Stroke in a Saudi Arabian National Guard Community
Analysis of 500 Consecutive Cases From a Population-Based Hospital

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Background and Purpose: We sought to determine the crude incidence rate, patterns, and risk factors associated with different types of stroke in a defined Saudi population.

Methods: Records of 500 (342 male, 158 female) consecutive patients with first-ever stroke admitted from December 1982 to June 1992 in a hospital that exclusively serves the Saudi Arabian National Guard community were reviewed. Diagnosis was confirmed by brain computed tomography, and the most likely etiology was determined on the basis of relevant clinical, radiological, and laboratory data.

Results: The mean age of the patients was 63 ± 17 years. Males predominated in all types of stroke (P < 0.001). The crude annual incidence rate was 43.8 per 100,000. Ischemic strokes accounted for 76.2%, and these included 52% with large and 24.2% with lacunar infarctions. Intracerebral hemorrhage was detected in 21.4%, whereas subarachnoid hemorrhage was rare (2.4%). Hypertension (56%), diabetes mellitus (42%), and cardiopathy (33%) were common risk factors. Sixty-one patients (12%) died during the first month after their stroke.

Conclusions: The study suggests that stroke incidence is low in Saudi Arabia compared with industrialized countries, which could be because of the predominance of young age groups. The overall distribution of stroke types was closer to that of Western populations than to the Japanese, in whom hemorrhagic strokes are highly prevalent. However, the high combined frequencies of lacunar infarctions and intracerebral hemorrhages suggest that disease of the small cerebral arteries played a more important role in Saudis than in Western populations. (Stroke. 1993;24:1635-1639.)

KEY WORDS • cerebrovascular disorders • epidemiology • risk factors • Saudi Arabia

Significant differences in the incidence rate, types, and pattern of strokes have been reported in different regions of the world. An annual incidence per 100,000 population that varies from less than 50 to more than 400 has been documented. In most studies cerebral infarctions were the most common and accounted for 50% to 80% of cases, whereas intracerebral hemorrhage (ICH) was seen in 10% to 30%. A few hospital-based reports from the Arabian peninsula have shown that strokes are more common in the young age group compared with Western patients, but certain similar risk factors are associated with each type of stroke. The King Fahad National Guard Hospital, a modern, well-equipped, tertiary care exclusive facility located in the central region of Saudi Arabia, provides free health care services of excellent quality to Saudi Arabian National Guard employees and their families, including descendants (population, 120,000). It has a 24-hour emergency service, and stroke cases are always treated as inpatients. A few eligible patients who are admitted to other hospitals are also transferred within 1 to 5 days after the attack.

This study describes the crude incidence rate and patterns of stroke in the Saudi Arabian National Guard community and predominant risk factors found with each type of stroke.

Subjects and Methods

The records of 500 consecutive Saudi patients with first-ever stroke (cerebral infarction or hemorrhage, subarachnoid hemorrhage [SAH]) admitted to King Fahad National Guard Hospital between December 1982 and June 1992 (9½ years) were reviewed. The cases of traumatic hemorrhage, transient ischemic attacks not followed by stroke, venous infarctions, and hypertensive encephalopathy were not included.

The relevant information retrieved from the charts included age, sex, history of previous systemic arterial hypertension (blood pressure at a distance from the stroke of 160/95 mm Hg or more; previous or current treatment of hypertension), diabetes mellitus (repeat fasting blood glucose greater than 7.7 mmol/L), cardiac disease (valvular and coronary diseases, dysrhythmias), cigarette smoking, oral contraceptive use, migraine, recent head or neck trauma, and drug abuse. The history of the stroke and also the neurological and general physical examination at admission were evaluated.
The results of the following investigations, which were performed in all patients, were also reviewed: complete blood count, erythrocyte sedimentation rate, electrocardiogram, serum levels of glucose and cholesterol, prothrombin and prothromboplastin time, and brain computed tomography (CT). Other results of investigations that were performed in selected cases were also reviewed: blood serology for syphilis (n=230), hemoglobin electrophoresis (n=32), serum antinuclear antibodies (n=30), complement levels (n=18), coagulation factors (n=32), antiphospholipid antibodies (n=15), cerebrospinal fluid examination (n=54), magnetic resonance imaging (n=26), ultrasound examination of neck vessels (n=22), cerebral angiogram (n=106), two-dimensional transthoracic (n=284) and transesophageal (n=52) echocardiogram, and Holter monitoring (n=53).

