A RETROSPECTIVE multicenter audit of carotid endarterectomies performed in 1981 was proposed, sponsored, and completed by the Cerebrovascular Surgery Section of the American Association of Neurological Surgeons. The purpose of this study was to achieve through a national audit covering a broad spectrum of practices a profile concerning the status of carotid endarterectomy in North America. The need for such a study is self-evident.

Methods

A. Case Material

This retrospective analysis was actually completed during the years of 1982 and 1983. The year 1981 was selected for retrospective analysis as it was felt that records on patients undergoing an endarterectomy during that year should have been completed by the time of the audit and that the time period was recent enough to represent the current state of the art.

A statistical form was designed with 14 questions (see Appendix A) permitting the collection of pertinent data from a minimal amount of effort on the part of the participants. This abbreviated form was used in order to increase the response and participation from the contributing institutions. This was necessary as no special funds were allocated for this study and the costs of the audit were borne individually by the participating centers and the Cerebrovascular Section of the American Association of Neurological Surgeons.

The participation was solicited from members of the Cerebrovascular Section initially, but thereafter letters were sent to all members of the AANS in an effort to increase the number of reporting centers. Participation was entirely voluntary and was without remuneration. It was not necessary to be a member of the AANS to participate in this study and some contributors were neurologists. Although case material is included from vascular and general surgeons, all correspondence was through neurosurgeons and neurologists. There was no pre-selection process as it was our goal to achieve a broadbased view of the spectrum of carotid endarterectomy in North America.

Anonymity of responses from participating institutions was guaranteed. A code number was assigned to each institution and only one person (NF) had access to the code list. The information obtained was key-punched into a computer bank for retrieval and analysis.

Forty-six centers (Appendix B) contributed their cases of carotid endarterectomy for the year 1981 resulting in a total of 3,328 cases for analysis. The size of responding institutions varied from under 200 beds to over 900 beds and included: private, county or city, university, and veteran’s hospitals. The number of cases contributed per center ranged from 12 to 243. The geographic distribution was representative of the continental United States (New England, Middle Atlantic, South, Midwest, Southwest, West Coast, Northwest, Midwest) and Canada (Quebec and Ontario). The patient population included 1,251 women and 2,077 men.
B. Categorization of Cases

1. Indications for surgery — The following indications for surgery with the numbers of recorded cases reported in each category were recorded: asymptomatic bruit, 396 cases; prelude to surgery elsewhere in the body such as coronary bypass or aortic aneurysm repair, 176; amaurosis fugax, 461; transient ischemic attacks, 1295; dizziness, vertigo or syncope, 336; mild stroke (grade 1 or 2 paresis), 388; severe stroke (grade 3 or 4 paresis), 51; progressing stroke and/or crescendo TIA’s, 38; and unspecified or other, 197.

2. Surgical Complications — Complications were coded as either intraoperative or postoperative (occurring during the patient’s hospital stay). Days in the hospital ranged from five days to > 99 days. Complications of surgery were divided into transient and permanent neurological deficits; death from stroke or myocardial infarction; and other:

   a) Transient
      1) Transient ischemic attack (TIA) — A neurological deficit resolving in 24 hours.
      2) Reversible Ischemic Neurological Deficit (RIND) — A neurological deficit resolving in 7 days.

   b) Permanent
      1) Minor Stroke — This was defined as a patient who was still able to work but had a minor deficit such as an incomplete field cut or clumsiness in one hand or arm.
      2) Major Stroke — Unable to work, able to care for self. This category included patients who had a non-dominant hemispheric major stroke rendering them unable for gainful employment but yet able to care for self.
      3) Major Stroke, Unable to care for self — This category included patients with a major stroke in the dominant hemisphere who, thereafter, required some nursing assistance for self-care and were essentially candidates for a nursing home.

   c) Death
      Causes for death were coded into two categories: death from stroke and death from myocardial infarction.

   d) Other
      The form used for compiling information included a code-space for other types of complications. Because of the range of “other” complications from minor (wound hematomas, transient cranial nerve deficits) to major (nonfatal myocardial infarction, death from pulmonary problems), this category was not included in the statistical analysis. However, there was an overall incidence of 9% of “other” complications.

3. Intra-Operative Monitoring — Three major groupings for analysis with two subgroups in each major group were used for analysis. These included: 1) no monitor (shunt and no shunt); 2) electroencephalographic (EEG) monitoring (shunt and no shunt); and 3) stump pressure (shunt and no shunt).

