Background and Purpose: A stroke registry covering the city of Malmö, Sweden (population 232,000) was started in January of 1989 to prospectively follow up stroke incidence, recurrence, and fatality rates.

Methods: Patients with presumed stroke were interviewed within 1 week after admission to the hospital, and their medical records were examined. Continuous validation against hospital diagnosis showed well over 90% of all stroke cases in Malmö to have been included.

Results: Incidence rates per 100,000 residents were 300 for all stroke events and 225 for first-ever stroke, lower than those reported from other studies. The distribution of stroke diagnostic categories was 3% subarachnoid hemorrhage, 10% intracerebral hemorrhage, 50% cerebral infarction, and 38% unspecified stroke. The diagnosis was based on computed tomography in 51% of first-ever stroke cases. Median age was 73.1 years for men and 79.7 years for women. Incidence rates for all stroke diagnostic categories except subarachnoid hemorrhage increased with age. Prior stroke, hypertension, smoking, atrial fibrillation, and diabetes mellitus were major risk factors for all stroke events. The presenting symptoms were hemiparesis in 74%, speech disorder in 49%, and clouded consciousness in 19% of the patients. The overall case–fatality rate at 30 days was 15%; the rate for intracerebral hemorrhage was 37% and that for cerebral infarction was 10%.

Conclusions: Our findings confirm the value of a stroke registry for stroke epidemiology purposes and as a tool for specific stroke research. (Stroke 1992;23:357-361)

Key Words: • incidence • stroke registry • Sweden

Malmö, situated in the southernmost province of Sweden, is the country's third largest city, with a population of almost a quarter of a million and a disproportionately high frequency of elderly people. Twenty-two percent of the inhabitants belong to the ≥65-year-old age group, of which 2% are foreign immigrants.

The city has the highest doctor/patient ratio in Sweden and is served by a single casualty and emergency unit dealing with 50,000 cases annually. Malmö General Hospital, with 1,400 beds, is the only hospital. Cooperation among the departments of internal medicine, neurology, and geriatrics is well established. Because patients with acute illness traditionally come to the hospital directly, virtually all patients with presumed stroke are examined there. This, together with the high necropsy rate at the hospital, renders Malmö well suited for epidemiological research on stroke.

The increased attention to stroke has been associated with the establishment of at least 20 stroke registries throughout the world.1–4 Findings in time-trend studies have suggested that the incidence of stroke is decreasing in most areas but increasing in others,5–8 making recent epidemiological data from various parts of the world of great interest.

The stroke registry in Malmö (STROMA) started on January 1, 1989, and was designed to fulfill three main functions: to record the incidence of stroke, both overall and cause-specific, in a large Swedish community; to trace changes in stroke incidence, recurrence, and fatality rates, long-term prognosis, and risk factor patterns over a 10-year period; and to serve as a data base for use in observational studies and interventional programs. We present a brief account of the results at 1 year and the findings of a 6–18-month follow-up of cases with regard to recurrence and fatality rates.

Subjects and Methods

Stroke was defined as rapidly developing clinical signs of local or global loss of cerebral function lasting for >24 hours (or leading to death before then) with no apparent cause other than cerebral ischemia or hemorrhage.1 In this context, the term global refers mainly to subarachnoid hemorrhage. By definition, cases of transient ischemic attack (TIA) were excluded.

Only patients with first-ever stroke after January 1, 1989, were included in STROMA. All recurrences were recorded, provided that the recurrent event occurred at least 4 weeks after the preceding event. Those patients with a prior stroke before January 1, 1989, were not included in STROMA but were recorded in a complementary stroke registry. All rates quoted below refer to STROMA-1989, which included 698 stroke events during the year, 524 of which were first-ever stroke.

Case finding was the responsibility of a specially trained nurse coordinator under the supervision of senior physicians. All cases of suspected or diagnosed symptomatic stroke were actively sought by the STROMA nurse, who kept a daily check on symptoms and preliminary diagnoses recorded in the hospital and casualty admission registers. All cases with a diagnosis such as stroke, paresis, dysphasia, dizziness, or confu-
sion were followed up, with about one in five eventually being included in STROMA.

