td>0.27 to 0.37</td>
</tr>
<tr>
<td>POCs</td>
<td>0.41</td>
<td>0.33 to 0.49</td>
</tr>
<tr>
<td>Unknown</td>
<td>1.08</td>
<td>0.65 to 1.79</td>
</tr>
<tr>
<td>SAH</td>
<td>0.82</td>
<td>0.58 to 1.15</td>
</tr>
<tr>
<td>Period</td>
<td></td>
<td>0.0019</td>
</tr>
<tr>
<td>1983–1985</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>1993–1995</td>
<td>0.84</td>
<td>0.75 to 0.94</td>
</tr>
</tbody>
</table>

*$P$ values denote the simultaneous individual effect of the different covariates (sex, age group, OCSP subtype and SAH, and period).
declining 3-year case fatality for POCS. In a univariate analysis, the case fatalities differed significantly between the different OCSP stroke subtypes \( (P<0.0001, \chi^2 \text{ test}) \). As mentioned before, the case fatality was significantly higher for patients with TACS.

**Discussion**

In the present study we found that the overall survival for patients with stroke onset between 1983–1985 and 1993–1995 improved, independently of changes in age, sex, and OCSP subtype distribution of stroke. Surprisingly, this decrease in case fatality was confined to patients aged \( \geq 75 \) years, whereas among patients aged \(<75 \) years the case fatality was stable. However, the change in case fatality among patients aged \( \geq 75 \) years was not explained by increased stroke survival during the first month. It was mainly the survival beyond the first month that improved.

One possible explanation for the increased survival could be the introduction of a stroke unit at our hospital. Stroke units have been reported to increase short-term as well as long-term survival after stroke.\(^\text{10}\) It has also been shown that stroke units lower case fatality in routine clinical practice.\(^\text{11}\) At Lund University Hospital, stroke unit care was introduced in 1991, ie, between the 2 time periods we have studied. However, it is noteworthy that no change in survival was noted during the first month and that the increased survival was not seen in the younger age group. This might indicate that the stroke unit care did not influence stroke survival, but another possible explanation is that stroke care at Lund University Hospital before 1991 had much in common with the principles for stroke care in a stroke unit. The strategies for secondary stroke prevention have also changed over the studied period. Trials have shown the benefit of antiplatelet therapy after ischemic stroke,\(^\text{12}\) anticoagulation for patients with atrial fibrillation,\(^\text{13}\) antithyptensive treatment in elderly patients,\(^\text{14}\) and carotid endarterectomy in symptomatic patients with high-grade carotid stenosis.\(^\text{15,16}\) It would be interesting to know the cause of death among the patients in our study as well as the functional outcome among the survivors, but these data are not available. Short-term case fatality might be seen as an indirect indicator of stroke severity.\(^\text{17}\) In our study the finding of unchanged 28-day case-fatality might indicate unchanged severity of stroke between the 2 study periods.

**Comparisons With Other Studies**

The 28-day and 1-year case fatalities in Lund-Orup are low compared with other studies (based on unadjusted figures). In other studies during the 1990s, the total 28-day (or 30-day) case fatality of first-ever stroke (all ages) has been reported to be between 13% and 34%.\(^\text{18–33}\) and the corresponding figure for the total 1-year case fatality is between 27% and 41%.\(^\text{19,21,26,29,31–33}\) Three-year case fatality has been reported to be 43% to 50%.\(^\text{34,35}\) Much of the differences in case fatality can probably be explained by differences between studies regarding age distribution of the studied stroke patients. The proportion of patients \( \geq 75 \) years of age in other studies ranged from 20% to 64%.\(^\text{18,23}\) Such large differences in age structure may strongly influence the case fatality. When compared with other studies (see overview of Marini et al\(^\text{36}\)), our study population is older than some other study populations (Dijon, Auckland, Rochester, Oxfordshire) and similar to others (Perth, Aosta). There are also other studies with older study populations (Belluno, Umbria, L’Aquila, Innherred, and Frederiksberg). When incidence studies are compared, it is therefore important to adjust to different age and sex distributions. As noted in the aforementioned article, age and sex adjustments do not completely eliminate these differences. Differences in age structure are, however, probably not the only reason why the case fatalities in the various studies differ. Other possible explanations are incomplete case ascertainment and differences in stroke severity. There are also indications of differences between countries concerning stroke management and use of secondary preventive therapies that might influence the case fatalities in different studies.\(^\text{32}\)

