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A Prospective Epidemiological Survey of Cerebrovascular Disease in a Swedish Community

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ABSTRACT

A prospective epidemiological study of cerebrovascular diseases and transient ischemic attacks (TIA) is presented. During a three-year period the annual incidence of strokes was 2.90 and of TIA 0.45 per thousand population. This difference in incidence and the disparities in age characteristics favour the hypothesis that TIA precedes only a minority of the strokes. The short-term mortality is high among the stroke patients.

INTRODUCTION

Chronic illness, such as cardiovascular disorders and malignant neoplasms, now dominate the panorama of diseases in middle-aged and old people in the industrialized countries (15). In Sweden, as in many other countries, cerebrovascular disease (stroke) is one of the leading causes of death (8, 17). Cerebrovascular disease (CVD) ranks as the number-one diagnosis on the list of days spent in hospital in the Uppsala region (20).

Numerous community-based (3, 4, 5, 10, 11, 12, 16, 18, 23, 24, 27, 30, 35, 41) as well as hospital-based (1, 2, 7, 28, 40) studies of CVD have been published, but so far very few have dealt with all kinds of stroke at all ages (27, 41). The aim of the present investigation was therefore to register all strokes in a well-defined area.

The prognosis in CVD and factors influencing it were also studied, as well as socio-medical aspects of the disease, and these results will be reported elsewhere. The information collected should provide a basis for the planning of care of patients with diseases of this group (17, 32).

Studied area and population

The municipality of Söderhamn consists of a small town with rural surroundings. In this self-administered area, of 1,062 sq.km, the population was 32,250 in 1975 at the beginning of the study and 32,000 in 1978 at the end

(25). The age distribution was similar to that of the general Swedish population (Fig. 1). There is only one hospital in the community. The general practitioners are usually eight in number and they work in close co-operation with the staffs of the medical and surgical departments of the hospital.

METHODS

In May 1975 a stroke register, for recording of all cases of stroke, both those with long-standing symptoms and those with transitory ischemic attacks (TIA), was set up at the Söderhamn Hospital, for the purpose of the present

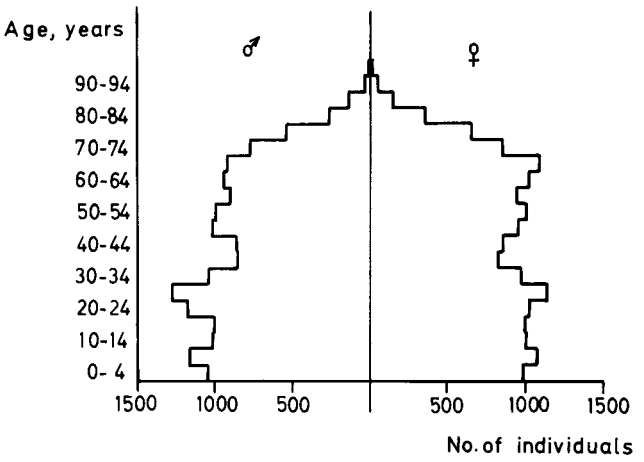

Fig. 1 A.

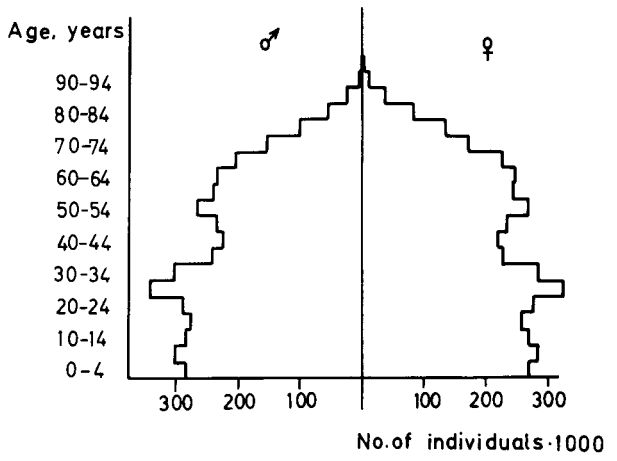

Fig. 1 B.

