Stroke
JOURNAL OF THE AMERICAN HEART ASSOCIATION
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Stroke 1998;29;346-350
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Epidemiology of Carotid Endarterectomy Among Medicare Beneficiaries

1985–1996 Update

David C. Hsia, JD, MD, MPH; Linda M. Moscoe, BA; W. Mark Krushat, MPH, ScD

Background and Purpose—This article describes changes in the rate and outcome of carotid endarterectomies among Medicare beneficiaries.

Methods—We analyzed *International Classification of Diseases, 9th Revision, Clinical Modification* (ICD-9-CM) codes as shown on Medicare bills to calculate carotid endarterectomy frequency, rate, and perioperative mortality by patient demography and hospital characteristics.

Results—After initially peaking at 61 273 procedures (20.6 per 10 000 beneficiaries) in 1985, the frequency of carotid endarterectomy among Medicare beneficiaries declined to 46 571 (14.3 per 10 000) in 1989 and then rose to 108 275 (28.6 per 10 000) in 1996. Patients were predominantly aged 65 to 74 years, male, and white; surgery occurred mainly in large, urban, nonprofit, and teaching hospitals. Perioperative mortality declined from 3.0% in 1985 to 1.6% in 1996.

Conclusions—The frequency and rate of carotid endarterectomy showed prompt response to reports from clinical trials. Perioperative mortality both improved and converged over time but did not attain the rates reported by the trials. Patients aged 85+ years suffered twice the average perioperative mortality. **(*Stroke*. 1998;29:346-350.)**

Key Words: carotid endarterectomy ■ cerebral ischemia ■ elderly ■ mortality ■ stroke management

According to projections from the National Hospital Discharge Survey (NHDS) sponsored annually by the National Center for Health Statistics (NCHS), the annual trend for carotid endarterectomies in the United States has twice changed direction.[1–4] Until 1985, use of the procedure increased rapidly, peaking at 107 000.[5] It then went out of favor, falling to a nadir of 67 000 in 1991. It subsequently recovered to 108 000 procedures in 1996, the most recent year for which the NCHS has tables (Fig 1).

These trends paralleled the medical developments pertaining to carotid endarterectomy.[6] The pre-1985 literature reported promising results and steady improvement in surgical technique.[7,8] Subsequent reports raised concerns about the effectiveness of carotid endarterectomy relative to medical management and about proper indications for surgical intervention.[9–11] Since 1991, a series of reports[12–19] from controlled trials have affirmed its utility in at least selected patients (Table).

These controlled trials began randomization in 1981. They necessarily limited their settings to large medical centers that performed high volumes of carotid endarterectomies and that attained low perioperative morbidity and mortality rates. They did not investigate whether community settings duplicated their experience. This article therefore describes the epidemiology of carotid endarterectomy among all Medicare beneficiaries. These patients both account for three fourths of all such surgeries and independently constitute a defined, dynamic population.[20]

Subjects and Methods

The data for 1989 through 1996 used in this study were derived from Medicare administrative files maintained by the Health Care Financing Administration (HCFA), US Department of Health and Human Services (HHS).[21] The Medicare Provider Analysis and Review (MEDPAR) file recorded diagnosis, procedure, and demographic information from each inpatient discharge for which HCFA received a bill. The Provider of Service (POS) file contributed information about hospital characteristics. The Enrollment Database (EDB) file supplied the date-of-death information, if any. The Denominator file provided demographic information about all beneficiaries eligible for Medicare billings during each year. Previous research reabstracted medical records to verify the accuracy of the MEDPAR data.[22,23]

SAS System software (SAS Institute) running on the HCFA Data Center's 3090 mainframe computer (IBM Corp) processed the annual MEDPAR files to identify all discharges with an *International Classification of Diseases, 9th Revision, Clinical Modification* (ICD-9-CM) code 38.12 (endarterectomy of head and neck vessels other than intracranial vessels) in any of the procedure fields. Unfortunately, ICD-9-CM did not identify anatomic location, symptoms, or degree of stenosis; administrative data did not permit identification of perioperative morbidity, particularly from stroke. A match to the POS file added hospital characteristics. A further match to the EBD file permitted calculation of perioperative mortality.

