Stroke in Young Adults in the Community-Based L'Aquila Registry

Incidence and Prognosis

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Background and Purpose—Stroke type in the young may influence the outcome and may have a dramatic impact on the quality of life in survivors. This study aimed to evaluate the incidence and prognosis of first-ever stroke in the young and to make comparisons with older patients within a well-defined population.

Methods—All first-ever strokes occurring in the L'Aquila district, central Italy, were traced by active monitoring of inpatient and outpatient health services. Incidence rates were standardized to the 1996 European population according to the direct method. Long-term survival was estimated by the Kaplan-Meier method; outcome in survivors was evaluated by the modified Rankin scale.

Results—Of 4353 patients who had a first-ever stroke, 89 patients <45 years of age (55 men and 34 women) (2%) were identified in a 5-year period. Mean age±SD was 36.1±8.1 years. Twenty patients (22.5%) had a subarachnoid hemorrhage, 18 (20.2%) an intracerebral hemorrhage, and 51 (57.3%) a cerebral infarction. The corresponding proportions in patients >45 years of age were 2.4%, 13.3%, and 83.1%. Neuroimaging studies of the brain detected 14 intracranial aneurysms and 6 arteriovenous malformations in 20 of 38 patients (52.6%) with either subarachnoid (n=17) or intracerebral (n=3) hemorrhage. The crude annual incidence rate was 10.18/100 000 (95% CI, 8.14 to 12.57) and 10.23/100 000 when standardized to the 1996 European population. The 30-day case-fatality rate was 11.2% (95% CI, 6.2 to 19.4). Patients with subarachnoid hemorrhage had the highest proportion of good recovery (60%), patients with intracerebral hemorrhage had the highest mortality (44%), and patients with cerebral infarction had the highest proportion of severe disability (47%).

Conclusions—Stroke patients <45 years of age showed a disproportionate cumulative high prevalence (42.7%) of subarachnoid and intracerebral hemorrhage with respect to older patients (15.7%), mainly (52.6%) due to aneurysms and arteriovenous malformations. Therefore, screening procedures and preventive strategies in the young should also be addressed to subjects at risk of subarachnoid and intracerebral hemorrhage. **(*Stroke*. 2001;32:52-56.)**

Key Words: incidence ■ prognosis ■ stroke ■ young adults

In Western countries, <5% of all strokes occur in subjects <45 years of age.[1] Higher proportions, between 19% and 30%, were reported in developing countries.[2,3] Stroke incidence rates in the young were reported by few surveys and were rarely assessed by community-based studies with adequate methodology.[1,3–10] Moreover, reported incidence rates had wide CIs because of the small number of incident cases in the young.[1,3–10]

This study aimed to evaluate the incidence and prognosis of first-ever stroke in the young and to make direct comparisons with patients in the older age group within a well-defined population.

Subjects and Methods

Study Design

The prospective community-based registry of stroke patients residing in the L'Aquila district, central Italy, started on January 1, 1994, and ended on December 31, 1998.[11] Stroke was defined as rapidly developing signs of focal or global disturbance of cerebral function, lasting >24 hours or leading to death, with no apparent cause other than that of vascular origin (codes 430 to 434 and 436 to 437, *International Classification of Diseases, 9th Revision* [ICD-9]).[11,12] Codes of the *Application of the International Classification of Diseases to Neurology* (ICD-10 NA) were also applied to patients who had neuroimaging studies of the brain to define stroke types and pathogenic mechanisms.[13] Study population and methodology were detailed elsewhere.[11]

Among a total resident population of 297 838 individuals, 174 875 (58.7%) were <45 years of age. The proportion of subjects in this age group was stable (+1%) between 1981 and 1991.[14] Because of the wide availability of health services in the district, nearly all young stroke patients included in the registry were probably referred to hospitals. All subjects were followed up with quarterly planned visits or a complete phone interview with the patient or the next of kin when appropriate, by means of a semistructured questionnaire,

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TABLE 1. ICD-9 vs ICD-10 NA Codes in 89 Patients <45 Years of Age