All 12 wards normally admitting stroke patients were visited by the STROMA nurse 1–3 times a week, when possible stroke events were followed up. Every second week other wards at Malmö General Hospital, as well as the neurosurgery department at University Hospital in the nearby city of Lund and all local institutions for the care of the elderly, were contacted for information on stroke events in subjects living in Malmö.

Both inpatient and outpatient consultations at the departments of internal medicine and neurology, filed in central records by diagnosis, were checked by the STROMA nurse at monthly intervals. Autopsy cases for which death certification recorded sudden death due to stroke were also included in STROMA.

In most cases, both the patients themselves and their care teams, together with the consulting specialist(s), were interviewed by the STROMA nurse within 1 week after a stroke event, and the medical records were carefully scrutinized. At inclusion in STROMA, the case information was entered on a standardized computer record form comprising 59 items, all of which were defined in a manual. These items included demographic data, history of cardiovascular disease, and details of clinical status at the onset of stroke and at inclusion in the registry. Details of some of the more complex items are given below.

Computed tomography (CT), performed within 1 week after the stroke, was used for classification purposes in 266 (51%) of the 524 cases included in STROMA-1989. Eighty-six percent of the CT examinations were performed within 2 days after the onset of symptoms, and the other 14% were performed 3–7 days after the onset. The mean age of the patients examined with CT was less than that of patients not undergoing CT (70.5 ± 11.5 versus 80.2 ± 8.9 years, respectively; p < 0.001). The criterion for stroke classified as subarachnoid hemorrhage or intracerebral hemorrhage was verification of the respective clinical picture at CT, lumbar puncture, or necropsy. Classification as cerebral infarction required a typical clinical picture and either a typical CT scan (or a normal CT scan when performed within 2 days after onset) or the presence of a potential source of emboli with a strong clinical reason to suspect cerebral embolism or verification at necropsy. Where CT was less than that of patients not undergoing CT (70.5 ± 11.5 versus 80.2 ± 8.9 years, respectively; p < 0.001). The criterion for stroke classified as subarachnoid hemorrhage or intracerebral hemorrhage was verification of the respective clinical picture at CT, lumbar puncture, or necropsy. Classification as cerebral infarction required a typical clinical picture and either a typical CT scan (or a normal CT scan when performed within 2 days after onset) or the presence of a potential source of emboli with a strong clinical reason to suspect cerebral embolism or verification at necropsy. Where none of these criteria were fulfilled, the event was classified as unspecified stroke. No attempts were made to intervene in the diagnostic routines of the various departments.

Doppler ultrasound or angiographic findings of >50% stenosis or ulceration and TIA verified from medical records were considered to indicate extracranial occlusive disease. Chronic or intermittent atrial fibrillation or flutter was recorded as atrial fibrillation. Other heart diseases listed included previously diagnosed organic left ventricle defects, myocardial infarction, and heart failure. Other recorded atherosclerotic manifestations consisted of previously diagnosed angina pectoris, intermittent claudication, and aneurysm of the abdominal aorta.

Hypertension was considered to be present if the patient was receiving chronic antihypertensive treatment at the onset of the stroke. The term “exsmoker” was taken to imply regular smoking at the onset of the stroke and the term “exsmoker” to mean previous regular smoking for a period exceeding 1 year but terminated before the onset of the stroke.

Previously diagnosed and suspected hypercholesterolemia were recorded if one plasma cholesterol value was ≥6.5 mmol/l (≥250 mg/dl). Hypercholesterolemia was considered to be not present if plasma values were <6.5 mmol/l. Previously diagnosed diabetes was recorded, and blood glucose values of ≥6.5 mmol/l (≥115 mg/ml) were taken to indicate suspected diabetes. Diabetes was considered to be not present if blood glucose values were consistently <6.5 mmol/l.

The course of disease during the first week after the stroke was classified by the care team as complete or almost complete regression, some improvement, deficit unchanged, progression, or death. The course of disease was evaluated in patients alive at admission and included in the registry within 2 weeks after the stroke.

On July 1, 1990, a 6–18-month (median 1 year) follow-up was carried out on all cases with a first-ever stroke during 1989. The registry was scrutinized for cases of recurrence. The hospital register, updated weekly, was checked against the mortality register for all cases included in STROMA-1989 to determine if death occurred later. This information was added to STROMA.