Fig. 1. The population by age in Söderhamn (1 A) compared with the Swedish population (1 B) on 31 December, 1974.

study. Before the registration started the diagnostic criteria and the therapy to be given were defined. Information concerning the stroke registration, including the diagnostic criteria and therapy, was given continuously to all doctors at the hospital, and to the general practitioners in the district. All nursing institutions were repeatedly asked to report definite and suspected cases of stroke. The hospital records were checked daily by the registered nurse. All death certificates for permanent residents of Söderhamn, issued in the district during the period or obtained from the Institute of Forensic Medicine in Uppsala, were examined. One important function in the study was carried out by a special registered nurse, who was responsible for the tracing and primary registration of new cases and for calling patients for follow-up.

The initial physical examination, either in hospital or elsewhere, was performed in all cases by members of the medical staff, with use of a special form. Interviews were conducted and physical examinations performed on admission to hospital, after three months and then once a year. In the event of a new stroke the procedure was started from the beginning again. After exactly three years the registration was stopped but the follow-up, including the examinations mentioned above, is still continuing. The same doctor (the author) was responsible for the final registration, throughout the study period.

Definitions

The definitions of stroke and TIA are in accordance with the recommendations of WHO.

Thus, stroke was defined as "rapidly developed clinical signs of focal (and/or global) disturbance of cerebral function, lasting longer than 24 hours or leading to death with no apparent cause other than vascular". The term "global" mainly applies to the cases of subarachnoid hemorrhage.

TIA was defined as "rapidly developed clinical signs of focal cerebral dysfunction of presumed vascular origin not lasting more than 24 hours".

The term recurrent stroke was used for a new stroke taking place more than three weeks after an initial stroke. In the case of TIA recurrence meant a new attack after a symptom-free interval of more than 24 hours.

Comments on diagnoses

The diagnosis was based mainly on clinical observations.

A diagnosis of hemispheric lesion was given if one or more of the following were observed: hemiparesis, Grasset's phenomenon, hemisensory loss, aphasia, facial nerve paresis of the central type, eye deviation, homonymous anopsia, abnormal finger-to-nose test of the non-atactic type, or unilateral positive plantar reflex.

A brainstem lesion was indicated by cranial nerve deficits of the lower motor neuron type. Doll's eye (loss of eye movements when the head is quickly rotated) or unilateral loss of the pupillary reflex was also taken as a sign of a brainstem lesion.

Cerebellar lesions are known to present with a large variety of symptoms, but a combination of typical tremor in the finger-to-nose test, dysdiadochokinesis and nystagmus were primarily regarded as signs of cerebellar dysfunction. A macroscopically hemorrhagic cerebrospinal fluid (CSF) indicated intracerebral breakthrough-bleeding or subarachnoid hemorrhage, depending on the presence or absence of localizing symptoms. An embolic infarction was suspected in patients with mitral valve disease with atrial fibrillation, patients with paroxysmal atrial fibrillation of other causes and in patients with recent myocardial infarction.

Exclusions

Patients who were unconscious at the onset of other neurological symptoms were excluded from the TIA group because of the possibility of the attack being an epileptic seizure. Migraine patients, who sometimes fit the definition of TIA, were naturally not included. Drop attacks or vertigo without any other symptoms were not sufficient for a diagnosis of TIA because of difficulties in the differential diagnosis.

Treatment design

The patients were treated according to the relevant principles of the medical department, which meant that no intensive care was available except for a few cases. Neither was it the rule to use vasodilators, edema-reducing agents or low-molecular weight dextran as a regular procedure. Early mobilization was prescribed, except in the case of subarachnoid hemorrhage. Anticoagulant treatment with warfarin sodium was given to patients with TIA or stroke due to embolism. The TIA patients received this treatment for two years. No time limits were set for the embolism patients. The TIA patients with unilateral symptoms who showed corresponding carotid lesions at angiography were considered for surgery.

Statistics

The incidence density (ID, in the text simply called incidence) is expressed as the number of new cases per 1,000 population and year. The five-yearly increase of the incidence was estimated by adjusting the formula $ID = a \cdot k^t$ to the stroke and the TIA groups, respectively. "t" stands for the number given to each consecutive five-year age group in which stroke cases were registered; the lowest age group in which stroke appeared being No. 1. Thus, when t increa-

sed one unit, there was a simultaneous increase in ID by (k - 1) · 100 %. The chi-square test was used when testing variables within the stroke and the TIA groups, respectively. When testing for differences between these two groups the variables studied, e.g. mean age, were thought to have a normal distribution due to the large number of observations (the central limit theorem). The critical value for λ at the 95 % significance level was - 1.645 in one-sided tests.

