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Research Report

Long-Term Relative Survival in Elderly Patients After Carotid Endarterectomy
A Population-Based Study

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Background and Purpose—Octogenarians were not included in the major trials of carotid endarterectomy. Concern has been expressed about the role of carotid endarterectomy in this age group. This concern is based in part on uncertainty about the long-term survival of elderly patients after carotid endarterectomy. The aim of the present study was to assess relative survival in those patients ≥80 years of age undergoing carotid endarterectomy.

Methods—A population-based record linkage study of all patients who underwent carotid endarterectomy from 1988 to 1998 in Western Australia was undertaken. Long-term relative survival after carotid endarterectomy was assessed against age- and sex-matched controls.

Results—During the period 1988 to 1998, 1796 (1306 male, 490 female) cases were identified. There were 151 patients ≥80 years of age. The cumulative survival at 5 years was 64.9% for those ≥80 years of age compared with 80.1% for those <80 years of age. Relative survival at 5 years was 118% (95% CI, 102 to 134) for those ≥80 years of age compared with 94.7% (95% CI, 92 to 97) for those <80 years of age.

Conclusions—Long-term relative survival after carotid endarterectomy in patients ≥80 years of age was better than that of an age-matched population. The likelihood of living long enough to gain benefit from a carotid endarterectomy is not jeopardized by being too old. (*Stroke*. 2003;34:e95-e98.)

Key Words: carotid endarterectomy ■ octogenarian ■ survival

Over the last decade, reports from the 2 major randomized clinical trials of carotid endarterectomy (CEA) have provided the scientific basis for the management of symptomatic carotid artery stenosis.[1,2] Because patients, institutions, and surgeons participating in these trials were carefully selected, it is not surprising that the surgical results were outstanding. Surgeons working with variable levels of individual skill and a more complex and aging case mix have endeavored to emulate these results ever since their publication.

One increasingly important group of patients excluded from the major trials are those ≥80 years of age.[3] Recent reanalysis of outcome in these trials based on age showed that patients ≥75 years of age obtained more benefit from CEA than younger patients.[4,5] The reason is that older patients have the highest risk of ischemic stroke if treated medically and the lowest surgical risk.[5] Whether this finding also applies to patients ≥80 years of age cannot be readily answered from the trial data.

There are reports that the elderly, including octogenarians, can undergo CEA safely.[6] Despite cogent arguments[3] that most octogenarians would probably live long enough to benefit from CEA, there are few studies of long-term survival in the very elderly after CEA. The present study used data from the Western Australia Data Linkage System to measure the long-term survival of patients undergoing CEA to assess relative survival in the very elderly.

Patients and Methods

The Western Australia Data Linkage System has been described elsewhere.[7] All patients who had CEA during the period 1988 to 1998 were selected by use of the International Classification of Diseases, Clinical Modifications (ninth revision) procedure code 38.12. Details of presenting symptoms and severity of carotid stenosis were not contained within the database. Any strokes occurring within 30 days were identified with diagnosis codes 430, 431, 433, 434, and 436.[8] A number of patients had >1 CEA; all analyses of outcome are based on the first procedure. Validation of 17% of records with an audit database and medical records from a single institution revealed no coding errors (false-positive cases) and 1.3% missing cases (false-negative cases).

Relative survival is the ratio of the survival observed in patients to the survival of a population that matched by calendar period, geographical location, age, and sex. Relative survival analysis was

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Summary Data Comparing Patients Aged 80 Years or More With Those Aged Under 80 Years

	<80 Years (n=1645)	≥80 Years (n=151)	P Value
Females, %	440 (27)	50 (33)	0.09
LOS: median (IQ range)	6 (4–11)	6 (4–12)	0.13
Case fatality within 30 days	28 (1.7%)	4 (2.6%)	0.40
Combined fatality or nonfatal stroke within 30 days	46 (2.8%)	4 (2.6%)	0.34
Fatal ischemic stroke (>30 days)	37 (9.4%*)	2 (4.4%**)	0.41
Fatal hemorrhagic stroke (>30 days)	7 (1.8%*)	2 (4.4%**)	0.23

*Using total late deaths in those <80 years (n=393) as denominator.
**Using total late deaths in those ≥80 years (n=45) as denominator.
LOS indicates length of stay; IQ, interquartile.

performed with a SAS macro based on the Hakulinen method.[9] The computer program was modified to include annual life table data for the Western Australian population in 1980 to 1998 supplied by the Australian Bureau of Statistics. Differences in relative survival by sex and octogenarian age group were evaluated by 95% CIs. Other differences between patients <80 and ≥80 years of age were determined by the χ^2 and Wilcoxon tests. Cox proportional-hazards regression evaluated the effect of sex on the risk of dying, adjusting for age.

