Effect of the Asymptomatic Carotid Atherosclerosis Study on Carotid Endarterectomy in Florida

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Background and Purpose—The value of carotid endarterectomy (CEA) has been defined by several recent multicenter trials. The clinical effect of these trials remains undetermined since the Asymptomatic Carotid Atherosclerosis Study (ACAS) Clinical Advisory (dated September 28, 1994).

Methods—Patients undergoing CEA (ICD-9-CM 38.12) in nonfederal Florida hospitals were identified from the discharge database. Data were analyzed by federal fiscal year (FY, October 1 through September 30), comparing the years following the Advisory (FY95-FY96) to the preceding 3 years (FY92-FY94).

Results—There was a 68.3% increase in the number of CEAs during FY95-FY96 (mean FY92-FY94, 7,343; mean FY95-FY96, 12,356). This exceeded increases in total hospital discharges (4.5%), surgical discharges (2.2%), and the state’s population (4.7%). The increase in CEAs spanned all patient demographic groups (gender, race, and age), although the magnitude was not consistent (range, 57.8% increase for 55 to 64 age group; 92.9% increase for >84 age group). Concomitantly, there was a significant decrease in mortality (1.2% versus 0.8%), cardiac complication rate (ICD-9-CM 997.1, 4.1% versus 3.0%) and percentage of patients discharged >3 days postoperatively (8.9% versus 4.9%). Mean length of stay declined 28% (5.8 versus 4.1 days), and mean adjusted charges declined 7% ($19,456 versus $18,055). Although the average case was less costly, the increased volume resulted in an estimated $56 million increase in annual hospital payments.

Conclusions—The dramatic increase in the number of CEAs performed in the state of Florida after release of the ACAS Clinical Advisory suggests a causal relationship and mandates further cost-effectiveness analyses. (Stroke. 1998;29:1099-1105.)

Key Words: carotid arteries | carotid endarterectomy | cerebrovascular disorders | epidemiology | stroke prevention

The value of CEA for both symptomatic and asymptomatic carotid artery stenoses has been defined by several recent multicenter trials.1-5 NASCET (1991)1 reported that CEA resulted in a 17% absolute risk reduction for any ipsilateral stroke compared with best medical management for stenosis >70%. Similar benefits for symptomatic stenoses were reported in ECST (1991)2 and VACSG/symptomatic (1991)3 despite different methodologies, end points, and formats.4 In contrast, the reported benefit of CEA for asymptomatic stenoses is less clear. VACS/asymptomatic (1993)4 reported that CEA resulted in a 12.6% risk reduction for ipsilateral neurological events at 4 years for stenosis >50%, but there was no significant benefit when transient ischemic attacks were excluded as end points. ACAS (1995)5 reported that CEA resulted in an estimated 5.9% absolute risk reduction over 5 years for ipsilateral stroke for stenosis >60%, but the results of the ACAS and the role of CEA for asymptomatic stenosis have been passionately debated in the literature.6-13 ACAS has been criticized on multiple points, including an overall stroke risk reduction of only 1% per year, no significant benefit for CEA for preventing disabling strokes, a minimal benefit of CEA in women, the failure of the degree of carotid stenosis to correlate with stroke risk, and the use of noninvasive testing to quantify stenosis.

Despite the continuing controversy concerning the results of the ACAS, it appears that release of these results may have significantly affected practice patterns. Huber et al14 recently reported a 43.4% increase in the volume of CEAs throughout the Veterans Affairs Medical Centers during the federal FY (October 1 through September 30) following release of the ACAS Clinical Advisory (September 28, 1994). This was seen despite a system-wide decrease in the number of surgical procedures and the number of inpatient admissions. Furthermore, the increase spanned almost all categories of health
Data were obtained from the Florida AHCA database for all patients of the ACAS results on the volume of CEAs performed in all designed to retrospectively examine the effect of the release were performed in male veterans. The current study was rable. Indeed, 98.6% of the CEAs examined in that study care providers (ie, surgeon type, hospital classification, geographic region). However, these results cannot be extrapolated outside Veterans Affairs Medical Centers because the patient populations and resources are not necessarily comparable. Indeed, 98.6% of the CEAs examined in that study were performed in male veterans. The current study was designed to retrospectively examine the effect of the release of the ACAS results on the volume of CEAs performed in all nonfederal Florida hospitals using the state hospital discharge database.