The Mann-Whitney rank sum test and the χ² test were used for statistical analysis. Probability values were two tailed, and p ≤ 0.05 was considered to be significant. Results are given as mean ± SD.

Results

In 1989 there were 698 stroke events and 524 first-ever strokes; the incidences per 100,000 residents were 300 and 225, respectively. In neither case did the incidence per 100,000 differ significantly between women and men, being 365 and 333, respectively, for all stroke events and 280 and 244, respectively, for first-ever stroke.

Among the first-ever stroke cases, mean ± SD age was 77.7 ± 10.1 years for women and 71.5 ± 11.8 years for men and median age was 79.7 and 73.1 years, respectively (p < 0.001 in both cases). A similar age difference between women and men was found among recurrent stroke cases (77.6 ± 8.9 and 72.4 ± 9.2 years, respectively; p < 0.001). The age-specific incidence rates of first-ever stroke are shown in Table 1. Although there was no sex-related difference in overall incidence, in all except the ≥85-year-old age group incidence rates were higher for men than for women; the difference was significant (p < 0.001) for the 45–54- and 65–84-year-old age groups. The most common type of stroke was cerebral infarction, accounting for 50% (260) of the cases (Table 2). The incidence rates of all types of stroke except subarachnoid hemorrhage increased with age.

Of the 524 patients with first-ever stroke included in STROMA-1989, 456 (87%) had been admitted to the hospital as acute cases, 41 (8%) had developed stroke while inpatients, and the remaining 27 (5%) were treated as outpatients or died before they could be admitted. Overall mortality before inclusion in STROMA-1989 was 8% (43 of 524), the cause-specific rate being significantly greater for subarachnoid hemorrhage (43%, six of 14) and intracerebral hemorrhage...
During the first week, 70% of cases improved, and the absence of any major atherosclerosis risk factor could be verified in 45% (9%) and the absence of concomitant disease in 243 (46%). Among first-ever stroke patients, the absence of any major atherosclerosis risk factor could be verified in 45% (9%) and the absence of concomitant disease in 243 (46%).

Patients were usually admitted with hemiparesis and speech disorders, and most were conscious (Table 3). During the first week, 70% of cases improved, the functional disability was unchanged in 18%, and the stroke progressed in 10%.

At follow-up on July 1, 1990, 19 of the 524 cases included in STROMA-1989 had suffered a recurrent stroke; that is, 3.6% of the series as a whole and 5.2% of the survivors had had a recurrence. The overall case-fatality rate was 9% (n=45) at 7 days, 13% (n=69) at 2 weeks, 15% (n=80) at 30 days, and 26% (n=136) at 6 months.

The case-fatality rate was higher among patients with intracerebral hemorrhage than among those with cerebral infarction at both 30 days (37% versus 10%, respectively) and 6 months (43% versus 17%, respectively) after first-ever stroke (p<0.001 in both cases). Among patients with subarachnoid hemorrhage, the case-fatality rate was 21% at 30 days and 29% at 6 months poststroke.

### Discussion

By tradition in Sweden, the majority of stroke patients are admitted directly to the departments of internal medicine or neurology via the emergency room of the local hospital. It is customary for a number of hospital departments to cooperate in the care of patients with cardiovascular disorders.

Our stroke registry at Malmö, STROMA, was designed to serve the whole community; general practitioners and community-employed physicians at institutions for the care of the elderly were informed that stroke

### Table 1. Number of First-Ever Stroke Cases, Incidence Rates, and Male/Female Incidence Rate Ratios in 1989 by Age Group

