Survival After Stroke and Transient Ischemic Attacks During the 1970s and 1980s

Andreas Terent, MD, PhD

Survival after stroke and transient ischemic attack was studied in Soderhamn, Sweden, during the periods 1975-1979 and 1983-1987; 640 patients with first-ever stroke and 97 with first-ever transient ischemic attack were registered and followed for 1–3 years. Approximately 90% of the patients were treated in the Department of Internal Medicine of Soderhamn Hospital. The protocols for physical rehabilitation and antithrombotic treatment changed between study periods. Between periods, 3-year survival after stroke increased by 16% (p<0.003). The 95% confidence intervals of the relative survival rates were 0.524–0.648, 0.435–0.567, and 0.337–0.475 at 1, 2, and 3 years, respectively, during the first period and 0.616–0.728, 0.600–0.732, and 0.576–0.748 during the second period. Fewer patients suffered fatal complications of stroke during the second period. The rate of stroke recurrence was approximately 10%/year during both study periods. Four patients suffered fatal hemorrhages during the first period, but no patient did so during the second period. Observed survival after transient ischemic attack did not differ from that expected in the first 2 years of follow-up during either study period. The risk for stroke after transient ischemic attack was approximately 5%/year during both periods. The higher survival rates after stroke during the second period seems to be the result of fewer fatal complications rather than of a reduced risk for recurrent stroke. (Stroke 1989;20:1320–1326)

The chance of surviving after stroke is a complex function of the brain lesion per se and of many other complicating factors. The size and location of a cerebral lesion and the general vascular status of the patient (including the function of the heart) have an impact on the immediate prognosis. Furthermore, associated diseases other than cardiac and complicating disorders (e.g., thromboembolism and infections) reduce short-term survival. Age and social factors also influence long-term prognosis. Consequently, secular trends in survival after stroke are best studied from an epidemiologic perspective. Very few such studies have been presented so far. I compare survival among all men and women in Soderhamn, Sweden, who suffered a first-ever stroke or transient ischemic attack (TIA) during the 1970s and the 1980s based on an ongoing epidemiologic study of stroke and TIA in this community. Complete case finding was ensured during both periods by informing all doctors in Soderhamn about the study and by asking them to send all cases of suspected stroke or TIA (regardless of history) to Soderhamn Hospital. There were eight general practitioners during the first and 10 during the second period. During the first period, 89% of the stroke patients were registered in Soderhamn Hospital compared with 95% during the second period. The corresponding rates for TIA patients were 82% and 84%, respectively. Most stroke patients (87.6% during the first and 90.8% during the second period) were initially treated at the Department of Internal Medicine (Table 1). A special registry nurse traced cases of stroke and TIA once a week in all institutions in the area. All death certificates were also scrutinized.
A nonintensive stroke unit was established at the Department of Internal Medicine between the study periods. The primary goal of this unit was to start rehabilitation during the acute phase of stroke in order to restore functional abilities as quickly as possible and to prevent complications. The major changes in the care of the patients implemented between the study periods are summarized in Table 2.

The protocol for antithrombotic therapy used during the first period was based on the recommendations of the Joint Committee for Stroke Facilities. The protocol was revised in 1980 to reduce the risk of serious hemorrhagic complications that occurred during warfarin treatment in the 1970s. The duration of anticoagulant treatment was shortened except in patients with valvular heart diseases (Table 3). In patients >75 years old, warfarin was replaced by antiplatelet therapy (0.5 g aspirin once daily). TIA patients underwent lumbar puncture before treatment with warfarin or aspirin. Intracranial hemorrhage was excluded by lumbar puncture during the first period and by CT during the second period in patients with minor stroke or possible embolism.

Postmortem examination was performed in 24% of the deceased during the first and in 31% during the second period.

For the first and second periods, observed survival was calculated for 1 and 3 years, respectively, by means of the actuarial (life table) method; I assumed that patients who were withdrawn alive during an interval were withdrawn (censored) in the middle of that interval. No patient was observed for <1 year. Life tables were also calculated for the risk of having a stroke during follow-up; I assumed that patients who died during an interval were censored in the middle of that interval. Survival curves for the two periods were performed by calculating the standard error of the cumulative chance of surviving. Stroke-specific mortality was estimated by calculating the relative survival, which is the ratio between the observed survival in the patient group and the expected survival in the general population, obtained from Swedish population tables by 5-year age groups and calendar year.

