Variability in Carotid Endarterectomy Practice Patterns Within a Metropolitan Area

Amit Kansara, MD; Daniel Miller, MD; Rahul Damani, MD; Darren Fuerst, PhD; Brian Silver, MD; Seemant Chaturvedi, MD

Background and Purpose—Previous clinical studies have suggested that patients with carotid stenosis with high surgical risk features may fare better with carotid artery stenting or aggressive medical therapy. The extent to which carotid endarterectomy is still being performed in this group of patients is unclear.

Methods—A retrospective audit was performed among 4 hospitals over a 2-year period. The proportion of high surgical risk patients was compared and the in-hospital stroke, myocardial infarction, and death rates were compared among conventional and high surgical risk patients.

Results—Three hundred thirty-five carotid endarterectomy operations were performed (63% asymptomatic) with 37.9% being high surgical risk subjects. The stroke, myocardial infarction, and death rate was 4.6% in conventional risk subjects and 10.2% in high surgical risk patients (P<0.05). The only hospital with multidisciplinary carotid conferences had the lowest proportion of carotid endarterectomy operations in asymptomatic patients.

Conclusions—A substantial proportion of carotid endarterectomy operations are performed in patients with high surgical risk features. These patients experienced a 2-fold increase in major in-hospital complications, raising doubts about whether they benefit from carotid surgery. The use of preintervention multidisciplinary conferences may improve patient safety. 

Key Words: carotid stenosis ■ endarterectomy ■ outcomes ■ surgery/endarterectomy

Carotid endarterectomy (CEA) has been studied in several multicenter clinical trials and it has been demonstrated to be useful in stroke prevention for select patients with both symptomatic and asymptomatic stenosis. Patients with high surgical risk (HSR) factors tend to have worse outcome after CEA.

Despite numerous guidelines, a substantial number of unproven or inappropriate CEAs are still being performed, especially in asymptomatic patients. We sought to define regional variation among hospitals in performing CEA on patients with HSR factors.

Methods

A retrospective chart review was performed at 3 urban hospitals and one suburban hospital (A, B, C, D) for CEA performed during years 2008 to 2009. All the hospitals were located within a 30-mile radius. Two hospitals had teaching programs for neurology and general surgery (A, B). Data were collected for patient demographics, medical history, symptom status (symptomatic or asymptomatic), and presence of HSR features. The study was approved by the Institutional Review Board.

Results

Patient Population

During the study period, 335 CEA procedures were performed (Table 1). Highest numbers of procedures were

Received July 2, 2012; final revision received July 30, 2012; accepted July 31, 2012.

From the Stroke Program and the Department of Neurology, Wayne State University, Detroit, MI (A.K., R.D., D.F., S.C.); the Stroke Program and Department of Neurology, Henry Ford Hospital, Detroit, MI (D.M.); and the Stroke Program and Department of Neurology, Rhode Island Hospital, Providence, RI (B.S.).

Statistical analysis done by Dr Fuerst.

The online-only Data Supplement is available with this article at http://stroke.ahajournals.org/lookup/suppl/doi:10.1161/STROKEAHA.112.669622/-/DC1.

E-mail SChaturv@med.wayne.edu

© 2012 American Heart Association, Inc.

Stroke is available at http://stroke.ahajournals.org DOI: 10.1161/STROKEAHA.112.669622
performed at Hospital A, 108 (32.3%). Mean age of the patients was 69.2±10.2 years. Of 335 patients, 137 (40.9%) were females. Of 335 patients, 124 (37%) patients were symptomatic, whereas 211 (63%) were asymptomatic. Other patient characteristics are found in Table 1.

### Variability Among the Hospitals

Compared with Hospital A, Hospital D had a significantly greater number of CEA patients with high-risk features (Z=2.48, significant). Hospitals B, C, and D had a lower number of CEA operations with symptomatic patients compared with Hospital A. This difference was significant for 2 of the hospitals with a difference for Hospital B (Z=−5.28) and D (Z=−4.84).