A separate comparison to the Denominator files calculated annual rates. Essentially, the entire US population aged 65 years or more had

Received June 9, 1997; final revision received December 1, 1997; accepted December 1, 1997.

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The views presented in this article do not represent the policy of any US government agency.

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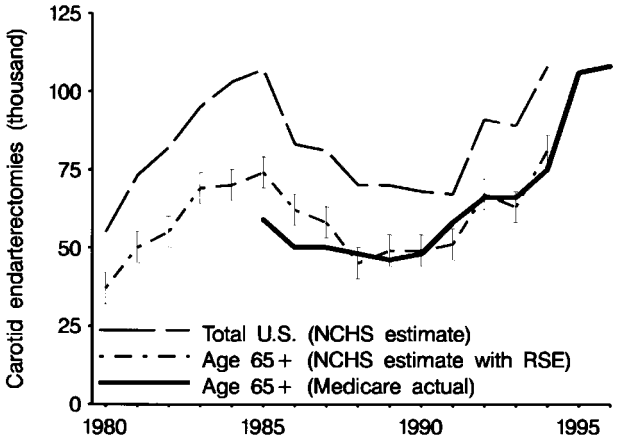

Figure 1. Carotid endarterectomies in short-stay, nonfederal hospitals by patient age, United States 1980 to 1996. NCHS indicates National Center for Health Statistics; RSE, relative standard error.

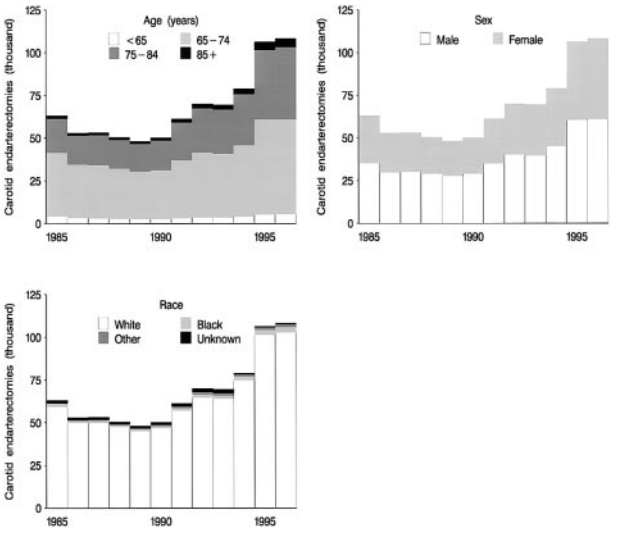

Figure 2. Carotid endarterectomy distribution by beneficiary demography, Medicare 1985 to 1996.

Medicare eligibility, but a small proportion of beneficiaries belonged to managed-care plans that did not consistently generate individual hospital bills.[24] The frequencies in this report therefore could have slightly undercounted carotid endarterectomies among the elderly. However, the rate calculations remained accurate because denominators also excluded beneficiaries in plans without individual billing records.

The data for 1985 through 1988 were derived from a previous report,[25] except for profit-nonprofit status. This study reprocessed and reanalyzed control status from more recent versions of the 1985–1988 MEDPAR files because of administrative changes in the definition and categorization of control status.

Results

Medicare received 63 137 bills for carotid endarterectomies in 1985. This number declined steadily to 48 098 in 1989, then increased to 108 275 by 1996. These frequencies closely matched the NCHS projections for persons over age 65, giving additional credence to NHDS estimates for the entire US population (Fig 1). For 1989 to 1996, 91.6% of these discharges had a principal diagnosis of cerebrovascular disease and 6.3% listed another circulatory system disease.