**Results**

Six-hundred forty patients with first-ever stroke and 97 patients with first-ever TIA were registered and followed for 1–3 years. The mean age of the men with stroke was 71.1 years during the first and 73.1 years during the second period; the corresponding figures for women were 75.4 and 76.8. The mean age of men with TIA rose from 67.7 to 71.2 years and that of women rose from 66.7 to 75.0 years between the study periods.

**Table 2.** Changes in Care of Stroke Patients Between Study Periods

<table>
<thead>
<tr>
<th>Change</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediate mobilization</td>
<td>Sitting in a chair (excluding cases of subarachnoid hemorrhage).</td>
</tr>
<tr>
<td>Flat bed</td>
<td>No tilting of whole or any part of bed when patient rests supine.</td>
</tr>
<tr>
<td>Resting positions</td>
<td>Paretic arm is stretched when patient rests on both flaccid and on motorically active side. Leg in contact with bed is always stretched, irrespective of which side is paretic; upper leg is semiflexed.</td>
</tr>
<tr>
<td>Urinary tract</td>
<td>No catheter except in case of urologic disease. Toilet training. Diaper when necessary.</td>
</tr>
<tr>
<td>Oral feeding</td>
<td>No intravenous fluids except in cases of clinical dehydration with normal or almost-normal level of consciousness. No tube feeding.</td>
</tr>
<tr>
<td>Mouth</td>
<td>Intensive treatment of oral fungal infections and affected swallowing reflexes.</td>
</tr>
</tbody>
</table>

**Table 3.** Design of Long-term Antithrombotic Treatment in Patients With First-Ever Stroke or Transient Ischemic Attack

<table>
<thead>
<tr>
<th>Study period</th>
<th>Duration</th>
<th>Warfarin</th>
<th>Aspirin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke (n=640)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1975–1979</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Embolic stroke</td>
<td>Unlimited</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Minor stroke</td>
<td>Unlimited</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>1983–1987</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minor stroke</td>
<td>3 months</td>
<td>Unlimited</td>
<td>—</td>
</tr>
<tr>
<td>Cardiac embolism</td>
<td>Unlimited</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transient ischemic attack (n=97)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1975–1979</td>
<td>2 years</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>1983–1987</td>
<td>3 months</td>
<td>Unlimited</td>
<td>—</td>
</tr>
</tbody>
</table>

No patient received aspirin during first period.
The proportion of stroke patients treated with warfarin did not change between study periods (17% during the first and 18% during the second). The use of warfarin decreased, however, from 11% to 2% in patients aged ≥75 years and increased from 24% to 42% in younger patients. During the first period, 57% of the TIA patients were treated with warfarin compared with 47% during the second period. No patient received aspirin during the first period. During the second period, aspirin was used in 16% of the stroke patients and in 21% of the TIA patients. In total, antithrombotic therapy of some kind was used in 17% of the stroke patients during the first and in 33% during the second period; the corresponding figures for TIA patients were 64% and 68%, respectively.

Observed survival of stroke patients increased between study periods (Figure 1); relative survival also increased (Table 4; $z=1.99$, $p=0.047$ 1 year after the event; $z=3.43$, $p<0.003$ 2 years after the event; and $z=4.55$, $p<0.003$ 3 years after the event). Observed survival of TIA patients 1 year after the event decreased during the second period (Figure 1); relative survival rates, on the other hand, did not show excess mortality 2 years after the event (Table 4). For both periods, mortality was slightly, but equally, raised 3 years after the event.

The chance of surviving 1 month after the stroke did not change between periods (Figure 2). Thereafter, there was a tendency to increasing survival, predominantly in men, during the second period. Looking at this question in more detail, men aged <75 years and treated from the onset at the Department of Internal Medicine of Söderhamn Hospital had significantly increased survival from the second month on ($z=2.44$, $p=0.015$; Figure 3). Survival for men ≥75 years old ($z=2.45$, $p=0.015$) and women ≥75 years old ($z=2.19$, $p=0.029$) also improved from the fourth month. For stroke patients referred to long-stay wards, survival for men also increased significantly ($z=2.34$, $p=0.020$) from the fourth month on; survival for women also increased from the second month on ($z=2.18$, $p=0.029$; Figure 4). The 1-year survival of men not initially treated at the Department of Internal Medicine was 63% during the first and 67% during the second period. The corresponding figures for women were 69% and 61%, respectively. In summary, the net increase in 1-year survival was 15.4% for men and 5.5% for women between periods. The main part of this