<table>
<thead>
<tr>
<th>Age group (yr)</th>
<th>Population at risk</th>
<th>Women</th>
<th></th>
<th></th>
<th>Men</th>
<th></th>
<th></th>
<th>All cases</th>
<th>Rate ratio (male/female)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>n</td>
<td>Rate</td>
<td>n</td>
<td>Rate</td>
<td>n</td>
<td>Rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–44</td>
<td>62,718</td>
<td>4</td>
<td>6</td>
<td>9</td>
<td>14</td>
<td>13</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45–54</td>
<td>13,630</td>
<td>5</td>
<td>37</td>
<td>15</td>
<td>113</td>
<td>20</td>
<td>74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>55–64</td>
<td>14,234</td>
<td>23</td>
<td>162</td>
<td>26</td>
<td>207</td>
<td>49</td>
<td>183</td>
<td></td>
<td></td>
</tr>
<tr>
<td>65–74</td>
<td>15,621</td>
<td>59</td>
<td>378</td>
<td>91</td>
<td>768</td>
<td>150</td>
<td>546</td>
<td></td>
<td></td>
</tr>
<tr>
<td>75–84</td>
<td>11,893</td>
<td>119</td>
<td>1,001</td>
<td>84</td>
<td>1,279</td>
<td>203</td>
<td>1,100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥85</td>
<td>3,972</td>
<td>70</td>
<td>1,762</td>
<td>19</td>
<td>1,575</td>
<td>89</td>
<td>1,719</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>122,068</td>
<td>280</td>
<td>229</td>
<td>244</td>
<td>222</td>
<td>524</td>
<td>225</td>
<td></td>
<td>1.0</td>
</tr>
</tbody>
</table>

Incidence rate per 100,000 population. Rate ratio is not given for group with n<20.

### Table 2. Number of Cases, Incidence Rates, and Male/Female Incidence Rate Ratio in 1989 by Type of Stroke and Age Group

<table>
<thead>
<tr>
<th>Type of stroke</th>
<th>Subarachnoid hemorrhage</th>
<th>Intracerebral hemorrhage</th>
<th>Cerebral infarction</th>
<th>Unspecified stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Rate (male/female)</td>
<td>n</td>
<td>Rate (male/female)</td>
</tr>
<tr>
<td>0–44</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>45–54</td>
<td>4</td>
<td>15</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>55–64</td>
<td>3</td>
<td>11</td>
<td>5</td>
<td>19</td>
</tr>
<tr>
<td>65–74</td>
<td>0</td>
<td>0</td>
<td>17</td>
<td>62</td>
</tr>
<tr>
<td>75–84</td>
<td>4</td>
<td>22</td>
<td>16</td>
<td>87</td>
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<tr>
<td>≥85</td>
<td>1</td>
<td>19</td>
<td>8</td>
<td>154</td>
</tr>
<tr>
<td>Women</td>
<td>8</td>
<td>7</td>
<td>28</td>
<td>23</td>
</tr>
<tr>
<td>Men</td>
<td>6</td>
<td>5</td>
<td>23</td>
<td>21</td>
</tr>
<tr>
<td>Total</td>
<td>14</td>
<td>6</td>
<td>51</td>
<td>22</td>
</tr>
</tbody>
</table>

Incidence rate per 100,000 population. Rate ratios are not given for groups with n<20.
TABLE 3. Clinical Status of Stroke Patients at Admission

<table>
<thead>
<tr>
<th>Clinical status</th>
<th>Intracerebral hemorrhage (n=51)</th>
<th>Cerebral infarction (n=260)</th>
<th>All cases (n=524)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consciousness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Awake</td>
<td>55*</td>
<td>81</td>
<td>77</td>
</tr>
<tr>
<td>Somnolent</td>
<td>16</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Comatose</td>
<td>20</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>No data</td>
<td>10</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Hemiparesis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>20</td>
<td>19</td>
<td>16</td>
</tr>
<tr>
<td>Yes</td>
<td>61</td>
<td>75</td>
<td>74</td>
</tr>
<tr>
<td>No data</td>
<td>20</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Speech disorder</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>29</td>
<td>37</td>
<td>31</td>
</tr>
<tr>
<td>Yes</td>
<td>35</td>
<td>49</td>
<td>49</td>
</tr>
<tr>
<td>No data</td>
<td>36</td>
<td>14</td>
<td>20</td>
</tr>
</tbody>
</table>

No data, item could not be properly judged due to patient's low level of consciousness. Values are %.

*p<0.001 different from cerebral infarction.

patients should be referred to Malmö General Hospital. Of the 524 cases of first-ever stroke included in STROMA-1989, 5% had been treated as outpatients or died before admission and 2% had suffered a stroke while in institutional care. Our results confirm previous reports; these categories account for <10% of all cases of first-ever stroke in Sweden.9,10

Scrutiny of hospital records suggests that <5% of all stroke patients admitted to a hospital were not included in STROMA. Moreover, because hospital diagnostic records are not always specific, many of the "missed" cases may have been stroke sequelae rather than stroke itself. Except for patients who did not seek medical advice and the oldest and most disabled patients in institutional care, where minor stroke might have remained undetected, it is reasonable to suppose that almost all cases of first-ever stroke were included in STROMA-1989. The few possibly undetected cases would be unlikely to affect the results, except perhaps in the ≥85-year-old age group.