The demographic composition of Medicare beneficiaries undergoing carotid endarterectomy changed only slightly over time, but the large population elevated minor trends to statistical significance. In patients over age 75 years, the share of surgery steadily increased from 34.5% in 1985 to 43.7% in 1996 (1985 versus 1996 difference, −9.2%; 95% confidence interval [CI], −9.7% to −8.7%). Less obviously, in men, the percentage went from 55.6% to 56.2% of procedures (1985 versus 1996 difference, −0.6%; 95% CI, −1.1% to −0.1%). Whites constituted 94.0% of patients at the beginning of the observation period and 94.9% at the end (1985 versus 1996 difference, −0.9%; 95% CI, −1.2% to −0.7%) (Fig 2).

Dividing demographic groups by their respective Medicare populations, annual rates paralleled the overall trend for carotid endarterectomy frequencies. On average, 20.6 procedures occurred per 10 000 beneficiaries in 1985, declining to 14.3 for 1989 (1985 versus 1989 difference, 6.3; 95% CI, 6.1 to 6.5) and recovering to 28.6 by 1996 (1989 versus 1996 difference, −14.3; 95% CI, −14.5 to −14.1) (Fig 3).

Perioperative Outcomes in Controlled Trials of Carotid Endarterectomy, 1982–1995

Trial	Study Period	Sample Size, No. of Patients		Mortality, %		Mortality and Major Strokes, %		Reported Risk Reduction
		Surgical	Medical	Surgical	Medical	Surgical	Medical	
Asymptomatic								
CASANOVA[12]	1982–88	206	204	1.5	0.5	4.9	1.5	None at 3 y
MACE[13]	1987–90	36	35	0.0	0.0	2.8	0.0	None at 2 y
VACS 167[14]	1983–91	211	233	1.9	0.4	4.7	0.9	None at 4 y
ACAS[15]	1987–93	825	834	0.4	0.1	2.3	0.4	5.9% at 5 y
Symptomatic								
ECST 0–29%[16]	1981–91	219	115	1.4	0.0	4.6	NA	None at 3 y
70–99%	1981–91	455	323	0.9	0.0	7.5	NA	5.0% at 3 y
ECST 30–49%[17]	1981–95	389	259	0.8	NA	8.0	NA	None at 4 y
50–69%	1981–95	570	372	1.4	NA	7.9	NA	None at 4 y
NASCET[18]	1988–91	328	331	0.6	0.3	2.1	0.9	17% at 2 y
VACS 309[19]	1988–91	92	101	3.3	0.0	4.3	0.0	11.7% at 1 y

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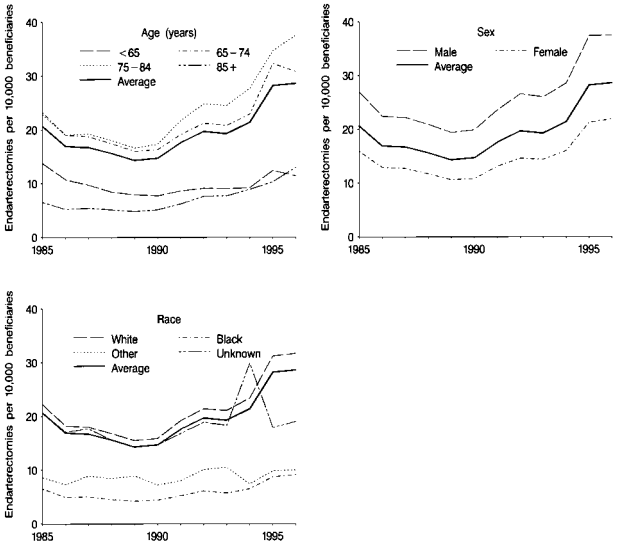

Figure 3. Carotid endarterectomy rate by beneficiary demography, Medicare 1985 to 1996.