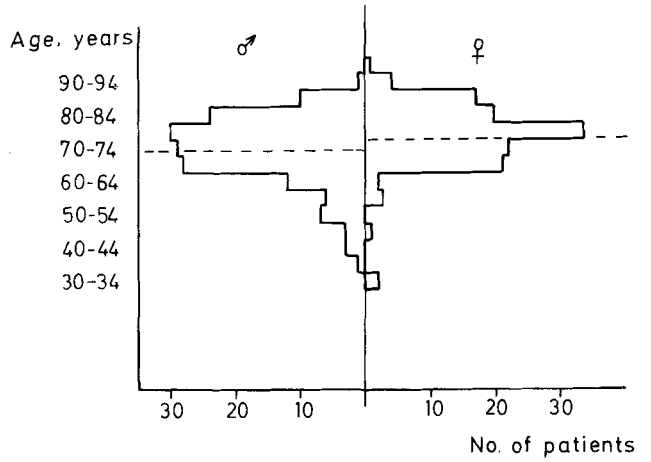

Fig. 2. A

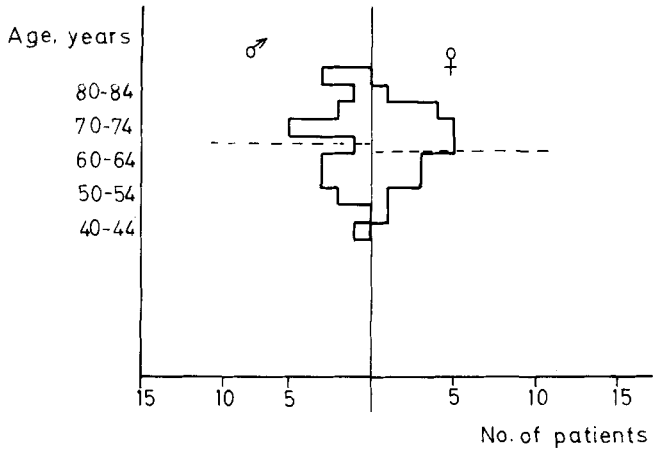

Fig. 2 B.

Fig. 2. The sex and age distribution of cases of stroke (2 A) and TIA (2 B) in Söderhamn 1975 - 1978.

RESULTS

Between 1 May 1975 and 30 April 1978, a total of 338 strokes and 51 TIAs were registered, of which 57 strokes and 7 TIAs were recurrences (Table 1). The number of strokes and TIAs were almost identical in each year of the study. The sex and age distribution are shown in Fig. 2. The mean age in the stroke group was 71.1 ± 1.7 years for men, 75.4 ± 1.7 years for women and 73.1 ± 1.2 years for both sexes combined. Up to the age of 80 years there was an unproportionately large number of men (χ^2_{obs} = 10.85 to be compared to $\chi^2_{0.95}(4)$ = 9.488).

Table 1. Number of cases of stroke and TIA, Söderhamn, 1975-78.

	New stroke	Recurrence	New TIA	Recurrence
First year	92	6	14	2
Second year	95	23	16	3
Third year	94	28	14	2
	281	57	44	7

In the TIA group the mean age for men was 67.7 ± 5.2, for women 66.7 ± 3.7 and for the whole group 67.2 ± 3.6. There was no significant sex difference in this group with respect to age. On the other hand, there was a significant age difference ($\lambda_{0.95}$ = -11.20) between the total stroke group and the total TIA group.

The relative risks of stroke and TIA were found to increase exponentially with age (Fig. 3), but some differences were found between them. Firstly, there were no TIA patients below the age of 40 years, whereas there were three strokes in this age group (one cerebellar hemorrhage and two subarachnoid hemorrhages). Secondly, the incidence of stroke increased by 55 % per 5-year interval compared with 36 % for TIA.

The overall incidence of stroke was 2.90/1000/year and that of TIA 0.45/1000/year. After correction for differences in age and sex, the corresponding incidences in the total Swedish population are calculated to be 2.50/1000/year and 0.39/1000/year, respectively.

Up to 30 April, 1978, 130 (46 %) of the stroke patients and 3 (7 %) of the TIA patients had died. During the same period of time 4 TIA patients developed completed stroke, including one of those who died. A history of TIA was found in 39 (14 %) of the patients with completed stroke.

Lumbar puncture was performed in 60 % of all patients. The other diagnostic procedures are listed in Table 2 and the different types of stroke in Table 3.