4. Classification of Operative Procedure — The categories for classification of the operation were as follows: single-stage unilateral endarterectomy; simultaneous bilateral endarterectomy; staged bilateral endarterectomy (bilateral procedures one week or more apart); endarterectomy combined with peripheral vascular procedure; and endarterectomy combined with coronary bypass.

5. Type of Procedure — Procedures were coded according to the type of closure used: endarterectomy without patch graft; endarterectomy with vein patch graft; or endarterectomy with fabric patch graft.

6. Type of Surgeon — Operative procedures were coded according to the type of surgeon: cardiovascular, peripheral vascular, general surgeon, and neurosurgeons.

C. Statistical Analysis

Chi square analysis was used for each of the six statistical analyses involving type of complication. Rank sum analysis was performed in looking at clinical indication for surgery versus type of surgeon.

Results

Types of complications were cross tabulated with each of the following six categories: 1) size of institution, 2) clinical indication for surgery, 3) classification of operation, 4) type of procedure, 5) type of intraoperative monitoring, 6) type of surgeon. Clinical indication for surgery was also cross tabulated with type of surgeon.

In the 3,328 cases reported, there were 82 postoperative TIA’s or reversible ischemic deficits (2.5%), 44 minor strokes (1.3% incidence), and 96 major strokes (2.9%) giving an overall incidence of transient deficits of 2.5% and permanent deficits of 4%. There were 26 deaths from myocardial infarction (over 1% incidence) and 40 deaths due to stroke (1.2%). Thus there was a 2.5% risk of transient neurological dysfunction following surgery and a 6% risk of stroke or death from endarterectomy in the group.

In each of the six categories mentioned above, there was no statistically significant difference found in the frequency of transient or reversible neurological events postoperatively. The incidence of reversible events was 2 to 3% in each category of analysis.

A. Size of Institution

Institutional morbidity and mortality ranged from a high of 16% major stroke and 5% mortality to a low of 1.5% minor stroke with no deaths. When data were analyzed according to the size of the institution, there were no major or striking differences among any institutions except for those greater than 700 beds. Those institutions with greater than 700 beds had a statistically lower incidence of stroke or death than did other institutions (table 1) ($p < 0.005$).

B. Indication for Surgery

The incidence of stroke or death postoperatively was significantly ($p < 0.01$) lower for those patients who
were operated on for amaurosis fugax or for unspecified reasons as compared to those patients who had their operations for: asymptomatic bruit; TIA; dizziness; vertigo, or syncope; mild stroke; severe stroke; progressing stroke; or as a prelude to surgery elsewhere in the body (Table 2). However, there were no significant differences between those of amaurosis fugax and asymptomatic bruit. Those patients operated on for progressing stroke had a higher incidence (although not significant) of stroke or death postoperatively than those in the other categories.

C. Classification of Operation

In looking at the incidence of stroke or death postoperatively compared to the classification of operation there was no statistical difference in the incidence among categories in the single-stage unilateral endarterectomy, staged bilateral endarterectomy, or endarterectomy combined with peripheral vascular procedure. When these three classifications were compared to endarterectomy combined with coronary bypass or simultaneous bilateral endarterectomy there was a statistically higher incidence of stroke or death in these latter two categories than in the three aforementioned groups (table 3) (p < 0.005).

D. Type of Procedure

There was a statistically significant difference among the complication rate of stroke and death vs. the type of closure with vein patch grafting being the lowest risk group analyzed (table 4). Vein patch grafting was statistically better than both fabric patch grafting and primary closure (p < 0.01). This could be skewed data as the technique of vein patch grafting was used as the preferred method of closure at one large center with a low morbidity and mortality. Balanced against this, however, was the use of this technique by other groups only for their complicated cases.

E. Type of Monitoring

When all patients who were monitored with EEG or stump pressures were compared to patients who were not monitored, there was a statistically significant difference in favor of the EEG group (table 5) (p < 0.005); but no difference in the group monitored with stump pressures. It was difficult to evaluate the use of a shunt in monitored patients as the shunt was placed only for their complicated cases.