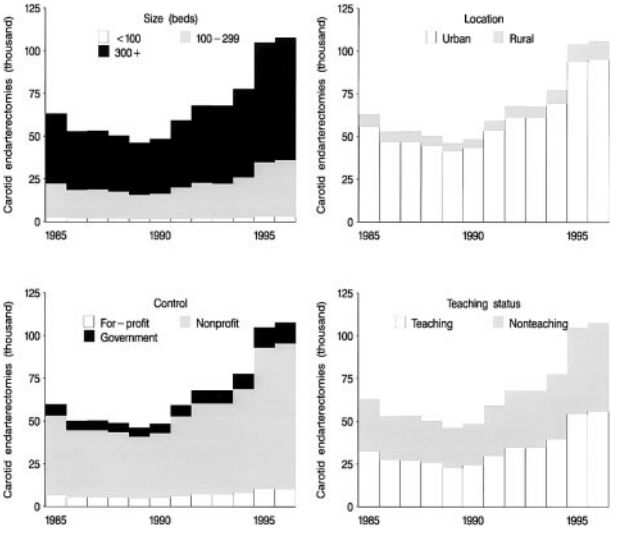

Figure 4. Carotid endarterectomy distribution by hospital characteristics, Medicare 1985 to 1996.

Beneficiaries of age 75 to 84 years had the highest rates, reaching 37.6 per 10 000 in 1996 (age 75 to 84 versus all ages difference, 9.0; 95% CI, 8.7 to 9.3). This age group also showed the most rapid changes in surgery rates (1989 versus 1996 difference, −21.1; 95% CI, −21.5 to −20.7). Beneficiaries under age 65 and age 85+ had the lowest surgery rates and changed the least over time.

Men had significantly higher surgery rates than women throughout the observation period (men versus women 1985–1996 difference, 11.4; 95% CI, 11.4 to 11.5). Whites had significantly higher rates than blacks (white versus black 1985–1996 difference, 15.4; 95% CI, 15.3 to 15.6). The 1994 divergence of unknown and other race probably represented an anomaly in the administrative systems that collected the data rather than an actual trend.

Proportional distributions by hospital characteristics also appeared stable over time but attained statistical significance because of the large numbers. The proportion of carotid endarterectomies performed in urban hospitals gradually increased from 88.3% in 1985 to 89.4% in 1996 (1985–1996 difference, 1.1%; 95% CI, −1.5% to −0.8%). Teaching hospitals' share rose from 50.9% to 51.7% (1985–1996 difference, −0.8%; 95% CI, −1.3% to −0.3%). Nonprofit hospitals went from 78.3% to 79.2% (1985–1996 difference, −0.9%; 95% CI, −1.3% to −0.5%). Institutions having 300+ beds grew from 64.9% in 1989 to 66.4% in 1996 (1989–1996 difference, −1.5%; 95% CI, −1.9% to −1.0%) (Fig 4).

The hospital volume of surgery largely reflected the overall frequency of carotid endarterectomies. Thus, in 1985 hospitals performing 50+ procedures per year comprised 12.2% of the 2747 institutions but had 44.5% of the patients. The concentration decreased until 1989 when 7.9% of the 2564 hospitals performed 50+ procedures on 32.7% of the patients (1985–1989 difference, 11.8%; 95% CI, 11.3% to 12.4%). The trend then reversed, with 28.0% of the 2607 hospitals doing 50+ carotid endarterectomies on 69.7% of the patients in 1996 (1989–1996 difference, −37.0%; 95% CI, −37.6% to −36.5%). Over the entire observation period, the 60.6% low-volume hospitals performed 20.4% of the procedures, the 24.8% medium-volume hospitals performed 32.8%, and the 14.7% high-volume hospitals performed 46.8% (Fig 5).

Dividing the number of deaths occurring within 30 days of surgery by the volume of procedures, case-fatality rates decreased steadily from 3.0% in 1985 to 1.6% in 1996 (1985 versus 1996 difference, 1.4%; 95% CI, 1.3% to 1.6%). Analyzed demographically, patients of age 85+ years had double the case-fatality rates of patients aged 65 to 74 throughout the observation period (age 65 to 74 versus age 85+ 1985–1996 difference, −2.1%; 95% CI, −2.2% to −1.9%), with the other age groups falling in between. Thus, in 1996, patients age 85+ had a 2.9% case-fatality rate versus 1.3% for patients age 65 to 74. Men had higher rates than women at all times (men versus women 1985–1996 difference, 0.2%; 95% CI, 0.2% to 0.3%).