ICD-9 Codes		ICD-10 NA Codes		No. of Patients
430	Subarachnoid hemorrhage	I60.00	Aneurysm at the origin of OA	1
		I60.10	Aneurysm of MCA (M1, horizontal segment)	2
		I60.11	Aneurysm at the major bifurcation of the MCA	1
		I60.20	Aneurysm of the AcoA	3
		I60.30	Aneurism of PcoA	1
		I60.41	Mid-BA aneurysm	1
		I60.64	Aneurysm of proximal PCA	1
		I60.8000	Ruptured AVM in hemisphere, cortical frontal	1
		I60.8001	Ruptured AVM in hemisphere, cortical temporal	1
		I60.8002	Ruptured AVM in hemisphere, cortical parietal	1
		I60.804	Ruptured AVM in cerebellum	1
		I60.90	Subarachnoid hemorrhage, unspecified	3
		I60.91	Primary subarachnoid hemorrhage	3
431–432	Intracerebral hemorrhage (including other and unspecified)	I61.00	Deep IH, basal ganglia	1
		I61.01	Deep IH, thalamus	1
		I61.02	Deep IH, internal capsule	1
		I61.11	Superficial IH, temporal	2
		I61.12	Superficial IH, parietal	2
		I61.17	Superficial IH, involving >1 lobe	7
		I61.31	IH in brain stem, pons	1
		I61.60	IH, multiple localized	1
		I62.02	Subdural hemorrhage, chronic nontraumatic	2
433–434	Occlusion and stenosis of precerebral and cerebral arteries	I63.00	CI, thrombosis of ICA	1
		I63.07	CI, thrombosis of MuPA	1
		I63.10	CI, embolism of ICA	1
		I63.30	CI, thrombosis of MCA	5
		I63.31	CI, thrombosis of ACA	1
		I63.32	CI, thrombosis of PCA	2
		I63.36	CI, thrombosis of LSA	2
		I63.39	CI, thrombosis of MuA	5
		I63.40	CI, embolism of MCA	1
		I63.46	CI, embolism of LSA	1
		I63.50	CI, unspecified occlusion or stenosis of MCA	12
		I63.51	CI, unspecified occlusion or stenosis of ACA	1
		I63.52	CI, unspecified occlusion or stenosis of PCA	3
		I63.55	CI, unspecified occlusion or stenosis of PICA	1
		I63.56	CI, unspecified occlusion or stenosis of LSA	7
		I63.9	CI, unspecified	7
Total				89

OA indicates ophthalmic artery; MCA, middle cerebral artery; AcoA, anterior communicating artery; PcoA, posterior communicating artery; BA, basilar artery; AVM, arteriovenous malformation; IH, intracerebral hemorrhage; CI, cerebral infarction; ICA, internal carotid artery; MuPA, multiple precerebral arteries; ACA, anterior cerebral artery; PCA, posterior cerebral artery; LSA, lenticulostriate arteries; MuA, multiple arteries; and PICA, posterior inferior cerebellar artery.

up to June 30, 2000. Outcome events were represented by nonfatal or fatal stroke recurrence and death from either cardiovascular or noncardiovascular causes. Functional outcome was evaluated by means of the modified Rankin scale (mRS) and considered as recorded at the last available follow-up visit.[15] The mRS is a 7-point scale that assesses overall function and mortality, because patients who die are scored with the worst possible score (6) in this scale. In the present study, patients were regarded as having a good recovery when the score was between 0 and 2 and severe disability when the score was between 3 and 5.

TABLE 2. Incidence Rates (per 100 000/y) for Pathological Groups of First-Ever Strokes According to Sex and Age, in Subjects <45 Years of Age in the L'Aquila District