Longitudinal studies of stroke incidence in Sweden have shown regional differences. In Stockholm, during the period 1974–1981 the incidence among men increased steadily while that among women remained stable.11 In Söderhamn, the incidence among women increased between 1975–1978 and 1983–1986 while that among men remained stable.5

The incidence rates found in the present study can be compared with those obtained in previous series.9–14 However, it should be borne in mind that inclusion criteria have varied among studies, all stroke manifestations having been included in some series, but only first-ever stroke in others. The annual incidence of first-ever stroke per 100,000 residents was 225 in Malmö compared with 176 in Lund-Orup,12 292 in Söderhamn,5 and about 200 in Gothenburg.9 However, figures for overall incidence are extremely dependent on the age distribution of the population studied; the ≥65-year-old age group, for instance, accounted for 22% of the residents in Malmö in 1989 compared with 15% in Gothenburg in 1974, 20% in Söderhamn in 1980, and 14% in Lund-Orup in 1984.

Age-specific incidence rates in selected communities in northern Europe are shown in Table 4. Because the differences in incidence rates among centers are only partly ascribable to differences in methodology, these figures suggest the existence of real geographic variation in the risk of stroke. A noteworthy difference is that the figure for Malmö was markedly lower than that for its immediate neighbor, the Lund-Orup district. Indeed, in all likelihood the real difference is even greater because the Lund-Orup study was based on hospital records only. Because that community is partly rural, stroke cases there are less commonly seen first in the hospital than is the case for Malmö. The relatively low incidence in Malmö may well be due to active intervention and preventive measures resulting from repeated health screening programs carried out during the past 15 years in the population at risk. The data collected by STROMA in the coming years will clarify whether this interpretation is correct.

Stroke classifications were based on CT examinations in both the present and the Lund-Orup studies.12 Although the proportions of cases of subarachnoid hemorrhage and intracerebral hemorrhage in the two studies were the same, in the Lund-Orup study 40% of all stroke cases were classified by clinical diagnosis as atherothrombotic infarction or cardiac embolism. In the present study, among stroke cases for which neither CT,
lumbar puncture, nor necropsy was performed stroke was classified as cerebral infarction only when the clinical picture was consistent with cardiac embolism. The relatively high proportion of cases designated as unspecified stroke is explained by the fact that exclusion of all possibility of the presence of hemorrhage was the sine qua non for a diagnosis of cerebral infarction.

Age, sex, prior stroke, diabetes mellitus, hypertension, cardiac disease, TIA, smoking, and a high blood cholesterol concentration have previously been shown to be risk factors for stroke. In the present study, atherosclerosis risk factors or prior manifestations of vascular disease were present in virtually all stroke cases, suggesting that stroke is a late complication of arterial disease.

The incidence of stroke has been found to be strikingly correlated to age, in both previous studies and the present study, where it was 10 times higher in the ≥85-year-old age group than among patients aged 55–64 years. That prior stroke is a strong predisposing risk factor for new stroke was borne out by the fact that 25% of all stroke events registered in STROMA-1989 were recurrences. Our data confirm that atrial fibrillation is associated with stroke among all age groups, but especially among the elderly. The prevalence of atrial fibrillation in a normal population was found to be 1.6% among women aged 70–90 years and 1.3% among men aged 60–80 years.

Although the case-fatality rate was high during the first poststroke weeks, the 1-month rate was relatively low, 15%, compared with 23% in Soderhamn, 18% in Lund-Orup, and 19% in Oxfordshire. The relatively low case-fatality rate in the present study may have been due to improvement in the acute care of stroke patients during the past decade.

To summarize, in all likelihood the overwhelming majority of first-ever strokes were registered in STROMA-1989. Incidence rates and case-fatality rates were lower than those reported from other centers. A number of typical stroke-associated features were confirmed to be major risk factors. Clearly, a stroke registry is an important tool for use in both specific stroke research and epidemiological investigations.

Acknowledgments

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Stroke registry in Malmö, Sweden.
P Jerntorp and G Berglund

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