Incidence and Short-Term Outcome of Cerebral Infarction in Young Adults in Western Norway

H. Naess, MD; H.I. Nyland, MD, PhD; L. Thomassen, MD; J. Aarseth, PhD; G. Nyland, MD; K-M. Myhr, MD, PhD

Background and Purpose—We sought to determine the incidence and short-term outcome of people aged 15 to 49 years with first-ever cerebral infarction in 1988–1997 in Hordaland County, Norway.

Methods—Cases were found from computer search of hospital registries and detailed review of patient records. Stroke subtype was classified according to the major intracranial artery affected. Short-term outcome was evaluated by the modified Rankin Scale (mRS).

Results—A total of 96 women and 136 men met the inclusion criteria. The average annual incidence was 11.4/100,000. Women outnumbered men among those aged <30 years (P=0.059); men predominated among those aged ≥30 years (P=0.004). A total of 148 patients had anterior circulation infarction (64%), and 84 had posterior circulation infarction (36%) (P<0.001). Patients with posterior circulation infarction had better mRS score at discharge (P=0.005). Eighty percent had favorable outcome (mRS score ≤2). The 30-day case fatality rate was 3.4%. The recurrence rate in hospital was 2.2%.

Conclusions—The incidence was in the lower range compared with other reports from western Europe. Although men predominated, there was a strong trend toward more women among patients aged <30 years. Short-term outcome was generally good. Patients with posterior circulation infarction had significantly better short-term outcome. (Stroke. 2002;33:2105-2108.)

Key Words: cerebral infarction ■ incidence ■ outcome ■ young adults

The incidence of ischemic stroke increases with age, but the incidence among young adults is not negligible. We sought to determine the average annual incidence rate of first-ever cerebral infarction, classify stroke subtypes, and evaluate the short-term outcome of people aged 15 to 49 years in a well-defined population. To our knowledge, this is the first population-based report on short-term functional outcome of cerebral infarction in young adults.

Subjects and Methods

Patients
All patients aged 15 to 49 years with first-ever cerebral infarction during 1988–1997 living in Hordaland County, Norway, for at least 5 years before the stroke occurred were included. Cases were found by computer search from hospital registries at each of the 5 acute care hospitals in the county. The searching criteria were patients admitted to either an inpatient or an outpatient department and discharged with a diagnosis of primary or secondary stroke: categories 430 to 438 of the International Classification of Diseases, Ninth Revision.

Cerebral infarction was defined in accordance with the Baltimore-Washington Cooperative Young Stroke Study Criteria.1 This definition includes patients who have neurological deficits lasting >24 hours because of ischemic lesions and patients with transient ischemic attacks in whom CT or MRI shows infarctions related to the clinical findings. We excluded patients with cerebral infarction associated with other intracranial diseases such as subarachnoid hemorrhage, sinus venous thrombosis, or severe head trauma. Case selection and classification were based on the examination of the neurologist in charge of treatment and follow-up of the patient as well as critical review of patient records.

Stroke subtypes were categorized according to the intracranial artery involved on the basis of the neurological deficits and CT or MRI findings.

Neurological deficits on admission and discharge were categorized into none, minor, moderate, and severe as defined by Hindfelt and Nilsson2 and were used to determine clinical change during the hospital stay. Because recovery may start early, we excluded patients admitted >24 hours after onset in this analysis. The mRS score, in which 0 represents complete recovery and 6 represents death, was evaluated on discharge. In case of insufficient data, patients were classified in the worst relevant mRS category. Interrater agreement was evaluated on 20 random patients as to mRS classification. A subanalysis of patients aged 15 to 44 years was done to compare our study with similar population-based studies. The number of serious complications was registered. All classification was done retrospectively on the basis of the patient records.

Statistical Analysis
Incidence rates were calculated on the basis of the number of first-ever cerebral infarctions and the population in Hordaland County on January 1 in the respective years. Ninety-five percent CIs...
were calculated on the basis of the Poisson distribution. The test comparing the annual number of patients was based on the assumption that the number of cases each year was independently Poisson distributed. The $\chi^2$ test, Fisher’s test, and nonparametric 2-sample tests were performed when appropriate. All tests were 2 sided.