Methods

Data were obtained from the Florida AHCA database for all patients undergoing CEA during federal FYs 1992 through 1996 (FY, October 1 through September 30) using the ICD-9-CM3 procedure code for CEA, 38.12. All CEAs performed in Florida were identified regardless of the indication or whether they were performed concomitant with another procedure. The AHCA database contains an abstract record for each inpatient hospitalization for the 202 nonfederal, general, acute-care hospitals in the state. These records contain up to 10 diagnosis and 10 procedure codes (3 and 2, respectively, for abstract. Hospital payments were estimated based on the ratios of rates were analyzed by year, age, gender, and race.

Postoperative central nervous system and cardiovascular complications were determined using the ICD-9-CM codes 997.0 to 997.9 (postoperative central nervous system complication) and 997.1 (postoperative cardiac complication), respectively. Postoperative length of stay >7 days was defined as “long” and used as an indirect measure of poor outcome.18 Mortality rates and complication rates were analyzed by year, age, gender, and race.

The hospital charges (in dollars) for the inpatient admission in which the patient underwent CEA were obtained from the discharge abstract. Hospital payments were estimated based on the ratios of charges to payments for the various payors. The following payment (collection) rate assumptions were used: Medicare traditional, 70%; Medicare HMO, 67%; Medicaid traditional, 60%; Medicaid HMO, 58%; commercial traditional, 85%; commercial HMO, 72%; commercial PPO, 80%; Workers’ Compensation, 70%; Champus, 67%.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>FY92</th>
<th>FY93</th>
<th>FY94</th>
<th>FY95</th>
<th>FY96</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEA procedures</td>
<td>6,905</td>
<td>7,181</td>
<td>7,943</td>
<td>12,052</td>
<td>12,660</td>
</tr>
<tr>
<td>Hospital discharges</td>
<td>1,774,995</td>
<td>1,816,827</td>
<td>1,847,132</td>
<td>1,914,834</td>
<td>1,901,148</td>
</tr>
<tr>
<td>CEA/10 000 discharges</td>
<td>38.9</td>
<td>39.5</td>
<td>43.0</td>
<td>63.9</td>
<td>66.1</td>
</tr>
<tr>
<td>Surgical discharges</td>
<td>508,012</td>
<td>508,398</td>
<td>509,181</td>
<td>516,892</td>
<td>523,052</td>
</tr>
<tr>
<td>CEA/10 000 surgical discharges</td>
<td>135.9</td>
<td>141.2</td>
<td>156.0</td>
<td>233.2</td>
<td>242.0</td>
</tr>
<tr>
<td>Florida population</td>
<td>13,424,416</td>
<td>13,608,627</td>
<td>13,878,905</td>
<td>14,149,317</td>
<td>14,411,563</td>
</tr>
<tr>
<td>CEA/10 000 Florida population</td>
<td>5.1</td>
<td>5.3</td>
<td>5.7</td>
<td>8.5</td>
<td>8.8</td>
</tr>
</tbody>
</table>

*Significant increase in rate FY92-FY94 vs FY95-FY96, P<0.05.
other state/local government, 45%; Veterans Affairs, 70%; self-pay/charity/underinsured, 15%; and other, 50%. These rates were believed to provide a reasonable estimation of payment rates (D.A.D., unpublished data, 1998) for inpatient hospital services in Florida during the study period. Data were not collected on a statewide basis for items such as professional fees and outpatient services or for indirect costs, such as lost work time for patients or family care providers. All charge data were adjusted to FY96 using a 4% annual rate of inflation.

The rate of CEA, the breakdown of the RMS and SIS groups, and the mortality and complication rates were compared per year and per demographic group as appropriate using \( \chi^2 \) analysis. All data analyses were performed using SAS Version 6.11 (SAS Institute Inc. running under AIX Version 4.2 on an IBM RS/6000–59H computer (International Business Machines Co).

### Results

There was a 68.3% increase in the total number of CEAs performed throughout the state of Florida during the two FYs following release of the ACAS Clinical Advisory compared with the average of the preceding 3 years (Table 1). The rates of CEA per surgical discharges (\( P = 0.001 \)), per hospital discharges (\( P = 0.001 \)), and per the state population (\( P = 0.001 \)) were all significantly higher during FY95-FY96 than during FY92-FY94, with the magnitude of the increase ranging from 60.5% to 64.6% (Table 1). The number of CEAs performed per quarter increased during the first quarter of FY95 (immediately after release of the Clinical Advisory) and was sustained throughout FY95-FY96 (see the Figure). Analysis of the procedural volume per hospital demonstrated that there was an increase in CEAs after ACAS throughout all regions of the state. The mean increase in the volume of CEAs during FY95-FY96 compared with FY92-FY94 among the 170 hospitals performing at least one CEA during FY92-FY94 was 85.1% (median increase, 57.7%), whereas the mean increase among the 99 higher volume hospitals (>20 CEAs during FY92) was 72.0% (median increase, 61.7%).

