Epidemiology of Stroke
In Tilburg, The Netherlands

The Population-Based Stroke Incidence Register:
1. Introduction and Preliminary Results

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SUMMARY We present the methodology and some preliminary findings of a population-based stroke incidence register operating in Tilburg (about 150,000 persons), The Netherlands. From October 1, 1978 to March 31, 1979, 152 new strokes occurred giving an estimated overall incidence (per 100,000 population) for total and first attacks of 202 and 162, respectively. No major sex difference in stroke risk (all ages) was noted, although males did have a significantly higher incidence at 55-64 years of age. Stroke incidence increased strikingly with age.

Thromboembolic infarcts comprised 83% and intracranial hemorrhage 13% of attacks. Males and females differed little in distribution of stroke types. The proportion of cerebral infarction was higher among older than younger cases. The opposite was true regarding intracranial hemorrhage. Embolic infarcts constituted a significantly higher proportion of cases at 65-74 years of age than at other ages.

Hemiplegia and speech deficits dominated the clinical picture at onset. The 3-week case fatality for all strokes was 26%. Both a lowering of consciousness (found among 38% of cases during the first 24 hours) and a history of prior stroke were found related to a reduction in survival. Of patients surviving 3 weeks 25% were completely dependent and 25% partially dependent upon others for personal care.

Methods

The basic definitions, guidelines and record forms for registration are modeled, for the most part, after those of the World Health Organization (WHO) Multicenter Stroke Register. This allows more meaningful comparisons between our findings and those of other countries.

Population-based incidence registers provide the means of obtaining this information and are, thus, requisite for the sound functioning of stroke programs involving preventive, diagnostic, therapeutic and rehabilitative services.

Such a registration scheme, including all new patients with stroke occurring among the resident population of Tilburg, began operating for the first time in the Netherlands as of October 1, 1978.

Tilburg is an urban center located in the south central part of the Netherlands in the province of North Brabant. It possesses a rather stable population of about 150,000 persons. The age and sex distributions of the study population are presented in Table 1. Every resident is listed with one of 45 family physicians and, furthermore, has adequate medical insurance covering specialist and hospital costs. The community has complete neurological diagnostic facilities, including a team of epidemiologically oriented neurologists, organized in one department, servicing the two Tilburg hospitals (St. Elisabeth and Maria). An additional advantage is that the city is isolated from other medical facilities by many miles.

THE EXISTENCE of complete and adequate data regarding stroke incidence and stroke followup is of utmost importance both nationally and internationally in arriving at a better understanding of the total natural history of the disease (i.e., both onset and outcome from the time of its first manifestations).

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A stroke is defined as rapidly developing clinical signs of focal (or global) disturbance of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than a vascular origin. The further classification of strokes by type is based upon diagnostic criteria set by both the WHO and the ad hoc Committee on Cerebrovascular Diseases of the National Institute of Neurological Diseases and Blindness (now, the National Institute of Neurological and Communicative Disorders and Stroke), U.S.A.

Case-finding involves multiple sources. The vast majority of patients with stroke are reported to a registry assistant attending the daily morning joint conference of neurologists and neurosurgeons practicing within the 2 Tilburg hospitals. Telephone con-
Table 2  Estimated Annual Incidence* of Stroke (Total Cases, First-Ever), City of Tilburg

<table>
<thead>
<tr>
<th>Female</th>
<th>Male</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>&lt;55</td>
<td>55-64</td>
</tr>
<tr>
<td>Under 20</td>
<td>3 (1)</td>
<td>3 (2)</td>
</tr>
<tr>
<td>20-49</td>
<td>9 (4)</td>
<td>16 (9)</td>
</tr>
<tr>
<td>50-64</td>
<td>24 (12)</td>
<td>47 (24)</td>
</tr>
<tr>
<td>65-74</td>
<td>9 (5)</td>
<td>18 (9)</td>
</tr>
<tr>
<td>75+</td>
<td>2 (1)</td>
<td>7 (4)</td>
</tr>
<tr>
<td>Total</td>
<td>35 (21)</td>
<td>70 (39)</td>
</tr>
</tbody>
</table>

*Per 100,000 population; based on first 6 months of registration.