	Subarachnoid Hemorrhage			Intracerebral Hemorrhage			Cerebral Infarction			Total		
Age, y	No. of Patients	Rate	95% CI	No. of Patients	Rate	95% CI	No. of Patients	Rate	95% CI	No. of Patients	Rate	95% CI
Men												
0–14	1	0.81	0.02–4.50	...	...	...	2	1.62	0.20–5.83	3	2.42	0.50–7.08
15–24	2	1.89	0.23–6.83	1	0.95	0.02–5.27	1	0.95	0.02–5.27	4	3.78	1.03–9.68
25–34	4	3.64	0.99–9.31	3	2.73	0.56–7.97	3	2.73	0.56–7.97	10	9.09	4.36–16.72
35–44	5	4.81	1.56–11.24	10	9.63	4.62–17.70	23	22.15	13.85–33.61	38	36.59	25.75–50.48
Women												
0–14	...	...	...	...	...	...	...	...	...	...	...	...
15–24	...	...	...	1	0.97	0.02–5.39	1	0.97	0.02–5.39	2	1.94	0.23–6.99
25–34	2	1.83	0.22–6.60	1	0.91	0.02–5.09	5	4.57	1.48–10.67	8	7.32	3.15–14.41
35–44	6	5.99	2.20–13.05	2	2.00	0.24–7.21	16	15.98	9.14–25.96	24	23.98	14.82–36.71
Both												
0–14	1	0.41	0.01–2.30	...	...	...	2	0.83	0.10–2.98	3	1.24	0.26–3.62
15–24	2	0.96	0.12–3.45	2	0.96	0.12–3.45	2	0.96	0.12–3.45	6	2.87	1.05–6.25
25–34	6	2.74	1.00–5.96	4	1.82	0.50–4.67	8	3.65	1.57–7.19	18	8.21	4.87–12.97
35–44	11	5.39	2.69–9.65	12	5.88	3.04–10.28	39	19.12	13.39–26.49	62	30.40	22.27–38.85
Total	20	2.29	1.40–3.53	18	2.06	1.22–3.25	51	5.83	4.38–7.60	89	10.18	8.14–12.57

Statistical Analysis

Average crude incidence rates were calculated over the study period. Ninety-five percent CIs for incidence rates were calculated assuming the Poisson distribution.[16] The expected number of patients missed by all the case-finding sources was estimated by a log-linear model including inpatient, outpatient, and death certificate sources, together with their second-order interaction terms.[11,17] All data used for comparisons were standardized for age and sex by the direct method to the 1996 European population.[18] Student's *t* test was used to compare group means. Survival after stroke was estimated by the Kaplan-Meier method, and comparisons among stroke types were performed by means of the log-rank test. Two-sided values of $P<0.05$ were considered to indicate statistical significance.

Results

During the study period, we identified 171 patients <45 years of age with clinical signs attributable to stroke. After comprehensive evaluation, 82 patients were excluded because of stroke due to head trauma (n=55; 67%), residence out of the district (n=17; 21%), perinatal intracerebral hemorrhage (n=3; 4%), transient ischemic attack (n=6; 7%), and recurrent stroke (n=1; 1%). The proportion of first-ever strokes in subjects <45 years of age was 2%, ie, 89 of 4353 patients. Fifty-five were men (61.8%) and 34 women (38.2%); mean age±SD was 36.1±8.1 years. It was estimated that ≈2 patients (2.2%) were missed by the capture-recapture technique. All patients but 1 were hospitalized, either within (n=79) or out of the district (n=9). Mean duration of hospital stay was shorter ($P=0.03$) in subjects <45 years of age (10.4±11.4 days) than in those >45 (13.0±10.6 days). All patients underwent brain CT (n=63), MRI (n=22), or both (n=4) at least once. Mean duration of follow-up was 49.7 months (range, 19.2 to 78.9 months).

Table 1 shows the distribution of stroke types according to the ICD-9 compared with the ICD-10 NA classification. Twenty patients (22.5%) had a subarachnoid hemorrhage, 18 (20.2%) an intracerebral hemorrhage, and 51 (57.3%) a cerebral infarction. The corresponding proportions for patients >45 years old were 2.4%, 13.3%, and 83.1%, with 1.2% of ill-defined cerebrovascular disease. The cumulative proportion of patients with subarachnoid and intracerebral hemorrhage was 42.7% in patients <45 years of age and 15.7% in patients >45 years. In 20 of 38 young patients (52.6%) with either subarachnoid (n=17) or intracerebral (n=3) hemorrhage, neuroimaging studies of the brain detected 14 intracranial aneurysms and 6 arteriovenous malformations.

In patients <45 years of age (Table 2), the crude annual incidence rate of first-ever stroke was 10.18/100 000 (95% CI, 8.14 to 12.57). Incidence rates increased steeply with age, with 30.3% of the events occurring in patients <35 years of age. Annual crude incidence rates were 2.29/100 000 for subarachnoid hemorrhage, 2.06/100 000 for intracerebral hemorrhage, and 5.83/100 000 for cerebral infarction. The incidence rate was 10.23/100 000 (Table 3) when standardized by age and sex to the 1996 European population and was within the range of the rates reported in comparable registries (9.7 to 13.8/100 000).