Table 2. Diagnostic procedures besides clinical examination and lumbar puncture.

	No. of patients	
	Stroke	TIA
Computed tomography	3	0
Cerebral arteriography	56	10
Isotope-encephalography and EEG	22	2
Isotope-encephalography	10	4
EEG	32	4
X-ray of skull or echoencephalography	76	4

Table 3. Types of stroke.

	CSF examination	Autopsy	Total	
			No.	%
Cerebral infarction	128	4	132	47.0
Intracerebral hemorrhage	40	9	49	17.4
Subarachnoid hemorrhage	12	3	15	5.3
Unclassified	-	-	85	30.3
			281	100.00

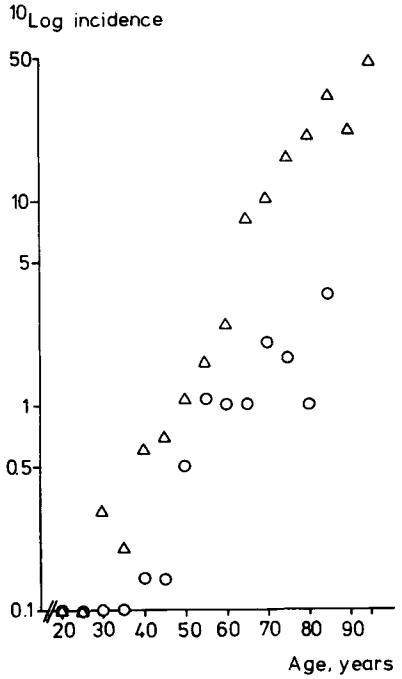

Fig. 3. The age-specific incidence of stroke (triangles) and TIA (circles) in Söderhamn in the period 1975 - 1978.

It is expected that some, at least, of the patients in the 'unclassified' group in Table 3 will be assigned to one of the other three groups when the results of all diagnostic procedures have been analysed. This will be reported in a future communication.

During the study 31 cases of suspected stroke were excluded. The most common reason was the demonstration of a cerebral tumor or an extradural hemorrhage. Other diagnoses giving reason for exclusion were Bell's palsy, Parkinson's disease and peripheral neuropathy.

Of the patients registered, 90.7 % were examined and treated at the medical department from the time of onset of symptoms. Thus, less than 10 % of the patients were primarily treated in their own home or an old people's home, or were found dead from a stroke. Except in the last case they were all examined, mostly several times, by the same doctor who was responsible for the final registration.

DISCUSSION

The choice of a small and very well-defined geographical area has the advantage that it diminishes the risk of patient loss. A final check-up showed that during the three-year period less than 10 per cent of the patients with stroke had been treated or had been found dead before admission to hospital. This figure is well at a level with those reported by other investigators (4, 16, 36).

By using the WHO definitions for stroke and TIA, a comparison with other results is possible. On the other hand, there is still a lack of simple and safe methods for diagnosing different types of strokes. In some comparable studies (3, 35) the diagnosis of a hemorrhagic lesion was based on the same criteria as were used here, and a similar definition was also used by Kannel (22) in the Framingham study. The diagnosis of thrombotic or embolic lesions has been made without any uniformity. The only factor in common in previously presented epidemiological studies has been an exclusion diagnosis with absence of evidence of intracranial bleeding (9). In the present study the lesion was considered of thrombo-embolic origin if the CSF was non-hemorrhagic or if autopsy showed cerebral infarction. However, 30 % of the cases still remain unclassified.

The TIA diagnosis is solely clinical (16). Although the great majority of the TIA population have arteriographically visible lesions in the neck vessels (31, 36, 38, 39), TIA patients lacking these have the same prognosis (39). In spite of exclusion of some cases with a difficult differential diagnosis, TIA as a whole is more unreliable as a diagnostic entity than stroke, as the findings may have disappeared at the clinical examination.

The frequency of autopsy was low in this material, owing to the traditions in this area. However, even in the case of a high autopsy rate it may be difficult to draw firm conclusions from the autopsy in every case (21, 24, 27). Thus, Jörgensen and Torvik (21) found evidence of CVD in 320 patients, of whom only 196 had had previous clinical signs. Recently the combined use of computed tomography and CSF spectrophotometry has been reported to increase the diagnostic reliability (37).