In nonmonitored patients, cases which were operated without a shunt did significantly better than patients

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**Table 1: Size of Institution vs. Major Morbidity and Mortality**

<table>
<thead>
<tr>
<th>Size of institution</th>
<th>Total # of cases</th>
<th>Minor stroke able to work</th>
<th>Able to care for self</th>
<th>Unable to care for self</th>
<th>Death Stroke</th>
<th>Death MI</th>
<th>Total death &amp; stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td>100-199</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>200-299</td>
<td>150</td>
<td>4 (2.7%)</td>
<td>2 (1.3%)</td>
<td>1 (0.7%)</td>
<td>1 (0.7%)</td>
<td>5 (3%)</td>
<td>13 (8.7%)</td>
</tr>
<tr>
<td>300-399</td>
<td>104</td>
<td>0</td>
<td>1 (1%)</td>
<td>6 (5.8%)</td>
<td>1 (1%)</td>
<td>1 (1%)</td>
<td>9 (8.7%)</td>
</tr>
<tr>
<td>400-499</td>
<td>446</td>
<td>4 (1%)</td>
<td>7 (1.6%)</td>
<td>10 (2.2%)</td>
<td>9 (2%)</td>
<td>4 (1%)</td>
<td>34 (7.6%)</td>
</tr>
<tr>
<td>500-599</td>
<td>588</td>
<td>10 (1.7%)</td>
<td>8 (1.4%)</td>
<td>8 (1.4%)</td>
<td>6 (1%)</td>
<td>4 (0.7%)</td>
<td>36 (6.1%)</td>
</tr>
<tr>
<td>600-699</td>
<td>327</td>
<td>8 (2.4%)</td>
<td>6 (1.8%)</td>
<td>6 (1.8%)</td>
<td>8 (2.4%)</td>
<td>6 (1.8%)</td>
<td>34 (10.4%)</td>
</tr>
<tr>
<td>700-799</td>
<td>255</td>
<td>1 (0.4%)</td>
<td>2 (0.8%)</td>
<td>1 (0.4%)</td>
<td>4 (1.6%)</td>
<td>0</td>
<td>8 (3%)</td>
</tr>
<tr>
<td>800-899</td>
<td>199</td>
<td>3 (1.5%)</td>
<td>3 (1.5%)</td>
<td>7 (3.5%)</td>
<td>1 (0.5%)</td>
<td>0</td>
<td>14 (7%)</td>
</tr>
<tr>
<td>over 900</td>
<td>1242</td>
<td>14 (1.1%)</td>
<td>16 (1.3%)</td>
<td>12 (1%)</td>
<td>10 (0.8%)</td>
<td>6 (0.5%)</td>
<td>58 (4.7%)</td>
</tr>
</tbody>
</table>

**Table 2: Indication for Surgery vs. Major Morbidity and Mortality**

<table>
<thead>
<tr>
<th>Indication for surgery</th>
<th>Total # of cases</th>
<th>Minor stroke able to work</th>
<th>Able to care for self</th>
<th>Unable to care for self</th>
<th>Death Stroke</th>
<th>Death MI</th>
<th>Total death &amp; stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amaurosis fugax</td>
<td>461</td>
<td>0</td>
<td>5 (1.1%)</td>
<td>6 (1.3%)</td>
<td>0</td>
<td>3 (0.7%)</td>
<td>14 (3%)</td>
</tr>
<tr>
<td>Asymptomatic bruit</td>
<td>396</td>
<td>3 (0.8%)</td>
<td>3 (0.8%)</td>
<td>4 (1%)</td>
<td>7 (1.8%)</td>
<td>4 (1%)</td>
<td>21 (5.3%)</td>
</tr>
<tr>
<td>TIA</td>
<td>1283</td>
<td>25 (1.9%)</td>
<td>16 (1.2%)</td>
<td>20 (1.6%)</td>
<td>10 (0.8%)</td>
<td>11 (0.9%)</td>
<td>82 (6.4%)</td>
</tr>
<tr>
<td>Dizziness, vertigo, syncope</td>
<td>336</td>
<td>5 (1.5%)</td>
<td>5 (1.5%)</td>
<td>6 (1.8%)</td>
<td>7 (2%)</td>
<td>1 (0.3%)</td>
<td>24 (7%)</td>
</tr>
<tr>
<td>Minor stroke</td>
<td>388</td>
<td>4 (1%)</td>
<td>9 (2.3%)</td>
<td>7 (1.8%)</td>
<td>8 (2.1%)</td>
<td>2 (0.5%)</td>
<td>30 (7.7%)</td>
</tr>
<tr>
<td>Major stroke</td>
<td>51</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4 (7.8%)</td>
<td>1 (2%)</td>
<td>5 (9.8%)</td>
</tr>
<tr>
<td>Progressing stroke</td>
<td>38</td>
<td>2 (5.3%)</td>
<td>2 (5.3%)</td>
<td>2 (5.3%)</td>
<td>2 (5.3%)</td>
<td>0</td>
<td>8 (21.1%)</td>
</tr>
<tr>
<td>Prelude to surgery elsewhere</td>
<td>176</td>
<td>4 (2.3%)</td>
<td>3 (1.7%)</td>
<td>3 (1.7%)</td>
<td>1 (0.6%)</td>
<td>3 (1.7%)</td>
<td>14 (8%)</td>
</tr>
<tr>
<td>Other or unspecified</td>
<td>195</td>
<td>1 (0.5%)</td>
<td>2 (1%)</td>
<td>3 (1.5%)</td>
<td>1 (0.5%)</td>
<td>1 (0.5%)</td>
<td>8 (4%)</td>
</tr>
</tbody>
</table>
who were operated with a shunt (p < 0.005). Thus, if no monitoring was used, it appeared to be statistically safer to operate the patient without a shunt than with a shunt.