The volume of CEAs done after the Clinical Advisory increased for all age groups (range, 57.8% [increase for age 55 to 64] to 92.9% [increase for age >84]), for both genders (male, 65.9%; female, 71.6%), and for both races analyzed (white, 62.9%; black, 58.6%) (Table 2). The magnitude of the increase was consistent across gender (\( P = 0.07 \)) and race (\( P = 0.71 \)) but was significantly different among age groups (\( P = 0.001 \)), with the greatest percentage of increase occurring in the two oldest age groups (75 to 84 years, 75.8%; >84 years, 92.9%). In addition, there was a significant shift (\( P = 0.001 \)) in the CEA case-mix after release of the Clinical Advisory, as reflected by the distribution of patients among the SIS and RMS (Table 3). The net effect appeared to be a shift toward the lower classifications for both indices, although the absolute magnitude of the changes were small.

There was a significant decrease in the procedural complication rate concurrent with the increased number of CEAs done during FY95-FY96 (Table 4). The operative mortality rate decreased from 1.2% to 0.8% (FY92-FY94 versus FY95-FY96, \( P = 0.001 \)), the mean cardiac complication rate decreased from 4.1% to 3.0% (\( P = 0.001 \)), and the percentage of patients with postoperative lengths of stay >7 days decreased from 8.9% to 4.9% (\( P = 0.001 \)). Furthermore, the mean length of stay declined by 28% (5.8 versus 4.1 days) and the mean adjusted hospital charges per CEA decreased 7% ($19 456 versus 18 055) after release of the Clinical Advisory.

### Table 2. Number and Rate* of CEA by Demographic Group

<table>
<thead>
<tr>
<th>Parameter</th>
<th>FY92</th>
<th>FY93</th>
<th>FY94</th>
<th>FY95</th>
<th>FY96</th>
<th>% Increase, FY92-FY94 to FY95-FY96</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>4 049 (6.2)</td>
<td>4 171 (6.3)</td>
<td>4 711 (7.0)</td>
<td>6 963 (10.1)</td>
<td>7 339 (10.5)</td>
<td>65.9</td>
</tr>
<tr>
<td>Female</td>
<td>2 856 (4.1)</td>
<td>3 010 (4.3)</td>
<td>3 232 (4.5)</td>
<td>5 089 (7.0)</td>
<td>5 321 (7.2)</td>
<td>71.6</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>No data</td>
<td>6 957 (6.1)</td>
<td>7 690 (6.6)</td>
<td>11 632 (9.8)</td>
<td>12 222 (10.0)</td>
<td>62.9</td>
</tr>
<tr>
<td>Black</td>
<td>No data</td>
<td>149 (0.8)</td>
<td>172 (0.9)</td>
<td>223 (1.1)</td>
<td>286 (1.4)</td>
<td>58.6</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–44</td>
<td>20 (0.0)</td>
<td>22 (0.0)</td>
<td>31 (0.0)</td>
<td>40 (0.1)</td>
<td>39 (0.0)</td>
<td>62.3</td>
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<tr>
<td>45–54</td>
<td>224 (0.0)</td>
<td>285 (0.0)</td>
<td>275 (0.0)</td>
<td>410 (0.0)</td>
<td>433 (2.5)</td>
<td>61.3</td>
</tr>
<tr>
<td>55–64</td>
<td>1 090 (8.5)</td>
<td>1 070 (8.3)</td>
<td>1 128 (9.1)</td>
<td>1 696 (13.1)</td>
<td>1 763 (13.2)</td>
<td>57.8</td>
</tr>
<tr>
<td>65–74</td>
<td>3 118 (22.2)</td>
<td>3 244 (22.9)</td>
<td>3 595 (25.6)</td>
<td>5 350 (36.7)</td>
<td>5 603 (38.8)</td>
<td>65.0</td>
</tr>
<tr>
<td>75–84</td>
<td>2 227 (26.6)</td>
<td>2 228 (25.9)</td>
<td>2 626 (28.8)</td>
<td>4 085 (44.0)</td>
<td>4 282 (45.1)</td>
<td>75.8</td>
</tr>
<tr>
<td>&gt;84</td>
<td>226 (10.0)</td>
<td>272 (11.2)</td>
<td>288 (10.4)</td>
<td>471 (18.5)</td>
<td>540 (19.9)</td>
<td>92.9</td>
</tr>
</tbody>
</table>