**Results**

A total of 525 possible study candidates were identified. All had CT or MRI of the brain. Detailed review of patient records disclosed 293 patients who did not fulfill the inclusion criteria because of transient ischemic attack ($n=154$) intracranial hemorrhage ($n=59$), follow-up incompatible with cerebral infarction ($n=39$), cerebral infarction before 1988 ($n=25$), or miscellaneous ($n=16$).

**Incidence**

A total of 232 patients aged 15 to 49 years (96 women [41%] and 136 men [59%]) had a first-ever cerebral infarction during 1988–1997, giving an average annual incidence rate of 11.4/100 000 (95% CI, 9.9 to 12.9). The average annual incidence rate for men was 12.9/100 000 (95% CI, 10.8 to 15.2) and for women was 9.7/100 000 (95% CI, 7.9 to 11.9) ($P=0.036$, test for homogeneity of Poisson rates). The average annual incidence rate among patients aged 15 to 44 years was 6.9/100 000 (95% CI, 5.8 to 8.3). The annual number of patients varied significantly ($P=0.001$, test for homogeneity of Poisson rates) (Figure). More strokes occurred between the spring and autumn equinoxes (summer): 133 versus 99 ($P=0.03$, test for homogeneity of Poisson rates). Forty percent of the patients were hospitalized within 6 hours from onset.

**Age and Sex**

More women than men aged <30 years had cerebral infarction: 16 (70%) versus 7 (30%) ($P=0.059$, test for homogeneity of Poisson rates). Among the patients ≥30 years, men outnumbered women: 129 (62%) versus 80 (38%) ($P=0.004$).

**Stroke Subtype**

More patients had anterior circulation infarction than posterior circulation infarction: 148 (64%) versus 84 (36%) ($P<0.001$, binomial test for proportions) (Table 1). Men and women did not differ regarding the location of infarction in anterior or posterior circulation ($P=0.489$, Fisher’s exact test).

**Neurological Deficits on Admission**

Patients with posterior circulation infarction had significantly milder neurological deficits on admission $\chi^2$ test than did patients with anterior circulation infarction ($P=0.03$, $\chi^2$ test) (Table 2). Most patients admitted >24 hours after onset had minor neurological symptoms.

**Serious Complications**

Five patients (2.2%) had recurrence of cerebral infarction, 10 (4.3%) suffered pneumonia, 5 (2.2%) developed venous thromboembolism, and 7 (3.0%) had epileptic seizures during their hospital stay.

**Short-Term Outcome**

Interrater agreement on mRS classification was good (weighted $\kappa=0.68$). Eighty percent had favorable outcome (mRS $\leq 2$). None needed a nursing home. The mRS score did not differ significantly between the sexes ($P=0.70$, Wilcoxon

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**TABLE 1. Intracranial Artery Affected and Annual Incidence of Cerebral Infarction per 100 000 in the Group Aged 15–44 Years in the Present and Similar Population-Based Studies**

<table>
<thead>
<tr>
<th>Intracranial artery affected, No. (%)</th>
<th>Men</th>
<th>Women</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior cerebral artery</td>
<td>1 (0.7)</td>
<td>2 (2.1)</td>
<td>3 (1.3)</td>
</tr>
<tr>
<td>Middle cerebral artery</td>
<td>83 (61)</td>
<td>62 (64.6)</td>
<td>145 (62.5)</td>
</tr>
<tr>
<td>Posterior cerebral artery</td>
<td>7 (5.1)</td>
<td>13 (13.5)</td>
<td>20 (8.6)</td>
</tr>
<tr>
<td>Vertebrobasilar artery</td>
<td>45 (33.1)</td>
<td>19 (19.8)</td>
<td>64 (27.6)</td>
</tr>
</tbody>
</table>

Population, No. (95% CI)

- Present study, $n=124$ 6.9 (5.3–8.8) 6.9 (5.3–8.9) 6.9 (5.8–8.3)
- Northern Sweden,* $n=88$ 13.6 (6.4–20.8) 8.9 (2.8–15.0) 11.3 (6.7–16.1)
- Baltimore whites, $n=41$ 10.3 (NA) 10.8 (NA) 10.5 (NA)
- Florence, $n=18$ 3.4 (NA) 3.4 (NA) 3.4 (2.0–5.4)
- Reggio Emilia, $n=17$ 8.4 (3.9–16) 7.6 (3.3–14.9) 8.0 (4.7–12.2)

NA indicates not available.