Ten patients died within 30 days of stroke onset. Six were men and 4 women; 7 patients had an intracerebral and 3 a subarachnoid hemorrhage; 9 were comatose since stroke onset; and 5 had arterial hypertension and 4 diabetes mellitus. The 30-day case-fatality rate was 11.2% (95% CI, 6.2 to 19.4). The 1-year case-fatality rate did not change because of the absence of any further event. The 30-day case-fatality rate for patients >45 years was 25.0%. Long-term survival was better in patients <45 years of age (n=89) than in those >45 years (n=4264) ($P<0.0001$; log-rank test) (Figure 1). One patient who had recovered from an intracerebral hemorrhage

TABLE 3. Crude and Age- and Sex-Standardized Incidence Rates (per 100 000/yr) of First-Ever Stroke in Patients <45 Years of Age According to Different Registries

Stroke Registry	Crude Rate	95% CI	Standardized Rate*
OCSP 1981–86[6]	9.27	6.15–13.41	9.74
Malmö 1989†[7]	10.19	5.42–17.42	10.07
Perth 1989–90[8]	13.61	8.19–21.25	13.83
Warsaw 1991–92[9]	14.76	10.03–20.97	13.51
Belluno 1992–93[10]	10.27	5.47–17.57	10.65
L'Aquila 1994–98	10.18	8.14–12.57	10.23

*Standardized to the 1996 European population.
†Standardized only by sex.

died of pneumonia after 3 years, and 1 patient who suffered a cerebral infarction had a nonfatal stroke recurrence after 3 months.

The long-term functional outcome evaluated by means of the mRS varied according to stroke type (Figure 2). Patients with subarachnoid hemorrhage had the highest proportion of good recovery (n=10; 60%), with a mortality rate of 15% (n=3); patients with intracerebral hemorrhage had the highest mortality (n=8; 44%) and the lowest proportion of severe disability (n=3; 17%); and patients with cerebral infarction had the highest proportion of severe disability (n=24; 47%) and no deaths.

Discussion

In subjects <45 years of age, the annual crude incidence rate of first-ever stroke was low (10.18/100 000). The cumulative proportion of patients with subarachnoid and intracerebral hemorrhage was higher (42.7%) than in patients >45 years of age (15.7%).[1,5,19] The 30-day case-fatality rate was lower (11.2%) than in patients >45 years of age (25.0%). Intracerebral hemorrhage was associated with the highest mortality, and cerebral infarction was associated with the most severe disability.[19,20] Hospital stay was shorter for the younger (10.4 days) than for the older (13.0 days) patients because of less comorbidity and different distribution of the stroke types.[20]

The strength of the present study relies on the inclusion of a number of cases allowing precise estimates of incidence and outcome of stroke in the young within a well-defined and stable population. Thoroughness of case ascertainment, together with a very high rate of hospitalization of the young

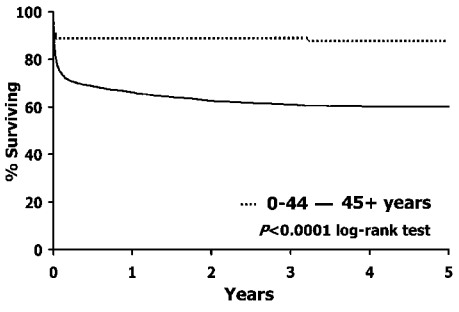

Figure 1. Long-term survival after a first-ever stroke in the L'Aquila district according to age >45 and <45 years.

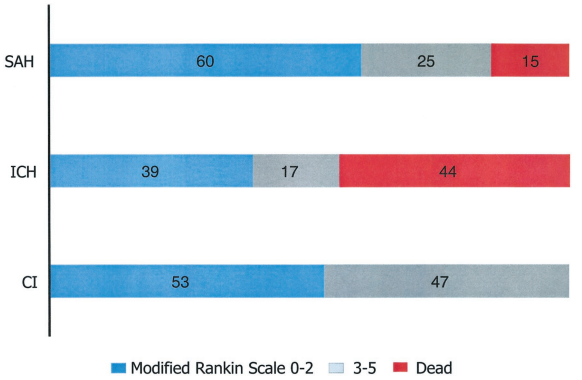

Figure 2. Prognosis of first-ever stroke in the young according to the mRS at the last follow-up visit. SAH indicates subarachnoid hemorrhage; ICH, intracerebral hemorrhage; and CI, cerebral infarction.

patients, allowed unbiased diagnoses and comprehensive follow-up.[11] Nevertheless, the number of patients included might have been too small to analyze associations with more rare risk factors and comorbid conditions. In addition, because the study was designed as a community-based study, the diagnostic protocol did not evaluate uncommon stroke causes. Any exhaustive investigation of pathogenetic determinants was beyond the scope of the study.