Differentiation between cerebral infarct and hemorrhage was based on brain CT findings. A cerebral infarct was diagnosed when CT showed a hypodense area corresponding to the clinical picture or when no lesion was seen. Large infarctions were classified into arterial territories using Damasio’s template mapping.6 Hemorrhagic infarct was identified as hypodense image conforming to a vascular territory within which a non-homogenous area of high density characteristic of blood was present.7 Lacunar infarct was defined by a small, deep, rounded infarct presumably due to an occlusion of a small penetrating artery.8 It was also diagnosed in a case of a typical clinical picture with repeated normal CT. ICH was diagnosed on a parenchymatous hypodense area on brain CT with or without intraventricular leak. SAH was identified by the presence of blood in the subarachnoid space on CT or by bloody cerebrospinal fluid in patients with a typical clinical picture and normal CT.

Cerebral infarction was presumed to be due to atherosclerosis if, in the absence of other obvious, mainly cardiogenic or inflammatory causes, any two of the following risk factors were present: age older than 50 years, hypertension, diabetes mellitus, or heavy smoking (more than 20 cigarettes per day). In the patients in whom cerebral angiography or ultrasound examination of the neck vessels was performed, the presence of an occlusive or stenotic lesion or ulcerated plaque on the corresponding vessel was diagnostic. Cerebral hemorrhage was considered to be due to hypertension when typical fundoscopic and electrocardiographic changes were present without any other obvious cause. Other etiologies were identified by the proper investigative means. Statistical analyses were performed using Student’s t test.

Results

Analysis of the data on 500 consecutive Saudi patients with stroke indicated that there were 342 males (mean±SD age, 65.2±15.8 years; range, 5 months to 100 years) and 158 females (62.2±16.5 years; range, 5 to 100 years). The age and sex distribution of these patients is shown in Fig 1. In both male and female groups the most likely stroke-prone age was 60 to 70 years. The hospital frequency of first-ever stroke patients was 53 per year, reflecting a crude incidence of 43.8 per 100 000 population per year.

Ischemic strokes constituted 76.2% of the cases. Among these were 260 cases of large infarctions (52%) and 121 of lacunar infarctions (24.2%). Intracranial hemorrhages included 107 cases of ICH (21.4%) and 12 cases of SAH (2.4%). Fig 2 describes the age distribution for each type of stroke. Male to female preponderance was evident in all types (P<.001).

Table 1 describes the risk factors associated with each type of stroke. Hypertension, diabetes mellitus, and cardiopathy were common. Cigarette smoking was uncommon, and only very few patients (4% of those with ischemic strokes) had cervical bruits. At least one third of these conditions, mainly cardiopathy, were discovered after the stroke.

The cerebral large infarction group was the largest (260 patients), with a mean age of 66±14 years. Carotid territory was involved on CT in 174 patients (66.9%) and vertebrobasilar territory (including posterior cerebral artery territory) in 74 patients (28.5%). Both territories were involved in 9 patients, including 4 cases of watershed infarction. In 18 patients (7%) a hemorrhagic component was detected in the infarction. A potential source of cardiac embolism was present in 115 patients (44%) (atrial fibrillation in 45, recent myocardial infarction [less than 30 days] in 10, old myocardial infarction in 55, other in 20) and was the only obvious cause in 42 (16%). Atherosclerosis was the only most likely cause in 96 patients (37%) and was associated with a potential source of cardioembolism in another 73 patients (28%). However, the presence of a significant (greater than 70%) atherosclerotic extracranial artery stenosis or occlusion was documented by angiography and/or ultrasonography in 7 patients only. Uncommon causes such as hematologic disorders, infections, dissecting aneurysms, anticoagulant antibodies, pregnancy, and oral contraception were found in 26 cases (10%). No clear etiology or even risk factor was found in 23 cases (9%).

Lacunar infarctions were diagnosed in 121 patients. More than one infarction was detected on CT scan in 39 patients (32.2%). Among the four categories of stroke, age was the highest in this group (67±11 years), and only 5% of the patients were younger than 45 years of age (Fig 2). Of the total patients with lacunar infarc-
Fig 2. Bar graphs show age distribution in 260 patients with large infarcts, 121 with lacunar infarcts, and 107 with intracerebral hemorrhage (ICH).

Intracerebral hemorrhage was diagnosed in 107 patients (mean age, 60±18 years). Hypertensive arteriolopathy was the probable cause in 68 of 107 (63.5%). Table 2 describes the other etiologies. Fifty-two (76%) of the hypertensive ICHs were located in the basal ganglia region, including thalamus, while 23 (56%) of the nonhypertensive ones were lobar. The risk factors associated with ICH are listed in Table 1; in 13% of the patients a potentially embolic cardiopathy (including 4 cases of atrial fibrillation) was present.