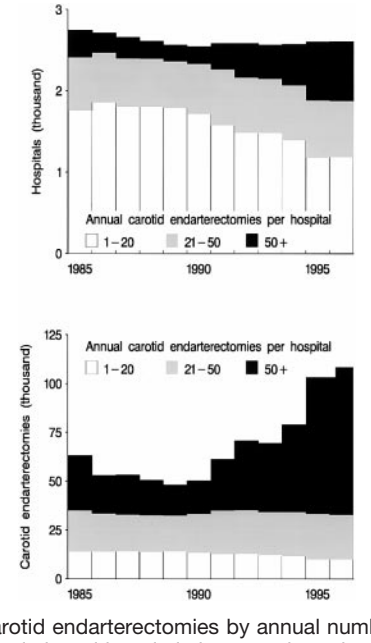

Figure 5. Carotid endarterectomies by annual number of procedures per hospital, and hospitals by annual number of procedures, Medicare 1985 to 1996.

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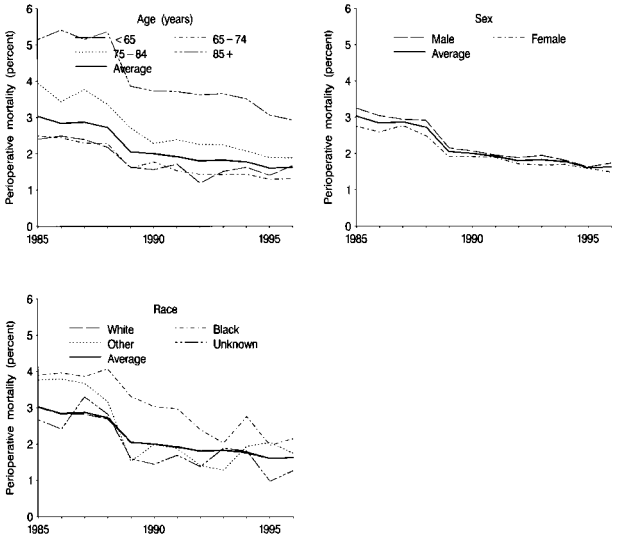

Figure 6. Carotid endarterectomy perioperative case-fatality rate by patient characteristics, Medicare 1985 to 1996.

Blacks had higher case-fatality rates than whites (white versus black 1985–1996 difference, −0.8%; 95% CI, −1.0% to −0.6%). The rates for different demographic groups appeared to converge over time (Fig 6).

Turning to hospital characteristics, smaller hospitals experienced lower case-fatality rates than larger hospitals (1 to 99 beds versus 300+ beds 1985–1996 difference, −0.2%; 95% CI, −0.4% to −0.1%), but the rates appeared to vary more. Nonprofit hospitals had lower case-fatality rates than for-profit hospitals (nonprofit versus for-profit 1985–1996 difference, 0.4%; 95% CI, 0.3% to 0.5%). Teaching status and urban-rural location had no effect. The rates by different hospital characteristics also appeared to converge over time (Fig 7).

As with other surgery, experience affected perioperative mortality. Hospitals performing 1 to 20 procedures per year had a 2.5% case-fatality rate, whereas hospitals doing 50+ procedures averaged 1.9% (1 to 20 annually versus 50+

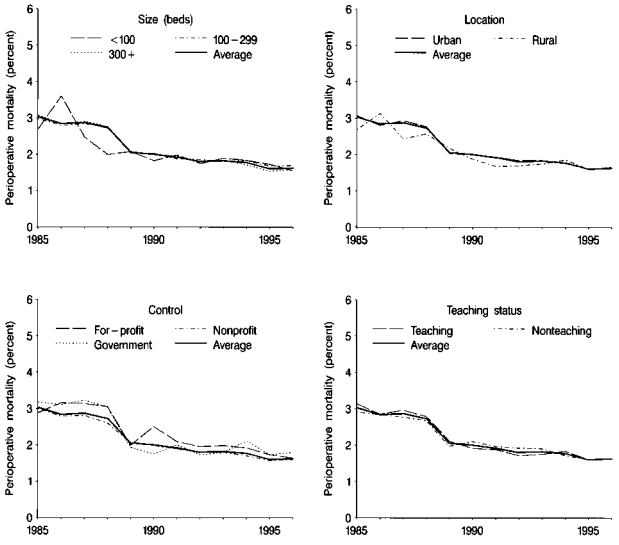

Figure 7. Carotid endarterectomy perioperative case-fatality rate by hospital characteristics, Medicare 1985 to 1996.