<table>
<thead>
<tr>
<th>Study period</th>
<th>Mean 1 yr</th>
<th>95% CI</th>
<th>Mean 2 yr</th>
<th>95% CI</th>
<th>Mean 3 yr</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke (n=640)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1975–1979</td>
<td>0.586</td>
<td>0.524–0.648</td>
<td>0.501</td>
<td>0.435–0.567</td>
<td>0.494</td>
<td>0.337–0.475</td>
</tr>
<tr>
<td>1983–1987</td>
<td>0.672</td>
<td>0.616–0.728</td>
<td>0.666</td>
<td>0.600–0.732</td>
<td>0.662</td>
<td>0.576–0.748</td>
</tr>
<tr>
<td>Transient ischemic attack (n=97)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1975–1979</td>
<td>1.009</td>
<td>0.962–1.056</td>
<td>0.972</td>
<td>0.873–1.071</td>
<td>0.859</td>
<td>0.722–0.996</td>
</tr>
<tr>
<td>1983–1987</td>
<td>0.933</td>
<td>0.842–1.024</td>
<td>0.939</td>
<td>0.828–1.050</td>
<td>0.797</td>
<td>0.627–0.967</td>
</tr>
</tbody>
</table>

CI, confidence interval.
Improved Survival After Stroke

Terent

Graph of observed survival of stroke patients (135 men and 111 women) initially treated at Department of Internal Medicine of Soderhamn Hospital during first study period (1975–1979; solid lines) compared with survival of 145 men and 181 women so treated during second study period (1983–1987; dashed lines). *p<0.05, **p<0.01, significant difference between periods by life table analysis.

increase, (9.9% for men and 1.5% for women) was attributable to the improved prognosis for patients treated only at the Department of Internal Medicine. Patients eventually treated on long-stay wards contributed to the increase in survival by 4.0% for men and 3.6% for women, and men and women not treated at any of these wards contributed 1.5% and 0.4%, respectively.

Cerebral dysfunction was the most common cause of death during the first year after stroke and increased in importance as the number of other causes decreased (Table 5). Heart failure was the second most common cause of death (approximately 30%), and bronchopneumonia (approximately 10%) was the third. Pulmonary embolism and malignancies each caused death in ≤5% of the patients during both study periods. Septicemia and gangrene were the causes of death in 7.5% of the patients during the first but in no patient during the second period. The causes of death were about the same in the 24 TIA patients who died; 70% died of cerebrovascular causes during both periods, approximately 20% from malignancies, and the rest from pulmonary embolism or renal failure.

During the first period, 57 stroke patients (20%) experienced another stroke; 60 (17%) did so during the second period. Stroke recurrence rate was approximately 10%/year during both periods (Figure 5). The stroke recurrence rate in the first year after the event was significantly lower during the second period than during the first ($z=2.801$, $p=0.005$), but this difference did not persist at 2 and 3 years after the event. The risk of a future stroke was somewhat lower in the 97 TIA patients (Figure 5). Eight of 44 (18%) were affected during the first period compared with seven of 53 (13%) during the second.

Four fatal hemorrhages (three intracranial) occurred during the first period, but none occurred during the second.

Discussion

The observed improvement in survival after stroke may be due to changes in hospital admission practices, in physical rehabilitation, in medical therapy, or simply to bias. Regarding the latter possibility, my studies was performed in a well-defined population using identical diagnostic criteria and methods of tracing of patients during both periods. This should have minimized the possibility of including uncertain cases. Also, the chance of missing some patients with only slight stroke symptoms was thought to be reduced as far as possible by this strategy. However, the latter period included more women. If more patients with slight symptoms were included during the second period, it would
seem remarkable that mortality during the first month, when large brain lesions contribute to most deaths,1,2 was the same for both periods. Also, the improvement from 2 months on should have appeared in women and not in men if inclusion bias had been an explanatory factor.

The change in hospital admission practices was minimal and contributed to only 1% of the overall improvement of survival, which was 9–16%. The observed improvement is modest compared with that found in Rochester, Minnesota.13 In that study, between 1945–1949 and 1975–1979 the 30-day survival rate following cerebral hemorrhage improved from 0% to 42% and the 7-year survival following cerebral infarction improved from 22% to 40%. In my study, no division into diagnostic subgroups was performed as CT was introduced between the periods and is known to have an impact on the observed incidence of cerebral hemorrhage.21 Both the Rochester study13 and mine show that improvement was most pronounced in patients aged >75 years. In my study the survival rate for younger men also improved, but only up to the rate for women during the first period.

Caution is warranted when comparing survival rates of different stroke populations. Figures based on epidemiologic studies (like this one) including patients suffering sudden death from stroke show higher mortality rates than other studies.22 The mean age of the patients also determines prognosis. In my study the higher mean age of the TIA patients during the second period was accompanied by a decrease in the observed survival but not in the relative survival, the latter taking changes in the expected survival into account.