*Values in parentheses are rate per 10,000 in demographic group.
Advisory. The annual hospital payments for CEA during FY92-FY94 was $100.3 million, and for FY95-FY96 it was $156.0 million. Despite a lower cost per case, the increase in volume of CEA procedures resulted in an estimated $55.7 million yearly increase in hospital payments, exclusive of professional fees (surgeons, anesthesiologists, radiologists, etc).

Analysis of the overall data set (FY92-FY96) revealed that CEA was performed most frequently in men (58.3%), whites (97.9%, FY93-FY96), and patients between 65 and 74 years (44.7%), although the rate per 10,000 population was highest in the 75 to 84 age group (34.1) (Table 5). In addition, the central nervous system complication rate (1.2% versus 0.9%, \( P < 0.003 \)) was significantly higher in women, but the cardiac complication rate (3.1% versus 3.8%, \( P < 0.001 \)) was lower.

The operative mortality rate (2.0% versus 0.9%, \( P < 0.001 \)), and the percentage of patients with postoperative lengths of stay >7 days (12.9% versus 6.8%, \( P < 0.001 \)) were both significantly greater in blacks, while the central nervous system complication rate trended toward significance (1.6% versus 1.0%, \( P = 0.08 \)). Furthermore, the mortality rate, cardiac complication rate, and percentage of patients with postoperative lengths of stay >7 days were significantly different (\( P < 0.001 \)) among the age groups, generally increasing with age.

**Discussion**

There was a dramatic, sustained increase in the volume of CEAs performed in nonfederal hospitals throughout Florida immediately after release of the ACAS Clinical Advisory on September 28, 1994. The increase could not be explained by increases in hospital discharges, surgical discharges, or the state’s population. The increased volume of CEAs was seen throughout all geographic regions of the state and spanned all patient demographic groups. Concomitantly, there was a decrease in the procedure-associated in-hospital mortality and complication rates and a shift in case-mix toward a lower overall severity.

The temporal relationship between the release of the Clinical Advisory and the increased procedural volume sug-

### TABLE 5. Overall (FY92-FY96) CEA Breakdown with Mortality and Complication Rates by Demographic Group

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Number</th>
<th>% Group</th>
<th>Incidence/10 000</th>
<th>Mortality (%)</th>
<th>CNS (%)*</th>
<th>CV (%)†</th>
<th>LOS &gt;7 Days (%)‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>27233</td>
<td>58.3</td>
<td>8.0</td>
<td>1.1</td>
<td>0.9</td>
<td>3.8</td>
<td>6.8</td>
</tr>
<tr>
<td>Male</td>
<td>19508</td>
<td>41.7</td>
<td>5.4</td>
<td>0.9</td>
<td>1.2§</td>
<td>3.1§</td>
<td>6.8</td>
</tr>
<tr>
<td>Female</td>
<td>830</td>
<td>2.1</td>
<td>1.1</td>
<td>2.0#</td>
<td>1.6</td>
<td>2.8</td>
<td>12.9#</td>
</tr>
<tr>
<td>Race¶</td>
<td>38501</td>
<td>97.9</td>
<td>8.1</td>
<td>0.9</td>
<td>1.0</td>
<td>3.5</td>
<td>6.8</td>
</tr>
<tr>
<td>White</td>
<td>630</td>
<td>2.1</td>
<td>1.1</td>
<td>2.0#</td>
<td>1.6</td>
<td>2.8</td>
<td>12.9#</td>
</tr>
<tr>
<td>Black</td>
<td>152</td>
<td>0.3</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.7</td>
<td>7.9</td>
</tr>
<tr>
<td>0–45</td>
<td>152</td>
<td>0.3</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.7</td>
<td>7.9</td>
</tr>
<tr>
<td>45–54</td>
<td>1627</td>
<td>3.5</td>
<td>0.5</td>
<td>0.8</td>
<td>0.9</td>
<td>1.3</td>
<td>4.6</td>
</tr>
<tr>
<td>55–64</td>
<td>6747</td>
<td>14.4</td>
<td>10.4</td>
<td>0.6</td>
<td>0.8</td>
<td>2.5</td>
<td>5.1</td>
</tr>
<tr>
<td>65–74</td>
<td>20190</td>
<td>44.7</td>
<td>25.2</td>
<td>0.9</td>
<td>1.1</td>
<td>3.4</td>
<td>6.0</td>
</tr>
<tr>
<td>75–84</td>
<td>15058</td>
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<td>34.1</td>
<td>1.2</td>
<td>1.1</td>
<td>4.3</td>
<td>8.3</td>
</tr>
<tr>
<td>&gt;84</td>
<td>1797</td>
<td>3.8</td>
<td>14.0</td>
<td>2.2</td>
<td>1.1</td>
<td>4.3</td>
<td>10.1</td>
</tr>
</tbody>
</table>