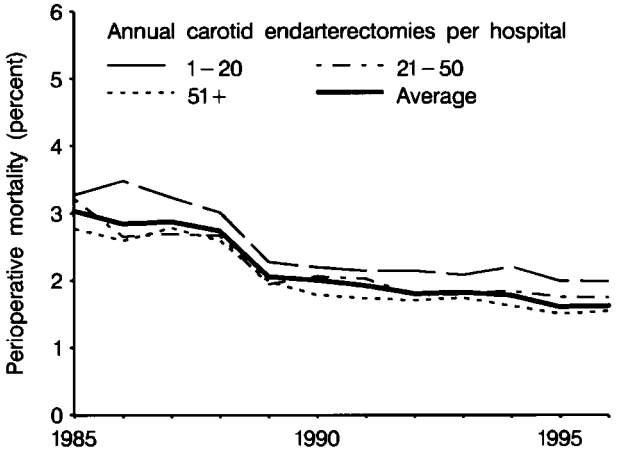

Figure 8. Carotid endarterectomy perioperative case-fatality rate by annual number of procedures per hospital, Medicare 1985 to 1996.

annually, 1985–1996 difference, 0.7%; 95% CI, 0.6% to 0.8%). These rates did not appear to converge over time (Fig 8).

Discussion

Despite the two trend reversals in the annual frequency of carotid endarterectomy, its epidemiology has remained relatively stable since 1985. The proportions of older, male, and white patients increased imperceptibly but significantly. Surgery rates for different demographic groups paralleled the population average but did not converge. The proportions of surgery occurring in rural, teaching, nonprofit, and large hospitals also increased over time. Concentration of procedures paralleled changes in overall surgical volume.

In contrast, perioperative mortality had both a general downward trend and convergence of subpopulations. The rates for those aged 85+, men, and blacks remained higher than average but gradually approached the mean. Curiously, at least one clinical trial reported greater perioperative complications among women.[15]

Large and for-profit hospitals had higher mortality rates, whereas urban-rural location and teaching status had no effect. However, all hospital characteristics eventually approached the mean. These trends suggest growing standardization of patient selection, quality of care, and operative skills.[26] Despite rapid developments in the standards used to identify patients deemed suitable for surgical intervention, all categories of institutions attained similar results. Only the case-fatality rate by hospital annual volumes of procedures failed to converge over time.

The controlled trials listed in the Table necessarily took place at large, academic medical centers that performed a high volume of carotid endarterectomies. Their perioperative mortality ranged from 0% to 3.3%. Indeed, most trials made previous excellence in perioperative outcomes a condition of eligibility for medical centers seeking to participate.[27] For whatever reason, the Medicare population experienced significantly higher perioperative mortality than the concurrent clinical trial populations (combined trials versus Medicare 1985–1996 difference, −1.1; 95% CI, −1.6 to −0.6). Medicare perioperative morbidity might also have differed signifi-

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cantly from that of the controlled trials had such data been available from administrative records (Table).

At the same time, the positive trials reported relatively modest risk reductions for their differing end points and observation periods. Only one of the four asymptomatic trials[15] and three of the six symptomatic trials[16–19] found significant risk reduction based on the observed survival functions. As pointed out by several of these trials' authors, the inability of other hospitals to attain comparable perioperative mortality and morbidity rates could affect their overall assessment of the benefits of carotid endarterectomy.[28,29]

Acknowledgments

The authors are indebted to William B. Baine, MD, Deby K. Blum, MLS, Renee A.W. McCullough, MH, MLS, and James P. Summe, MS, of the HHS Agency for Health Care Policy and Research, and to Brian P. Ritchie of the HHS Office of Inspector General, for their technical assistance with this article.

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