Hospital C had a lower number of octogenarian patients undergoing CEA than Hospital A, which was statistically significant (Z=−1.73). Hospital D had a greater proportion of patients undergoing CEA in the >80-year age group, which was also statistically significant (Z=3.01). Using a cutoff age range ≥75 years, a statistically significant difference

### Table 1. Patient and Hospital Characteristics

<table>
<thead>
<tr>
<th>Hospital</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Total, % (No.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of hospital</td>
<td>Teaching/urban</td>
<td>Teaching/urban</td>
<td>Nonteaching/urban</td>
<td>Nonteaching/suburban</td>
<td></td>
</tr>
<tr>
<td>No. of patients</td>
<td>108</td>
<td>91</td>
<td>53</td>
<td>83</td>
<td>335</td>
</tr>
<tr>
<td>Age, mean y</td>
<td>69.45</td>
<td>67.13</td>
<td>67.8</td>
<td>71.74</td>
<td>69.2±10.2</td>
</tr>
<tr>
<td>&gt;80, %</td>
<td>13.9</td>
<td>14.3</td>
<td>5.7</td>
<td>25.3</td>
<td>52</td>
</tr>
<tr>
<td>≥75, %</td>
<td>35.2</td>
<td>30.8</td>
<td>17.0</td>
<td>45.8</td>
<td>113</td>
</tr>
<tr>
<td>Female, %</td>
<td>38</td>
<td>37.4</td>
<td>49.1</td>
<td>43.4</td>
<td>40.1 (137)</td>
</tr>
<tr>
<td>Symptomatic patients</td>
<td>51.9</td>
<td>24.2</td>
<td>47.2</td>
<td>25.3</td>
<td>37 (124)</td>
</tr>
<tr>
<td>Asymptomatic patients</td>
<td>48.1</td>
<td>75.8</td>
<td>52.8</td>
<td>74.7</td>
<td>63 (211)</td>
</tr>
<tr>
<td>History of stroke and/or TIA</td>
<td>55.6</td>
<td>34.1</td>
<td>39.6</td>
<td>28.9</td>
<td>40.6 (136)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>89.8</td>
<td>87.9</td>
<td>92.4</td>
<td>90.4</td>
<td>89.9 (301)</td>
</tr>
<tr>
<td>DM</td>
<td>40.7</td>
<td>31.9</td>
<td>41.5</td>
<td>34.9</td>
<td>37 (124)</td>
</tr>
<tr>
<td>CAD</td>
<td>39.8</td>
<td>34.1</td>
<td>47.2</td>
<td>59</td>
<td>44.2 (148)</td>
</tr>
<tr>
<td>Active smoking in last 5 y</td>
<td>39.8</td>
<td>42.9</td>
<td>52.8</td>
<td>41</td>
<td>43 (144)</td>
</tr>
<tr>
<td>Bed size</td>
<td>900</td>
<td>600</td>
<td>500</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>No. of surgeons performing CEA</td>
<td>6</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>CAS performed</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>3</td>
</tr>
<tr>
<td>CAS volume during study period</td>
<td>21</td>
<td>298</td>
<td>14</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

TIA indicates transient ischemic attack; DM, diabetes mellitus; CAD, coronary artery disease; CEA, carotid endarterectomy; CAS, carotid artery stenting.