F. Type of Surgeon
There were statistical differences related to surgical complications and the type of surgeon doing the operation, but this information is probably not valid on a sampling basis. The difficulty in making such an analysis obviously refers to the bias of the sampling group in that neurosurgeons with good results were probably more inclined to pursue this form and report their results than were neurosurgeons with bad results. Furthermore, if they knew that bad results were being obtained in their hospitals by vascular and cardiovascular surgeons and they themselves were not tending to do the surgery, they were still more likely to fill out the form.

An analysis concerning the type of surgeon vs. the indication for surgery is of some interest. The rank-sum type of analysis based on table 6 was used for this examination. Here the indications for surgery were divided into two groups: the “solid” or tangible indications for surgery and “less solid” or disputable indications for surgery. These “solid” or tangible indications for surgery included: amaurosis fugax, TIA, mild stroke, severe stroke (with however important residual function), or progressing stroke. The “less solid” or disputable indications for surgery included: asymptomatic bruit; dizziness, vertigo or syncope; and prelude to surgery elsewhere in the body. The cases with “other or unspecified indications for surgery” were not included in this analysis. Neurosurgeons ranked first in this analysis having more patients in the group considered as having solid indications for surgery.

Discussion
The results of this audit are self-explanatory. The variations concerning: indications for surgery, the type of operation performed, and the use of monitoring procedures indicates that there is as yet no consensus regarding any of these. Conflicting reports in the literature indicating excellent results with no monitoring,1-5 routine closure of the arteriotomy,2,6 electroencephalographic monitoring,7-10 no monitoring and no shunting,2-3 shunting routinely,4 monitoring without shunting,4 surgery under local anesthesia2-3 and reliance upon stump pressures for the use of shunts2-3 leave the discriminating reader bewildered. Experienced surgeons adamantly support their position concerning their methods of arterial repair and thus an evaluation of these differences is difficult to achieve.14-19

Among the major problems with any multicenter study are the variations in populations treated, the dedication of the correspondents and investigators, and the completeness of hospital records. Recognition of minor neurological deficits is often not the same from institution to institution and several community studies suggest minor complications are not always recorded.20-23

The original purpose of this investigation was to define the current state of the art. In that we only
achieved reports from 46 centers with 3,328 cases we fell far short of our original goal of 100-200 centers and 7,000 cases.

There is an admitted bias in this report in that neurosurgeons were the correspondents. Nevertheless, the above information reported here may serve as a benchmark for further studies and may represent a possible cross-section of carotid endarterectomy in North America today. Parenthetically, it should be noted, that there was considerable variability from institution to institution in the obvious time taken for preparation of the answered computerized form. This was a simplified computer form and only two code numbers required any comment. In those computer forms with more complete information in these areas, indicating possibly a more discriminating analysis, the reported complications were higher. Thus, this retrospective analysis may represent an optimistic report on the current state of the art.

Acknowledgments

The authors would like to thank Mr. Robert Anderson, B. A. S. for his assistance in the statistical analyses and Ms. Bernita Bruns for preparation of the manuscript.