Results

During the period 1988 to 1998, 1796 patients underwent CEA in Western Australia. Of these, 227 patients subsequently underwent a contralateral CEA. There were 1306 men with a mean±SD age of 68.7±8.4 years and 490 women with a mean±SD age of 69.6±8.7 years. Overall case fatality within 30 days was 1.7% for men and 2.2% for women. There were 18 nonfatal strokes (1%) within 30 days of surgery, all occurring in patients <80 years of age. The median length of follow-up was 4.7 years, representing a total of 9200 person-years. Cumulative survival at 5 years from date of admission for the first procedure was 77.8% (95% CI, 75.4 to 80.3) for men and 82.2% (95% CI, 78.5 to 85.6) for women. There was no difference in the risk of dying between men and women (hazard ratio, 1.175; P=0.12).

There were 101 men (8%) and 50 women (10%) ≥80 years of age. The proportion of octogenarians increased steadily from 1.5% in 1988 to 1990 to 12.4% in 1997 to 1998. Differences between patients ≥80 and <80 years are summarized in the Table. The cumulative survival at 5 years for octogenarians and for those <80 years of age is shown in Figure 1 (log rank test, $\chi^2=16.34$, P<0.0001); relative survival is shown in Figure 2.

Discussion

Although randomized clinical trials provide the basis for practice guidelines, population-based data can be used to assess the effect of implementation and to study the outcome of groups of patients not included in the trials. We have examined outcome after CEA in a large population-based study. This type of study reflects the results of multiple surgeons operating on all patients from an entire community and avoids some of the bias associated with single-institution reports.[10] It is also large enough to examine subgroups such as those ≥80 years of age.
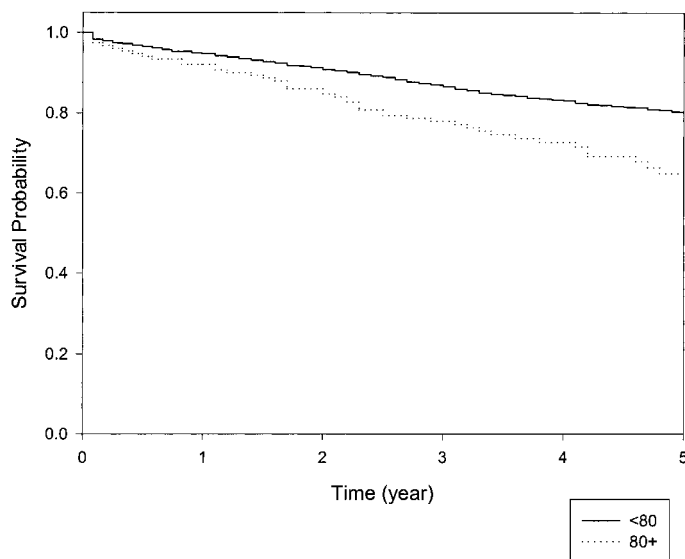

Figure 1. Cumulative survival of patients <80 and ≥80 years of age who underwent CEA in Western Australia from 1988 through 1998.