Subarachnoid hemorrhage was rare (12 patients [2.4%]; mean age, 57±27 years). In 8 patients an arterial aneurysm was the proven etiology. No cause was found in 2 other patients, and 2 patients were not explored by angiography.

A total of 61 of 500 (12.2%) stroke patients (38 male; 23 female) died in the first 30 days after stroke. Their mean age at death was 67.3±17.9 years. They included 34 patients with large cerebral infarctions (13.1%), 25 patients with ICH (23%), and 2 patients with SAH (16.6%). No patient with lacunar infarction died in the first month. Advanced age appeared to be a strong risk factor.

### Table 1. Risk Factors Related to Type of Stroke

<table>
<thead>
<tr>
<th></th>
<th>Cerebral Large Infarct (n=260)</th>
<th>Lacunar Infarct (n=121)</th>
<th>Cerebral Hemorrhage (n=107)</th>
<th>Subarachnoid Hemorrhage (n=12)</th>
<th>Total (n=500)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>51</td>
<td>62</td>
<td>62</td>
<td>42</td>
<td>56</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>48</td>
<td>57</td>
<td>16</td>
<td>8</td>
<td>42</td>
</tr>
<tr>
<td>Cardiopathy</td>
<td>47</td>
<td>21</td>
<td>13</td>
<td>17</td>
<td>33</td>
</tr>
<tr>
<td>Previous TIA</td>
<td>13</td>
<td>8</td>
<td>1</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>Cigarette smoking</td>
<td>5</td>
<td>9</td>
<td>6</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Cervical bruit</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

Values are percentages. TIA indicates transient ischemic attack.

Hypertension was associated with lacunar infarctions and cerebral hemorrhages compared with other types of stroke. Diabetes mellitus, previous TIAs, and cervical bruits were associated with ischemic strokes compared with hemorrhagic strokes, and cardiac disorders were associated with large infarctions compared with other types of stroke. Cigarette smoking was not associated with any particular type of stroke. Other differences were all significant at the 1% level.
TABLE 2. Probable Etiologies of the 107 Intracerebral Hemorrhage Cases

<table>
<thead>
<tr>
<th>Etiology</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertensive arteriolopathy</td>
<td>68</td>
<td>63.5</td>
</tr>
<tr>
<td>Arteriovenous malformation</td>
<td>6</td>
<td>5.6</td>
</tr>
<tr>
<td>Hemorrhages and coagulopaties</td>
<td>4</td>
<td>3.7</td>
</tr>
<tr>
<td>Tumor (glioma)</td>
<td>2</td>
<td>1.9</td>
</tr>
<tr>
<td>Amyloid angiopathy</td>
<td>2</td>
<td>1.9</td>
</tr>
<tr>
<td>Heroin addiction</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Arteritis</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Spontaneous</td>
<td>24</td>
<td>22.4</td>
</tr>
</tbody>
</table>

factor for early death in that 23 of these patients were aged 75 years or older (P<.01).

Discussion

This study has some limitations, and because it was retrospective there may be underreporting of cases or incomplete data, mainly in regard to clinical symptoms and signs. It is also possible that some patients might have died after their stroke before reaching the hospital. It is unlikely that some patients might have stayed at home because of the free excellent health care system in Saudi Arabia.

Analysis of our data showed that the annual crude incidence rate of stroke was 43.8 per 100 000 population. This was similar to preliminary results of an ongoing stroke registry based on a survey of all hospitals and clinics in a defined area in the Eastern Province of Saudi Arabia, in which the crude stroke incidence rate is approximately 40 per 100 000 per year with a male-female ratio of approximately 2:1. On the other hand, in a total population survey of a defined community in the same region (population, 23 237), the prevalence of stroke was found to be 186 per 100 000, which is one fourth to one third of the commonly reported prevalence in Western societies and is consistent with the low crude incidence rate calculated in our study.

A wide variation in the annual crude incidence of stroke (26 to 422 per 100 000 population) has not only been documented in the European and North American populations but also in developing countries. However, most age-adjusted rates except some Japanese and Far Eastern rates are in the 105 to 280 per 100 000 range. In the absence of basic demographic data in our target population, the age-adjusted rate could not be calculated, and the only conclusion that can be made is that our crude incidence rate was low but similar to that found in other developing countries where the population is predominantly young. Our male-female ratio of 2.2:1 was high compared with other studies and difficult to explain but similar to that found in the stroke registry in eastern Saudi Arabia.