*Group aged 18–44 years.
Table 2. Neurological Deficits on Admission and Discharge (Survivors) for Patients Admitted Within 24 Hours of Onset and mRS Score on Discharge for All Patients

<table>
<thead>
<tr>
<th>Neurological deficits on admission</th>
<th>Anterior Circulation</th>
<th>Posterior Circulation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td>None</td>
<td>0.0</td>
<td>1</td>
</tr>
<tr>
<td>Minor</td>
<td>2</td>
<td>0.0</td>
</tr>
<tr>
<td>Moderate</td>
<td>24</td>
<td>1.6</td>
</tr>
<tr>
<td>Severe</td>
<td>22</td>
<td>1.6</td>
</tr>
<tr>
<td>mRS score</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

2-independent-sample test). The mRS score was better among patients with infarction in the posterior circulation than in the anterior circulation system (P = 0.005, χ² test for linear trend) (Table 2). The difference in outcome between patients with infarction in the anterior and posterior circulation systems reflected the difference in neurological deficits on admission. The degree of recovery was similar for patients in both systems. Eight patients (3.4%) died during the hospital stay (3 men and 5 women) because of either the cerebral infarction (n = 6), secondary hemorrhagic transformation after thrombolytic treatment (n = 1), or poststroke myocardial infarction (n = 1).

Discussion

Acute neurological deficits are alarming symptoms leading to hospital admission for young patients. A previous study found reliable classification of stroke by neurologists based solely on history and neurological examination, supporting the validity of our case finding.

Our series is one of the largest studies based on detailed review of patient records to determine the incidence of cerebral infarction among young adults. The average annual incidence rate was 11.4/100 000 among those aged 15 to 49 years, whereas the average annual incidence rate among those aged 15 to 44 years old was 9.0/100 000. Previous reports from Denmark and Stockholm have disclosed an average annual incidence rate of cerebral infarction among patients aged 15 to 44 years to be 10.5/100 000 and 9.0/100 000, respectively. However, these 2 studies were based solely on hospital surveys or regional inpatient registries, and therefore they suffered from possible methodological weaknesses by only including inpatients, losing some patients with minor symptoms, and wrongly including misclassified cases because of lack of detailed review of patient records.

Several population studies based on review of patient records similar to the present study are presented in Table 1. The incidence of cerebral infarction among those aged 15 to 44 years in the present study was in the lower range.

In accordance with previous studies, we found a rapidly rising incidence with increasing age among patients aged ≥30 years. Furthermore, we found a trend (P = 0.059) toward higher incidence among women aged <30 years than among men, whereas men significantly outnumbered women in older age groups, which is compatible with the findings of Lidegaard et al in Denmark.

The annual number of cases varied markedly during the study period, especially among men. Annual variation was also found in Denmark during 1977–1982. Significantly more strokes occurred between the spring and autumn equinoxes. Annual and seasonal variations indicate possible exogenous causes.

The distribution of infarction according to anterior or posterior circulation (62% versus 38%) is compatible with the findings in a population-based study in northern Sweden (59% versus 41%). In patient series from referral hospitals, the distribution has ranged from 85% versus 15% to 67% versus 33%, indicating relatively more infarctions in the posterior circulation in population-based studies than in other studies.

Knowledge of the outcome of cerebral infarction in young adults is important because of vocation or choice of education. Except mortality, no population studies have described the short-term neurological or functional outcome of young patients. Favorable outcome (mRS score = 2) was found in 80%, and the short-term prognosis was significantly better among patients with posterior circulation infarction. The 30-day mortality rate was low (3.4%) and was compatible with the case fatality within 28 days in northern Sweden (5.7%). The main cause of death in our study was malignant middle cerebral artery infarction. The short-term prognosis did not differ overall between men and women.


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