The precision of the measurement must be high to permit an extrapolation of the incidence rates from Söderhamn to other communities (29). Although the population of Söderhamn is rather small, this precision is certainly increased by the fact that a three-year period was used for the study. The incidence of new strokes in the present material, 2.9/1000/year, may by compared with that found previously in other countries. In Finland (4) an incidence of 1.42/1000/year has been reported, while in Denmark (7) it has been estimated to be 2.2/1000/year for males, and 2,5/1000/year for females. These seemingly large differences between the Finnish figure, on the one hand, and the figures from the Danish and the present study, on the other, are reversed if the annual age--specific incidences are calculated (Table 4). In this case the incidence is highest in Finland and lowest in Denmark, with the Söderhamn figures in the intermediate position. This again illustrates the great influence of the age composition of the population on the incidence (25). The proportion of the population above 65 years in the Finnish study was 5.2 per cent, while the corresponding figures for the Danish and the present study were 21 and 18.2, respectively. In Gothenburg, one study with stroke registration in people up to 66 years of age has been published (16). The incidence of new strokes in that city was 0.52/1000/year, compared with 0.53/1000/year in the same age group in Söderhamn. Thus, there seems to be no difference in this respect between a big city and a small town. One retrospective investigation of hospital records in

Table 4. Annual incidence of stroke in some Scandinavia communities, per 1,000 population.

Community	Study years	Males Age (years)			Females Age (years)		
		55-64	65-74	75-84	55-64	65-74	75-84
Fredriksberg Denmark (35)	1971-73	4.5	8.6	14.9	1.9	5.1	14.2
Espoo-Kauniainen Finland (3)	1972-73	4.9	12.2	26.8	2.5	9.5	21.5
Söderhamn Sweden	1975-78	3.4	10.6	22.7	1.0	7.3	17.2

the Uppsala region in 1964 revealed an incidence of 2.3/1000/year, including some cases (18 %) not satisfying the stroke criteria and some with TIA (33). In another retrospective study of hospitalized patients, Frithz (13) calculated the incidence of stroke below 70 years of age to be 0.36/1000/year. This incidence is based on figures from 1967 to 1971. The present corresponding figure in Söderhamn is 1.0/1000/year. A decline was reported for the two decades up to 1971 (6, 14), after which the level remained unchanged up to 1976 (19). Though there has been a shift towards a larger proportion of old people between the two periods 1967 - 1971 and 1975 - 1978, this cannot possibly explain the difference between 0.36 and 1.0. This discrepancy possibly reflects the difficulties of case-finding in retrospective studies.

The TIA incidence in Sweden is so far unknown. The incidence in Söderhamn, 0.45/1000/year, can only be compared with findings in the USA (Table 5). In

Table 5. Annual incidence of TIA and stroke in various communities, per 1,000 population.

Community	Age years	TIA	Stroke
Söderhamn	All	0.45	2.90
Rochester (27, 41)	All	0.31	1.54
Seal Beach (12)	$\geq$ 52	1.1	7.1

Rochester (41) the incidence of TIA at all ages was 0.31/1000/year. In Seal Beach (12), with a population above the age of 55 years it was 1.1/1000/year, compared with 1.0/1000/year in the same age classes in Söderhamn. Thus, stroke seems to be about six times more frequent than TIA. Our findings, as well as reports of other authors (Table 6), show that a history of TIA is known in only 15 - 20 per cent of the stroke patients (3, 16). There is one exception, namely the study from Rochester (27). Here 73 patients out of 777 with presumed cerebral infarction had experienced TIA, constituting only 5.9 per cent of the

Table 6. History of TIA in stroke patients in various studies.

Community	No. of patients	Age years	No. with TIA	Percentage with TIA
Söderhamn	281	All	39	13.9
Espoo-Kauniainen (9)	286	All	44	15.4
Rochester (3, 41)	1245	All	73	5.4
Harlem (23)	328	All	41	12.5

total number of 1,245 stroke patients. This latter low figure supposedly reflects the difficulties in identifying this diagnosis retrospectively. In Söderhamn the youngest cases with stroke come at a lower age than those with TIA. In contrast, however, the mean age is lower in the TIA group. Also, the incidence of TIA increases more slowly than that of stroke. All these observations support the hypothesis that TIA precedes only a minority of strokes. Of course some TIA may be ignored by the patients, but probably not to such a degree that these differences can be explained simply as missing registrations. If this hypothesis is true, only a minority of the strokes may be prevented by good care of TIA patients. On the other hand, the poor prognosis for TIA patients (26, 41) justifies active investigation and treatment.

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