In comparisons with other studies, our incidence rate was within the range of comparable registries from Western countries (9.7 to 13.8/100 000) that used a similar methodology and included patients in the same age range[6–10] and within the range of most of the other studies.[1,3–5,20] Higher rates were reported by a few studies with less accurate identification of the study population.[2,21,22] The cumulative proportion of subarachnoid and intracerebral hemorrhage in young patients, although high (42.7%), was within the range found in previous studies (33.3% to 57.5%).[1,5–10] The prevalence of aneurysms and arteriovenous malformations in patients with subarachnoid and intracerebral hemorrhage was also relevant (52.6%), although in the range reported by other studies (49% to 75%).[1,5,19]

Stroke was a rare event in the young; the annual incidence rate was 10.18/100 000, representing 2% of all strokes. Stroke was even rarer in patients <35 years old; only 30.3% of our young patients with a first-ever stroke belonged to this age group. However, because of the longer expected survival at this age, young patients accounted for as much as 20% of the years of potential life lost because of the stroke.[23] The high proportion of subarachnoid and intracerebral hemorrhages in patients <45 years old mandates tailored preventive strategies. In addition, because 52.6% of the subarachnoid and intracerebral hemorrhages were due to aneurysms or arteriovenous malformations, some events might have been prevented by means of invasive and expensive screening strategies applied to asymptomatic patients.[24] Screening protocols that focused on the relatives of patients who suffered from subarachnoid hemorrhage might potentially be cost-effective.[25] It is worth mentioning the exclusion from our study of a relevant number of patients who suffered a stroke related to head trauma.

Although the 30-day case-fatality rate in patients <45 years of age was less than half of that reported in patients >45 years (11.2% versus 25.0%), stroke in the young does not represent a benign event.[23] The role of arterial hypertension in comatose patients with early death might have depended on previous reduced compliance with antihypertensive treatment, whereas any interpretation of the role of diabetes mellitus requires further study. As already shown, however, stroke type was the most important predictor of mortality. In addition, it should be emphasized that in our study, the low case-fatality rate was attributable primarily to the lack of short- and long-term mortality in young patients with cerebral infarction. Disability after the first stroke was inversely related to mortality, at variance with other studies.[20]

The question of whether appropriate diagnostic procedures might identify a larger proportion of subjects at risk of subarachnoid and intracerebral hemorrhage remains unanswered and should be addressed by future research. Nevertheless, the proper identification and evaluation of factors that might influence outcome and especially return to work after stroke is mandatory to reduce the global burden of this disease, which, although rare, maintains a relevant social impact in the young.