The estimated over-all incidence rate (per 100,000 population) for “total” cases and “first-ever” cases was 202 and 162, respectively. Although the age-adjusted rates were found slightly higher for males than females (“total” M:F = 1.07; “first-ever” M:F = 1.06), the differences were not statistically significant. Males did, however, have significantly higher rates at 55-64 years-of-age. The incidence rate of stroke (per 100,000 population) increased strikingly (and significantly) with age: 35 at ages below 55, 302 at 55-64 years-of-age, 671 in the age group 65-74 years, and 209 at 75 years-of-age and older (all cases); 31 at <55 years-of-age, 302 in the age group 55-64 years, 616 at 65-74 years-of-age and 1767 in the oldest age category (first-ever cases).

Diagnosis

Frequency of Use of Diagnostic Methods

To arrive at an idea of the extent of clinical support for a differential diagnosis of stroke, the figures regarding specific patient workup are presented in table 3. In addition, a neurologist reviewed all histories of patients not seen by the neurological staff. These histories are based upon both the family physicians' and/or nursing home physicians' reports, and registry staff interviews and observations.

Types of Stroke (Table 4)

The majority of the strokes were cerebral infarction (84%), of which 72% were thrombotic and 11% embolic (cardiac). Intracranial hemorrhage accounted for 13% of the strokes ("intracerebral hemorrhage," 9%, subarachnoid hemorrhage, 3%). The remaining 3% of patients were classified as stroke, unspecified.

The relative frequency of types of stroke did not vary with sex. Both males and females had almost identical proportions of the different diagnoses.

"intracerebral hemorrhage" combines intracerebral hemorrhage (6%) and intracerebral hematoma (3%).
Table 3: Frequency of Diagnostic Methods Performed

<table>
<thead>
<tr>
<th></th>
<th>Surviving 3 weeks (N = 112)</th>
<th>Dead within 3 weeks (N = 40)</th>
<th>Total (N = 152)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Seen by a physician</td>
<td>112 (.100)</td>
<td>40 (.100)</td>
<td>152 (.100)</td>
</tr>
<tr>
<td>2. Seen by a neurologist</td>
<td>94 (.84)</td>
<td>32 (.80)</td>
<td>126 (.83)</td>
</tr>
<tr>
<td>3. Lumbar puncture</td>
<td>79 (.71)</td>
<td>11 (.28)</td>
<td>90 (.59)</td>
</tr>
<tr>
<td>4. Cerebral angiography</td>
<td>16 (.14)</td>
<td>0</td>
<td>16 (.11)</td>
</tr>
<tr>
<td>5. EEG</td>
<td>88 (.79)</td>
<td>12 (.30)</td>
<td>100 (.66)</td>
</tr>
<tr>
<td>6. Brain Scan (Isotope and/or Computer Tomography)</td>
<td>70 (.63)</td>
<td>9 (.23)</td>
<td>79 (.52)</td>
</tr>
<tr>
<td></td>
<td>Isotope (I)</td>
<td>24 (.34)</td>
<td>26 (.33)</td>
</tr>
<tr>
<td></td>
<td>Comp. Tomography (CT)</td>
<td>20 (.29)</td>
<td>26 (.33)</td>
</tr>
<tr>
<td></td>
<td>(I) + (CT)</td>
<td>26 (.37)</td>
<td>27 (.34)</td>
</tr>
<tr>
<td>7. Echoencephalography</td>
<td>69 (.62)</td>
<td>19 (.48)</td>
<td>88 (.58)</td>
</tr>
<tr>
<td>8. ECG</td>
<td>88 (.79)</td>
<td>28 (.70)</td>
<td>116 (.76)</td>
</tr>
<tr>
<td>9. Brain Autopsy</td>
<td>—</td>
<td>13 (.33)</td>
<td>—</td>
</tr>
<tr>
<td>10. At least one of (3)—(7)</td>
<td>92 (.82)</td>
<td>28 (.70)</td>
<td>120 (.79)</td>
</tr>
</tbody>
</table>

Although not reaching statistical significance, a positive trend with age was noted for cerebral infarction. Embolic (cardiac) infarction was found significantly more frequently among patients 65-74 years-of-age. The inverse relationship of age with percent of intracranial hemorrhage was statistically significant.