Regarding the 30-day mortality rate, the 12.2% rate was lower than the 17.3% reported from Libya and much less than the rate reported from Nigeria or from the national survey of stroke in the United States, where it was 30.3%. The probable explanation is that in these studies the diagnosis was based mainly on clinical data, and many "benign" strokes (which are now being diagnosed on the basis of CT scan) were probably missed. On the other hand, the management of general medical complications of stroke in the acute phase is now more standardized and effective. Another explanation is the lower frequency of elderly patients in our series of patients.

Ischemic strokes accounted for 76.2% of patients (381/500). This was consistent with most reports, slightly lower than Western studies, but significantly higher compared with Japanese studies (Table 3). SAH (2.4% of cases) was the least common in our study. Its frequency was much lower than both Western and Japanese figures and even lower than the Libyan report of 4.5%. However, it was similar to previous studies from other parts of Saudi Arabia where the majority of SAH patients were expatriates. In one hospital-based study, Far Eastern young expatriates were seven times more at risk of developing spontaneous intracranial hemorrhage than Arabs.

In our study 107 cases (21.4%) were due to cerebral hemorrhage, and the combined frequency of both lacunar infarctions and ICH was 45.6%. These two types of stroke, which are generally related to small-artery disease and are more directly linked to hypertension, had a much higher combined frequency in our series compared with Western figures. On the other hand, in the patients in whom angiographic studies were performed, the extracranial arterial atherosclerotic lesions were rare. Although cervical bruit is a poor indicator of carotid stenosis, its frequency was even lower in our population than the prevalence rate reported in the normal population in the United States aged older than 45 years and one quarter to one third of its rate in hypertensive patients. Racial differences in the distribution of occlusive cerebrovascular disease are well established. Blacks, Japanese, and probably Chinese have a tendency toward intracranial occlusive disease, whereas whites have more extracranial disease. However, other factors may play a role. While hypertension has been documented as a risk factor for atherosclerotic disease in cerebral arteries of all calibers, cigarette smoking seems to be mainly a risk factor for large extracranial arteries. The low rate of smoking in women and the elderly Saudi population

| Table 3. Pattern of Strokes in Saudi Patients Compared With Other Studies |
|-----------------------------|----------------|----------------|------------|----------------|
|                             | Present Study | Harvard17 | Lausanne18 | Akita19       |
| Large infarct               | 52            | 65        | 71         | 56            |
| Lacunar infarct             | 24            | 19        | 17         |               |
| Cerebral hemorrhage         | 21            | 10        | 12         | 30            |
| Subarachnoid hemorrhage     | 2             | 6         | Excluded   | 14            |

Values are percentages.
could be another explanation for the low frequency of cervical bruits in Saudi patients. The extremely low consumption of alcohol can also be a contributory factor.27

Both hypertension and diabetes mellitus are highly prevalent in Saudi Arabia. A 10% incidence of hypertension was reported in the population aged 40 to 60 years,28 and a variable frequency (2% to 12%) of diabetes mellitus was also described from different regions of the country.29 Among treatable risk factors, hypertension was the most important and highly prevalent in our patients (Table 1). The presence of various types of heart disease such as atrial fibrillation, ischemic heart disease, valvular disease, and cardiomyopathy independently increases the risk of stroke. All these cardiac abnormalities were frequent in our patients (33%), suggesting that cardiac embolism probably played an important role in the development of ischemic stroke. Diabetes mellitus, an important risk factor for stroke in general and cerebral infarction in particular, was present in 42% of our cases. In the Framingham Study30 it was the most predictive factor, but it was far more common in our patients.

In summary, despite its limitations, this study offers some preliminary data on stroke from an area particularly known for its climate, demography, and social habits. The calculated crude incidence of stroke in the Saudi Arabian National Guard community was extremely low compared with industrial societies, but this was probably due to the young age of the population. Ischemic strokes were highly prevalent, and the overall distribution of stroke types was similar to that in Western reports compared with that in Japanese reports. Strokes related to disease of the small cerebral arteries and linked to hypertension, such as lacunar infarctions and cerebral hemorrhage, were common. Among the associated risk factors, both cervical bruits and cigarette smoking were rare, whereas hypertension, diabetes mellitus, and cardiopathy were frequently encountered and often discovered at the time of the stroke.

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