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References

1. Nencini P, Inzitari D, Baruffi MC, Fratiglioni L, Gagliardi R, Benvenuti L, Buccheri AM, Cecchi L, Passigli A, Rosselli A, Amaducci L. Incidence of stroke in young adults in Florence, Italy. *Stroke*. 1988;19: 977–981.
2. Radhakrishan K, Ashok PP, Sridharan R, Mousa ME. Stroke in the young: incidence and pattern in Benghazi, Libya. *Acta Neurol Scand*. 1986;73:434–438.
3. Kittner SJ, McCarter RJ, Sherwin RW, Sloan MA, Stern BJ, Johnson CJ, Buchholz D, Seipp MJ, Price TR. Black-white differences in stroke risk among young adults. *Stroke*. 1993;24(suppl I):I-13–I-15.
4. Ellekjær H, Holmen J, Indredavik B, Terent A. Epidemiology of stroke in Innherred, Norway, 1994 to 1996: incidence and 30-day case-fatality rate. *Stroke*. 1997;28:2180–2184.
5. Guidetti D, Baratti M, Zucco R, Greco G, Terenziani S, Vescovili E, Sabadini R, Bondavalli M, Masini L, Salvarani C, Solimé F. Incidence of stroke in young adults in the Reggio Emilia area, Northern Italy. *Neuroepidemiology*. 1993;12:82–87.
6. Bamford J, Sandercock P, Dennis M, Burn J, Warlow C. A prospective study of acute cerebrovascular disease in the community: the Oxfordshire Community Stroke Project—1981–86, II: incidence, case fatality rates and overall outcome at one year of cerebral infarction, primary intracerebral and subarachnoid haemorrhage. *J Neurol Neurosurg Psychiatry*. 1990;53:16–22.
7. Jerntorp P, Berglung G. Stroke registry in Malmö, Sweden. *Stroke*. 1992;23:357–361.
8. Anderson CS, Jamrozik KD, Burvill PW, Chakera TMH, Johnson GA, Stewart-Whynne EG. Ascertaining the true incidence of stroke: experience from the Perth Community Stroke Study, 1989–1990. *Med J Aust*. 1993;158:80–84.
9. Czlonkowska A, Ryglewicz D, Weissbein T, Baranska-Gieruszczak M, Hier DB. A prospective community-based study of stroke in Warsaw, Poland. *Stroke*. 1994;25:547–551.
10. Lauria G, Gentile M, Fassetta G, Casetta I, Agnoli F, Andreotta G, Barp C, Caneve G, Cavallaro A, Cielo R, Mongillo D, Mosca M, Olivieri PG. Incidence and prognosis of stroke in Belluno province, Italy: first-year results of a community-based study. *Stroke*. 1995;26:1787–1793.
11. Carolei A, Marini C, Di Napoli M, Di Gianfilippo G, Santalucia P, Baldassarre M, De Matteis G, di Orio F. High stroke incidence in the prospective community-based L'Aquila registry (1994–1998): first year's results. *Stroke*. 1997;28:2500–2506.
12. World Health Organization. *Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death*. 9th rev. Geneva, Switzerland: WHO; 1977;vol 1.
13. World Health Organization. *Application of the International Classification of Diseases to Neurology (ICD-10 NA)*. 2nd ed. Geneva, Switzerland: WHO; 1997.
14. Istituto Centrale di Statistica. Popolazione e abitazioni: 13° Censimento generale della popolazione e delle abitazioni, 20 ottobre 1991, Fascicolo provinciale 66, L'Aquila; Rome, Italy. 1993:1–300.
15. van Swieten JC, Koudstaal PJ, Visser MC, Schouten HJA, van Gijn J. Interobserver agreement for the assessment of handicap in stroke patients. *Stroke*. 1988;19:604–607.
16. Schoenberg BS. Calculating confidence intervals for rates and ratios: simplified method utilizing tabular values based on the Poisson distribution. *Neuroepidemiology*. 1983;2:257–265.
17. McCarty DJ, Tull ES, Moy CS, Kwoh CK, LaPorte RE. Ascertainment corrected rates: applications of capture-recapture methods. *Int J Epidemiol*. 1993;22:559–565.
18. EUROSTAT. *Demographic Statistics, 1997: Population and Social Conditions*. Luxembourg: Office for Official Publications of the European Communities; Yearbooks and yearly statistics 3A; 1997:1–275.
19. Ruìz-Sandoval JL, Cantù C, Barinagarrementeria F. Intracerebral hemorrhage in young people: analysis of risk factors, location causes, and prognosis. *Stroke*. 1999;30:537–541.
20. Rozenthul-Sorokin N, Ronen R, Tamir A, Geva H, Eldar R. Stroke in the young in Israel: incidence and outcomes. *Stroke*. 1996;27:838–841.
21. Giroud M, Beuriat P, Vion P, D'Athis PH, Dusserre L, Dumas R. Stroke in a French population study. *Neuroepidemiology*. 1989;8:97–104.
22. Bonita R, Broad JB, Beaglehole R. Changes in stroke incidence and case-fatality in Auckland, New Zealand, 1981–91. *Lancet*. 1993;342: 1470–1473.
23. Marini C, Totaro R, Carolei A, for the National Research Council Study Group on Stroke in the Young. Long-term prognosis of cerebral ischemia in young adults. *Stroke*. 1999;30:2320–2325.
24. Mast H, Young WL, Koenncke HC, Sclacca RR, Osipov A, Spolman JP, Hacein-Bey L, Duong H, Stein BM, Mohr JP. Risk of spontaneous hemorrhage after diagnosis of cerebral arteriovenous malformation. *Lancet*. 1997;350:1065–1068.
25. Raaymakers TWM, the MARS Study Group. Aneurysms in relatives of patients with subarachnoid hemorrhage: frequency and risk factors. *Neurology*. 1999;53:982–988.

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