Clinical Picture (Maximum Impairment Within 24 Hours of Onset)

During the first day after onset, 62% of the 152 patients were fully conscious; 15% were somnolent, 10% semi-comatose and 13% comatose at some time during the first 24 hours.

Motor deficits (weakness/paralysis) in the limbs were noted in 84% of the 142 patients assessed. Hemiplegia was the predominant problem (80% of the motor disturbances). Monoplegia was found in an additional 18%. The remaining 2% of motor deficits comprised 1% paraplegia and 1% where 3 or 4 limbs were involved.

Some form of speech disturbance (dysarthria/dysphasia) was found in about two-thirds of the assessed patients (N = 133).

Of the 133 evaluated patients, 92% experienced a motor and/or speech deficiency (31% motor alone; 11% speech alone; and 58% both motor and speech).

Survival Rates Within 3 Weeks of Onset

About 90% of the 152 patients survived the first day of the attack. This was reduced by 6% at 3 days and an additional 4% (to 81%) at one week. At 2 weeks, 76% of the cases were alive (5% less) and by 3 weeks, the survival rate was further reduced to 74%.

Patients with disturbances of consciousness (N = 58) had considerably and statistically significantly lower age-adjusted survival rates than those without such a deficit (N = 94) at each of the time periods (1

Table 4: Relative Frequency of Types of Stroke

<table>
<thead>
<tr>
<th>Stroke type</th>
<th>Male%</th>
<th>Female%</th>
<th>&lt;65</th>
<th>65-74</th>
<th>75+</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cerebral infarction††</td>
<td>57(.85)</td>
<td>71(.84)</td>
<td>33(.79)</td>
<td>37(.82)</td>
<td>58(.89)</td>
<td>128(.84)</td>
</tr>
<tr>
<td>Thrombotic</td>
<td>48(.72)</td>
<td>62(.73)</td>
<td>31(.74)</td>
<td>27(.60)</td>
<td>52(.80)</td>
<td>110(.72)</td>
</tr>
<tr>
<td>Embolic (cardiac)</td>
<td>8(.12)</td>
<td>9(.11)</td>
<td>1(.02)</td>
<td>10(.22)</td>
<td>6(.09)</td>
<td>17(.11)</td>
</tr>
<tr>
<td>Intracranial hemorrhage††</td>
<td>10(.15)</td>
<td>10(.12)</td>
<td>9(.21)*</td>
<td>6(.13)</td>
<td>5(.08)</td>
<td>20(.13)</td>
</tr>
<tr>
<td>Intracerebral hemorrhage</td>
<td>5(.08)</td>
<td>4(.05)</td>
<td>5(.12)</td>
<td>3(.07)</td>
<td>1(.02)</td>
<td>9(.06)</td>
</tr>
<tr>
<td>Intracerebral hematoma</td>
<td>3(.04)</td>
<td>2(.02)</td>
<td>2(.05)</td>
<td>2(.04)</td>
<td>1(.02)</td>
<td>5(.03)</td>
</tr>
<tr>
<td>Primary subarachnoid hemorrhage</td>
<td>2(.03)</td>
<td>3(.04)</td>
<td>1(.02)</td>
<td>1(.02)</td>
<td>3(.04)</td>
<td>5(.03)</td>
</tr>
<tr>
<td>Stroke unspecified</td>
<td>0</td>
<td>4(.05)</td>
<td>0</td>
<td>2(.04)</td>
<td>2(.03)</td>
<td>4(.03)</td>
</tr>
<tr>
<td>Total</td>
<td>67(1.00)</td>
<td>85(1.00)</td>
<td>42(1.00)</td>
<td>45(1.00)</td>
<td>65(1.00)</td>
<td>152(1.00)</td>
</tr>
</tbody>
</table>