*CNS indicates central nervous system complication, ICD-9-CM 997.0 to 997.09.
†CV indicates cardiovascular complication, ICD-9-CM 997.1.
‡LOS indicates percentage of patients with postoperative length of stay >7 days.
§Significant difference from male gender, \( P < 0.05 \).
#Significant difference from white race, \( P < 0.05 \).
gests a casual relationship. Unfortunately, a more definitive relationship cannot be established from the database because data on the indications for the CEA (ie, asymptomatic carotid stenosis, symptomatic carotid stenosis) were not available. Interestingly, the volume increase corresponded to release of the Clinical Advisory rather than publication of the complete study 7 months later (May 10, 1995). However, the Clinical Advisory and the results of the trial both were widely disseminated throughout the medical and lay literature. The observed increase is unlikely to be spurious or coincidental in light of the severe scrutiny applied to CEA historically and the fact that the increased volume was sustained throughout both FY95 and FY96. There are other potential explanations for the increase, including a belated response to the reports of the other symptomatic and asymptomatic CEA trials. However, the symptomatic trials were published earlier in the decade and have been well accepted as reflected by position statements from the American Heart Association and the Society of Vascular Surgery/International Society for Cardiovascular Surgery. Furthermore, the volume was fairly constant during the 3 years before the release of the Clinical Advisory, and the ACAS was the first multicenter prospective trial to report that CEA reduced the incidence of ipsilateral stroke for asymptomatic stenosis.

The observed trends for CEA in Florida are consistent with the 43.4% increase of CEAs in Veterans Affairs Medical Centers after release of the ACAS Clinical Advisory and likely reflect changes in practice patterns throughout the country. The rate of CEA reported in the current study for FYs 1992 and 1993 are comparable to those reported for the corresponding calendar years by Gillum using data from the National Hospital Discharge Survey. Admittedly, there are regional variations in the utilization of healthcare services. Interestingly, Goldstein et al reported that the availability of CEA was the lowest in the South relative to the Central, Northeast, and West in a national survey of stroke prevention practices. Thus, it is conceivable that the increase in procedural volume after ACAS was even greater in the other geographic regions.

The morbidity and mortality rates reported in the study are consistent with those from multicenter carotid endarterectomy trials. This is somewhat surprising in that these figures include results of every CEA performed in nonfederal hospitals in Florida regardless of indication, including those performed concomitant with other procedures (eg, coronary artery bypass grafting). However, these data must be interpreted with caution and should not be used to draw inference about the safety of CEA statewide. The AHCA database is an administrative one that was adapted to answer a specific clinical question. The abstracts that make up the database include a finite number of diagnostic and procedural codes and are generated retrospectively by trained medical coders. The clinical application of the database is limited by several factors including the inability to distinguish whether a medical condition (eg, stroke) was preexisting or a postoperative complication, the accuracy and completeness of the retrospective coding, and the inability to link the procedural admission to earlier admissions (complications) that may have been part of the diagnostic evaluation. An attempt to reduce the former limitation was made by using the ICD-9-CM code for postoperative central nervous system complication, but even this is subject to reporting and coding errors. Interestingly, Rothwell et al systematically reviewed all the published series of CEA performed for symptomatic stenosis since 1980 and found that the stroke and/or mortality rates varied with the methods and the authorship of the study, with the highest rates (7.7%) reported in those studies in which the patients were examined by a neurologist postoperatively and the lowest rates (2.3%) reported in studies with a single author affiliated with a department of surgery. Additionally, the postoperative mortality rate reported here includes only the deaths that occurred during the admission in which the CEA was performed rather than the customary 30-day mortality rate. It is unlikely, however, that the 30-day mortality rate would differ significantly from these rates because the majority of the complications and deaths after CEA occur in the immediate postoperative period, ie, during the same hospital admission.