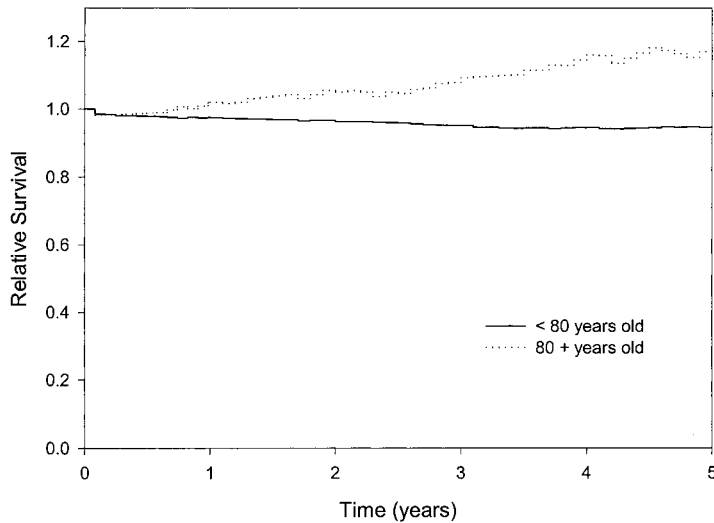|	<80 years (t0=1645)	At risk	80+ years (t0=151)	At risk
30 day survival	98.3 (95% CI: 97.7-98.9)	1617	97.3 (95% CI: 94.7-99.9)	147
1 year survival	94.8 (95% CI: 93.7-95.8)	1560	92.1 (95% CI: 87.7-96.4)	139
5 year survival	80.1 (95% CI: 78.1-82.2)	797	64.9 (95% CI: 56.1-73.9)	39

Figure 2. Relative survival of patients <80 and ≥80 years of age who underwent CEA in Western Australia from 1988 through 1998.

	<80 years (t_0=1645)	At risk	80+ years (t_0=151)	At risk
30 days	98.5 (95% CI:97.9-99.1)	1617	98.1 (95% CI: 95.5-100)	147
1 year	97.5 (95% CI: 96.4-98.6)	1560	101 (95% CI: 97.2-106)	139
5 years	94.7 (95% CI: 92.3-97.2)	797	118 (95% CI: 102-134)	39

Because octogenarians were not included in the major trials of CEA, clinicians have had to base their management of increasing numbers of elderly patients on data from additional sources. Reports from single institutions indicate that CEA can be performed in octogenarians with acceptable 30-day stroke and mortality rates.[6] Although most studies show that both stroke and death within 30 days of CEA tend to be higher in octogenarians compared with those <80 years of age, the difference is not usually considered clinically significant. Outcomes within 30 days in the present study are comparable to similar population-based series,[11] with a combined death and stroke incidence of 2.6% in octogenarians. This is almost certainly an underestimation because patients were not reviewed independently by a neurologist.

Despite evidence that the incidence of stroke increases with age,[12] outcome from medical treatment is worse in the elderly,[5] and early surgical outcome is reasonable in octogenarians, clinicians still have doubts about the overall benefit of CEA in these patients. This concern is due in part to uncertainty about the life expectancy of elderly patients with significant atherosclerotic disease. Previous economic analyses of CEA suggested that on the basis of poor long-term survival, the procedure was unlikely to be cost-effective in patients >79 years of age.[13] There are a small number of single-institution reports of long-term survival in octogenarians after CEA; the study from the Cleveland Clinic[6] is the only one of sufficient size (n=167) and duration to report a meaningful cumulative 5-year survival of 45% (42% stroke free) in octogenarians.

The cumulative 5-year survival for octogenarians in our study was 64.9% (Figure 1). However, when background all-cause mortality is taken into account, relative survival was greater (118.0%) in octogenarians after CEA than that of a matched population (Figure 2). Obviously, the patients undergoing CEA, particularly those in their 80s, were carefully selected, but the data show that those that have been selected have greater longevity than the average octogenarian.

The focus of this study has been on overall survival. Clearly, stroke-free survival and quality of life are also important issues. The feasibility of studying late nonfatal stroke using the Western Australia Data Linkage System is limited by the facts that at least 20% of stroke cases are not admitted to hospital and that the system does not contain data from community-based general practices.[12] As can be seen from the Table, the proportion of late deaths attributed to ischemic stroke in octogenarians (4.4%) was less than in those ≥80 years of age (9.4%). Although it is possible that there were a greater number of nonfatal strokes in the older age group, there is no reason to suspect that the overall (fatal and nonfatal) incidence of stroke was greater.

Clinical decisions about performing CEA in the very elderly are difficult, particularly in the absence of trial data. Although no one wants to have an operation, uncomplicated CEA is not a major procedure in terms of postoperative pain, length of hospital stay, complexity of follow-up, and length of convalescence. These are increasingly important considerations as a patient's age increases. In this study, perioperative morbidity and mortality were not increased in older patients,

and the likelihood of living long enough to gain benefit from CEA was not jeopardized by being too old.

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