† Age-adjusted to age distribution of total cases.
‡ Includes 1 M, 65 y.o. with an infarction due to "other mechanisms."
†† Includes 1 P, 65 y.o. with a hemorrhage stemming from a vascular malformation.
* x² = 9.05 (p < 0.00): all ages; x² = 0.99 (p > 0.10): < 65 vs 75+. y.o.
x² = 8.00 (p < 0.05).
day: 78 vs 100%, 3 days: 64 vs 97%, 7 days: 57 vs 97%, 14 days: 49 vs 93%, 21 days: 47 vs 90%) since onset (all z values were > 4.4, p < 0.0001).

Although the age-adjusted survival rates for patients with a prior stroke (N = 30) were in general lower than those for patients without such a history (N = 122), statistically significant differences were found only for “within 3 days” (68 vs 88%, z = 2.86, p < 0.005) and “within one week” (66 vs 83%, z = 2.13, p < 0.04) of onset categories.

Self-Care At 3 Weeks of Onset

All of the patients included in this analysis (N = 107) were totally independent regarding self-care (feeding, dressing, washing and toilet) up until the time of their stroke. After, however, only about 50% (alive at 3 weeks) were still completely independent. Of the remaining patients, half were partially dependent and half totally dependent upon others for care. The degree of independence in self-care at 3 weeks was found statistically significantly related to age at stroke onset (χ² = 12.39, d.f. = 4, p < 0.02). Older patients were found more dependent regarding the above activities than were those younger.

Discussion

It is believed that finding new strokes in the community has been rather complete by utilizing all possible sources of such patients (both in and out of the hospital setting) to their fullest extent. The differential diagnosis of stroke in Tilburg can be viewed as similar to stroke registers in other parts of the world. 6 The Tilburg overall stroke incidence rates, observed with a pronounced increase in rate with age and lack of substantial sex difference in stroke (as compared to heart disease) risk for all ages combined (although tending to be slightly higher for males), fit the pattern of results noted in other places. 5-7

There is, as yet, no explanation for the apparent higher risk of stroke among Tilburg men than women 55-64 years of age. 8

Whether done longitudinally or cross-sectionally, epidemiological studies have shown that the majority of strokes occurring within populations are thromboembolic, as opposed to hemorrhagic. 5 This was also observed in Tilburg where 83% of strokes were diagnosed as thromboembolic.

The present study and others, 5, 6 have demonstrated deficiencies in both mobility and speech. When one deficit alone was found (42% of cases), a motor, rather than a speech, disturbance was more common with a ratio of about 3 to 1. Hemiplegia was by far the most common motor deficit resulting from stroke. Moreover, the stroke left more than 60% of patients handicapped with speech problems (dysarthria/dysphasia).

Fatality within 3 weeks was 26% for all strokes and the fatality rate was at its maximum during the first week (and, in particular, within the first day) after onset of stroke.

A lowering of the level of consciousness, irrespective of degree, was found related to a substantially reduced short-term survival. A history of prior stroke also had a negative bearing upon the patient’s short-term prognosis, especially within one week (and, more specifically, within 3 days) of onset.

It is apparent from the the current investigation that if patients are fortunate enough to survive the first 3 weeks of the attack, the illness, nevertheless, leaves about one-half of these patients at least partially dependent upon others for basic biological and hygienic needs. One quarter of the patients are completely dependent regarding self-care, and the older the patient when the stroke occurs, the more likely he is to be dependent upon others for such care.

Acknowledgment

We wish to thank the medical staff and administration of the Tilburg hospitals, the family and nursing home physicians, the municipal administrative and health bureaus, and the TESS staff, who are making this study possible.

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References

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