Despite these inherent limitations, several additional features of the observed mortality and morbidity rates merit further comment. First, there was a decrease in the mortality and complication rates concomitant with the increased procedural volume after the Clinical Advisory. A possible explanation for this observation is an increase in the number of procedures performed on asymptomatic patients. This is supported by the observed shift in case-mix to the lower mortality and lower resource utilization categories, together with the fact that the mortality and complication rates in ACAS were lower than those reported from the multicenter symptomatic trials. Furthermore, a lower complication rate was reported for CEAs for asymptomatic stenosis in a review of literature on symptomatic and asymptomatic CEA series that were performed either by the same surgeon or at the same institution. Interestingly, a comparable decrease in the mortality and morbidity was not seen in the Veterans Affairs Medical Centers after release of the Clinical Advisory. Second, the central nervous system complication rate was significantly higher in women. Admittedly, the clinical significance of the small difference is uncertain. However, this observation is consistent with the ACAS trends in which the risk reduction for CEA was less in women because the perioperative complication rate was twofold higher. The authors of the ACAS have commented on these findings, saying there were too few women in the study and that outcome differences by gender were not part of the experimental design. Third, the rates of mortality and percentage of patients with postoperative lengths of stay > 7 days were significantly greater in blacks. The explanation for this observation is not obvious from the data, but may be related to an increased number of comorbid conditions. Finally, postoperative length of stay > 7 days was used as an indirect marker for poor outcome after CEA. Admittedly, the postoperative length of stay is subject to multiple forces unrelated to surgical outcome, including economic pressures, preexisting medical conditions, and social situation that potentially confound the interpretation of the data. Interestingly, Mitchell et al have reported that physician claims for postop-
operative head CT, head MRI, or surgical exploration of the neck may provide better markers for complications after CEA.

Analysis of the entire data set revealed that there was a marked disparity in the rate of CEAs between blacks and whites. This observation is consistent with previous reports from several national databases including Medicare, National Hospital Discharge Survey, and Veterans Affairs Medical Centers. In addition, these observations parallel the racial disparities reported for other major cardiovascular procedures. Although these observations suggest a potential racial bias, Horner et al have identified three other plausible explanations associated with the diagnosis and treatment of cerebrovascular disease that may explain the disparity: differences in clinical factors such as location and extent of disease, comorbid conditions, and operative risk; differences in economic status and the ability to pay; and differences in patients' decisions to use diagnostic and therapeutic procedures. Furthermore, Yatsu et al recently identified a genetic variation among blacks that appears to identify individuals with significant carotid artery stenosis, and Oddone et al reported that socioeconomic class and access to care do not completely explain the racial differences in the rates of cerebral arteriography and CEA in the Veterans Affairs system.

The dramatic increase in the volume of CEAs and the concomitant significant increase in the estimated hospital payments raise the issue of whether CEA is cost-effective in patients with asymptomatic stenoses. The authors of ACAS concluded that CEA was beneficial for select asymptomatic patients, but stated that 19 CEAs would be necessary to prevent one stroke over 5 years. Kuntz and Kent developed a Markov decision analysis model based on the NASCET and ACAS trials to examine the cost-effectiveness of CEA and reported that it was cost-effective (cost-effectiveness threshold, $50 000/QALYS) for symptomatic ($52 700/QALYS) lesions. However, CEA for asymptomatic stenoses became cost-effective in their model when several of the baseline assumptions were changed (ie, the risk of untreated patients doubled or the cost of CEA halved). Cronenwett et al used a similar decision analysis model and reported that CEA was cost-effective ($8000/QALYS) for the typical asymptomatic patient in ACAS; however, the cost-effectiveness for CEA in asymptomatic patients was adversely affected by an increase in patient age, an increase in perioperative stroke rate, and a decrease in the medical stroke risk. An increase in the patient age (decrease in life expectancy) had the most dramatic impact in their model, with the $50 000/QALYS threshold occurring at approximately 75 years of age. The total number of CEAs performed in patients aged >75 years in the current study is remarkable in light of this finding. Admittedly, the specific indications for the procedures in this age group were not available, but it is likely that a significant proportion, particularly after the ACAS Advisory, were performed for asymptomatic stenosis.

In conclusion, the dramatic increase in the number of CEAs performed throughout the state of Florida after release of the ACAS Clinical Advisory suggests a causal relationship. The estimated increase in hospital payments concomitant with the increased volume mandates further cost-effectiveness analysis, particularly in view of the limited reported benefit of CEA in asymptomatic patients.

References
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