Time trends of case fatality have shown different results. In Finland,\(^\text{37}\) Göteborg (Sweden),\(^\text{38}\) Auckland (New Zealand),\(^\text{20}\) Tartu (Estonia),\(^\text{27}\) and Shanghai (China)\(^\text{39}\) and in the Northern Sweden MONICA Project,\(^\text{40}\) decreasing 28-day case fatalities have been reported. However, stable or increasing 28-day case fatalities have been reported in Rochester (Minnesota)\(^\text{41}\) during 1980–1984 and 1985–1989, Söderhamn (Sweden),\(^\text{42}\) Kaunas (Lithuania),\(^\text{43}\) and Novosibirsk (Russia).\(^\text{24}\) Long-term survival improved in the Northern Sweden MONICA Project,\(^\text{44}\) and similar results have been reported from Finland\(^\text{29}\) and Denmark.\(^\text{33}\) Long-term survival also improved in Söderhamn (Sweden)\(^\text{45}\) and in the Minnesota Heart Survey.\(^\text{46}\) However, no significant short- or long-term trend was seen in Rochester (Minnesota) during 1975–1989.\(^\text{47}\)

The 28-day (or 30-day) and 1-year case fatality of the different main types of stroke varied between studies during the 1990s. Twenty-eight day (or 30-day) case fatality has been reported to be 11% to 26% for CI, 22% to 57% for ICH, 8% to 54% for SAH, and 31% to 82% for undetermined pathological type.\(^\text{21,23,25,26,28,29,35,48}\) One-year case fatality has been reported to be 30% to 32% for CI, 36% to 58% for ICH, 38% to 58% for SAH, and 46% to 88% for undetermined pathological type.\(^\text{21,26,29}\) The corresponding case fatalities in Lund-Orup were within the lower range compared with most other studies. As mentioned above, variations in case fatality may depend partly on differences in age structure of the studied stroke populations, but differences in case ascertainment and stroke severity probably also contribute to those differences. The case fatalities (28 or 30 days and 1 year) for the different OCSP subtypes in Lund-Orup were comparable to other studies.\(^\text{9,49}\)

**Methodological Aspects**

There may be some potential sources of error in this retrospective and institutional-based study. Theoretically, a higher hospitalization rate of milder strokes during the latter period might have resulted in decreasing case fatality trends. However, it has been estimated that <5% of all first-ever stroke survivors in Sweden are treated out of hospital (for review, see Norris’), and between the 2 study periods there were no major changes in hospital admission policy in Lund-Orup.\(^\text{5}\) We did not screen routinely for nonhospitalized stroke
patients in our study. Because full coverage of every single possible nonhospitalized stroke patient was not performed, it is thus possible that some of these patients may have remained undetected (eg, patients with sudden fatal stroke that were not subject to autopsy). However, according to Swedish regulations, autopsy should be performed in cases of sudden death without known cause occurring outside hospital. Therefore, we believe that we detected most cases of sudden fatal stroke, using our method of screening possible stroke diagnoses at the departments of pathology and forensic medicine. We believe that the number of undetected patients was low and did not influence our results more than marginally.

Survival status was obtained 6 months after the end of follow-up, ie, in mid-1999. We believe that the Swedish population register is sufficiently accurate after this time because death certificates must be sent in without delay to the authorities according to official Swedish regulations.

In part, increased long-term survival may reflect an improved survival in the general population that has occurred during the last decades in Sweden as well as in most other countries. The relative contribution of this factor for patients with stroke is unknown and needs to be addressed in future studies.

The 62 patients during 1983–1985 lost to follow-up had higher short-term case fatality, and they may have had higher long-term case fatality as well. However, this would not influence the main results of the present study.

In conclusion, the recently reported increase in stroke incidence among patients aged <75 years was not accompanied by changes in case fatality in that age group. However, among patients aged ≥75 years, the survival after first-ever stroke increased. The reasons for this change are unknown but may be related to an improved long-term care of elderly stroke patients.

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