The major improvement in survival occurred between 2 and 6 months after stroke. During this interval, cardiac and pulmonary complications are known to be as common as cerebrovascular ones as causes of death.2-9 In my study, the relative importance of fatal complications decreased between the two periods.

The physical rehabilitation of patients changed between study periods. A new strict protocol was introduced, the aim of which was to minimize complications by almost instantly starting mobilization and oral feeding. It is hard to claim that this program alone caused the observed improvement, though the major part of the improvement was ascribed to treatment in the Department of Internal Medicine. In a controlled study of the impact of a nonintensive stroke unit on outcome after stroke, mortality was equally high in this unit and in control wards after 1 year23; very early rehabilitation was a main feature of that trial. In another study of early activation, the 1-month and 1-year mortalities were 10% and 5% lower, respectively, in the experimental group. The number of patients was too small, however, for significance to be reached.24-25 Pulmonary embolism and pneumonia were not actively prevented in my study, and occurred as infrequently as in other trials.2-26 It may be reasonable to assume, however, that the elimination of septicemia and gangrene as causes of death may be due to the more active therapy (predominantly physiotherapy and avoidance of urinary catheters) during the early phase after stroke.

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**Table 5.** Cause of Death During First Year After Stroke in 640 Patients

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Cerebral dysfunction</td>
<td>28</td>
<td>42%</td>
<td>24</td>
<td>54.5%</td>
</tr>
<tr>
<td>Heart failure</td>
<td>19</td>
<td>29%</td>
<td>13</td>
<td>29.5%</td>
</tr>
<tr>
<td>Bronchopneumonia</td>
<td>9</td>
<td>14%</td>
<td>6</td>
<td>14%</td>
</tr>
<tr>
<td>Pulmonary embolism</td>
<td>2</td>
<td>3%</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Septicemia</td>
<td>3</td>
<td>4.5%</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Gangrene</td>
<td>2</td>
<td>3%</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>Malignancies/other</td>
<td>5</td>
<td>7.5%</td>
<td>4</td>
<td>7.5%</td>
</tr>
<tr>
<td>Total</td>
<td>66</td>
<td>100%</td>
<td>44</td>
<td>100%</td>
</tr>
</tbody>
</table>

Caution is warranted when comparing survival rates of different stroke populations. Figures based on epidemiologic studies (like this one) including patients suffering sudden death from stroke show higher mortality rates than other studies.22 The mean age of the patients also determines prognosis. In my study the higher mean age of the TIA patients during the second period was accompanied by a decrease in the observed survival but not in the relative survival, the latter taking changes in the expected survival into account.

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Antithrombotic therapy was more widely used in Söderhamn during the second period than during the first. The use of warfarin increased in younger and decreased in elderly patients, in whom warfarin was more or less replaced by aspirin. The change in protocol and the use of CT scanning in those treated with warfarin was accompanied by the reduction of fatal complications to an acceptable level.

The 3-year risk of stroke recurrence did not change, however, which means that more patients were receiving therapy (mainly aspirin) when stroke recurred. The average risk of stroke recurrence was 10%/year, approximately that in two other reports but much higher than that in a third.

The stroke population of the third study was much younger, however.

TIA patients showed the same risk of developing stroke during the second period as they did during the first. The average risk for stroke was 5%, which is greater than that expected in the Söderhamn population. Survival of TIA patients is especially hard to compare as most series contain few patients. However, the methods of case finding differ in some respects. However, the risk for stroke in my TIA patients was half that in Rochester, while the survival was approximately the same.

On the other hand, both mortality and stroke recurrence rates were much higher in my study than in a Finnish long-term follow-up (but those patients were much younger).

Finally, changes in other aspects of medical therapy not presented here (e.g., more widespread use of beta blockers and calcium channel blockers) in the 1980s may have influenced the long-term outcome.

In conclusion, the survival of stroke patients improved. The reason for this is not established, but early physical rehabilitation may have reduced the incidence of complications. The risk for stroke recurrence was not reduced in spite of the increased use of antithrombotic treatment. TIA patients had the same long-term prognosis during both study periods.

Acknowledgments

I wish to thank Mrs. Pirjo Raappana, RN, and Mrs. Ingrid Westerberg, RN, for help with the stroke registry. I also want to thank Mrs. Gunilla Wedin, physiotherapist, and Mrs. Marja Lundbäck, occupational therapist, for help with the design of the new rehabilitation protocol.

References


KEY WORDS • aspirin • epidemiology • survival • warfarin
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