References


### Table 5: Cerebral Protection vs. Major Morbidity and Mortality

<table>
<thead>
<tr>
<th>Cerebral protection</th>
<th>Total # of cases</th>
<th>Minor stroke able to work</th>
<th>Major stroke unable to work</th>
<th>Stroke</th>
<th>MI</th>
<th>Death</th>
<th>Total death &amp; stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td>No monitor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shunt</td>
<td>953</td>
<td>19 (2.0%)</td>
<td>19 (2.0%)</td>
<td>10 (1.0%)</td>
<td>20 (2.1%)</td>
<td>13 (1.4%)</td>
<td>81 (8.5%)</td>
</tr>
<tr>
<td>No shunt</td>
<td>955</td>
<td>6 (0.6%)</td>
<td>9 (0.9%)</td>
<td>23 (2.4%)</td>
<td>10 (1.0%)</td>
<td>5 (0.5%)</td>
<td>53 (5.5%)</td>
</tr>
<tr>
<td>EEG</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shunt</td>
<td>462</td>
<td>2 (0.4%)</td>
<td>0</td>
<td>2 (0.4%)</td>
<td>2 (0.4%)</td>
<td>3 (0.6%)</td>
<td>8 (1.7%)</td>
</tr>
<tr>
<td>No shunt</td>
<td>511</td>
<td>7 (1.4%)</td>
<td>8 (1.6%)</td>
<td>5 (1.0%)</td>
<td>3 (0.6%)</td>
<td>3 (0.6%)</td>
<td>26 (5.3%)</td>
</tr>
<tr>
<td>Stump pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shunt</td>
<td>41</td>
<td>2 (4.9%)</td>
<td>0</td>
<td>0</td>
<td>1 (2.4%)</td>
<td>0</td>
<td>3 (7.3%)</td>
</tr>
<tr>
<td>No shunt</td>
<td>135</td>
<td>0</td>
<td>2 (1.5%)</td>
<td>3 (2.2%)</td>
<td>0</td>
<td>0</td>
<td>5 (3.7%)</td>
</tr>
<tr>
<td>Other/unknown</td>
<td>262</td>
<td>8 (3.0%)</td>
<td>7 (2.7%)</td>
<td>7 (2.7%)</td>
<td>4 (1.5%)</td>
<td>3 (1.1%)</td>
<td>29 (11.1%)</td>
</tr>
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</table>

### Table 6: Type of Surgeon vs. Indication for Surgery

<table>
<thead>
<tr>
<th>Type of surgeon</th>
<th>Total # of cases</th>
<th>Amusoria fugax</th>
<th>Asymptomatic bruit</th>
<th>TIA</th>
<th>Dizziness, vertigo, syncope</th>
<th>Mild stroke</th>
<th>Severe stroke</th>
<th>Progressing stroke</th>
<th>Prelude to surgery elsewhere</th>
<th>Unspecified or other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiovascular</td>
<td>652</td>
<td>78</td>
<td>105</td>
<td>178</td>
<td>75</td>
<td>34</td>
<td>7</td>
<td>6</td>
<td>77</td>
<td>92</td>
</tr>
<tr>
<td>Peripheral vascular</td>
<td>707</td>
<td>102</td>
<td>97</td>
<td>245</td>
<td>87</td>
<td>67</td>
<td>11</td>
<td>6</td>
<td>67</td>
<td>25</td>
</tr>
<tr>
<td>General surgeon</td>
<td>245</td>
<td>26</td>
<td>22</td>
<td>96</td>
<td>42</td>
<td>24</td>
<td>3</td>
<td>1</td>
<td>19</td>
<td>12</td>
</tr>
<tr>
<td>Neurosurgeon</td>
<td>1720</td>
<td>254</td>
<td>172</td>
<td>764</td>
<td>132</td>
<td>263</td>
<td>30</td>
<td>25</td>
<td>13</td>
<td>67</td>
</tr>
</tbody>
</table>

### Appendix A

#### Current Status Carotid Endarterectomy-In-House Audit

<table>
<thead>
<tr>
<th>Patient's Initials</th>
<th>(for in-house surveyor's)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td></td>
</tr>
<tr>
<td>4-9</td>
<td>Case code number</td>
</tr>
</tbody>
</table>

#### Item

<table>
<thead>
<tr>
<th>Column</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Size of institution:</td>
</tr>
<tr>
<td>11</td>
<td>Regional location:</td>
</tr>
<tr>
<td>12</td>
<td>Type of institution:</td>
</tr>
<tr>
<td>13</td>
<td>Sex of patient:</td>
</tr>
<tr>
<td>14</td>
<td>Clinical indication for surgery:</td>
</tr>
</tbody>
</table>

#### Classification of operation:

- 1 = Single stage unilateral endarterectomy
- 2 = Simultaneous bilateral endarterectomy
- 3 = Staged bilateral endarterectomy (bilateral procedures 1 week or more apart)
- 4 = Combined with peripheral vascular procedure
- 5 = Combined with coronary bypass

#### Type of procedure:

- 1 = Endarterectomy without patch graft
- 2 = Endarterectomy with vein patch
- 3 = Endarterectomy with fabric patch
- 9 = Unknown

#### Cerebral protection:

- 1 = No shunt, no type of monitor
- 2 = Shunt, no type of monitor
- 3 = Stump pressure, no shunt
- 4 = Stump pressure, shunt
- 5 = EEG monitor, no shunt
- 6 = EEG monitor, shunt
- 7 = Xenon blood flow
- 8 = Other (i.e., stump, eeg; or local anesthetic; or shunt + local
- 9 = Unknown

#### Type of complications:

- 0 = None
- 1 = TIA
- 2 = RIND
- 3 = Minor stroke with minimal residual deficit, employable
- 4 = Major stroke, unable to work; able to care for self
- 5 = Major stroke, unable to work and unable to care for self
- 6 = Intracerebral hemorrhage
- 7 = Death from stroke
- 8 = Death from myocardial infarction
- 9 = Other (specify )

#### Time of complications:

- 0 = None
- 1 = Intra-operative
- 2 = Post-operative

#### Neurologic evaluation:

- 1 = Neurologist or neurosurgeon prior to surgery
- 2 = Neurologist pre and post op
- 3 = Neurosurgeon preop
- 4 = Neurosurgeon prior to and following surgery
- 5 = No apparent neurological consultation
- 7 = Neurologist or neurosurgeon postop only
- 9 = Unknown

#### Type of surgeon:

- 1 = Cardiovascular
- 2 = Peripheral vascular
- 3 = General surgeon
- 4 = Neurosurgeon
- 5 = Other
- 9 = Unknown

#### Age of patient

- 22-23

#### Days in hospital

- 24-25
Appendix B

Carotid Endarterectomy In-House Audit Institutions

Ann Arbor, MI, University of Michigan Hospital & VA Hospital
Augusta, GA, Eugene Talmadge Memorial Hospital & VA Hospital
Baton Rouge, LA, Baton Rouge General Hosp. & Our Lady of the Lake Medical Center
Billings, MT, Billings Deaconess & St. Vincent's Hospital
Birmingham, AL, University Hospital & VA Hospital
Boston, MA
Buffalo, NY, Dent Neurologic Institute of Millard Fillmore Hospital
Chatham, N.J., Morristown Memorial Hospital
Chatham, N.J., Overlook Hospital
Chapel Hill, NC, N.C. Memorial Hospital
Cincinnati, OH, Good Samaritan Hospital
Cleveland, OH, University Hospitals of Cleveland
Columbus, OH
Columbus, OH, Ohio State University Hospital
Concord, NH, Surgical Neurology Professional Association
Dallas, TX, Presbyterian Hospital
Des Moines, IA, Mercy Hospital
Detroit, MI, Henry Ford Hospital
Evansville, IN, Deaconess Hospital
Evansville, IN, St. Mary's Medical Center
Greenville, S.C., Greenville Memorial Hospital
Lexington, KY, University of Kentucky
Little Rock, AR, Baptist Medical Center
Little Rock, AR, St. Vincent's Infirmary
London, Ontario, University Hospital
Louisville, KY
Memphis, TN, Baptist Hospital
Memphis, TN, Methodist Hospital
Memphis, TN, St. Francis Hospital
Memphis, TN, VA Hospital
Minneapolis, MN, University of Minnesota Hospital
Minneapolis, MN, VA Hospital
Montreal, Quebec, Canada, Montreal Neurological Hospital
Norfolk, VA
Pascagoula, MS
Phoenix, AZ
Pittsburgh, PA, University of Pittsburgh
Regina, Saskatchewan, Canada, South Saskatchewan Hospital Centre
Rochester, MN, Mayo Clinic
San Diego, CA, Grossmont District Hospital
St. Cloud, MN
St. Louis, MO, Barnes Hospital & Jewish Hospital
Syracuse, N.Y.
Tulsa, OK, Hillcrest Medical Center
Wilmington, DE, Wilmington Medical Center & Thomas Jefferson University Hospital
Winston-Salem, NC, N.C. Baptist Hospital
Multicenter retrospective review of results and complications of carotid endarterectomy in 1981.

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Stroke. 1986;17:370-376
doi: 10.1161/01.STR.17.3.370

Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the World Wide Web at:
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