### Table 2. High-Risk Features

<table>
<thead>
<tr>
<th>Hospital</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Total, % (No.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of hospital</td>
<td>Teaching/urban</td>
<td>Teaching/urban</td>
<td>Nonteaching/urban</td>
<td>Nonteaching/suburban</td>
<td></td>
</tr>
<tr>
<td>High-risk patients (%)</td>
<td>35.2</td>
<td>31.7</td>
<td>37.7</td>
<td>48.2</td>
<td>37.9 (127)</td>
</tr>
<tr>
<td>Cardiac (CHF, recent MI, NYHA III/IV)</td>
<td>12</td>
<td>4.4</td>
<td>11.3</td>
<td>14.5</td>
<td>10.5 (35)</td>
</tr>
<tr>
<td>Severe pulmonary disease</td>
<td>0</td>
<td>3.3</td>
<td>3.8</td>
<td>4.8</td>
<td>2.7 (9)</td>
</tr>
<tr>
<td>Previous radical neck surgery/radiation</td>
<td>0</td>
<td>6.6</td>
<td>5.7</td>
<td>14.5</td>
<td>6.3 (21)</td>
</tr>
<tr>
<td>Contralateral laryngeal nerve palsy</td>
<td>0</td>
<td>1.1</td>
<td>0</td>
<td>0</td>
<td>0.03 (1)</td>
</tr>
<tr>
<td>Recurrent stenosis after CEA</td>
<td>0.009</td>
<td>3.3</td>
<td>7.5</td>
<td>2.4</td>
<td>3 (10)</td>
</tr>
<tr>
<td>Contralateral complete carotid occlusion</td>
<td>8.3</td>
<td>1.1</td>
<td>3.8</td>
<td>2.4</td>
<td>4.2 (14)</td>
</tr>
<tr>
<td>Age &gt;80 y</td>
<td>13.9</td>
<td>14.3</td>
<td>5.7</td>
<td>25.3</td>
<td>15.5 (52)</td>
</tr>
<tr>
<td>Length of stay &gt;7 d</td>
<td>4.6</td>
<td>10</td>
<td>37.7</td>
<td>14.5</td>
<td>14.0 (47)</td>
</tr>
</tbody>
</table>

CHF indicates congestive heart failure; MI, myocardial infarction; NYHA, New York Heart Association; CEA, carotid endarterectomy.

### High-Risk Features

Patients with HSR features as per the SAPPHIRE criteria are shown in Table 2. In aggregate, 127 (37.9%) patients had high-risk features (range, 32%–48% at the 4 hospitals). Age >80 years was the most common high-risk feature in 52 (15.5%) patients. Other notable high risk features were cardiac in 35 (10.5%) and previous radical neck surgery/radiation in 21 (6.3%) patients.
Complication Rates
The composite stroke, cardiac events, or death rate was 6.3% and stroke/death rate was 3.9%. The complication rate at teaching Hospitals A and B was 3.7% and 5.5%, respectively. The complication rate was lower at the 2 teaching hospitals (4.5%) compared with the nonteaching hospitals (8.8%; Z=2.41; P<0.05). The complication rate was 4.6% (10 of 218) among patients without HSR features and 10.2% (13 of 127) among high-risk patients (z score 2.86; P<0.05).

Discussion
A substantial proportion of CEA operations are done in patients with HSR features. Second, we found the complication rate to be higher in patients with HSR features. Third, the only hospital that had multidisciplinary case conferences performed a lower proportion of operations on asymptomatic patients.

In the aftermath of the SAPPHIRE study, there were several single-center surgical studies that claimed that CEA results were not different in conventional risk versus high-risk patients. However, larger studies such as an analysis of 13,622 CEA operations in the National Surgical Quality Improvement Program have found higher periprocedure complication rates in patients with SAPPHIRE high-risk features (3.0% mortality in high risk versus 1.7% without high risk, P<0.001). Despite the availability of several high-volume carotid artery stenting centers within the geographic region in this study, we found that surgeons still preferred to perform CEA in this population.

Irrespective of their risk profile, most procedures (63%) were done in asymptomatic patients. Differences among the hospitals in the proportion of asymptomatic patients were statistically significant for 2 hospitals compared with the reference hospital. The reference hospital was the only one with multidisciplinary case conferences and it is likely that the neurologists tempered the enthusiasm for procedures in asymptomatic patients.

The value of CEA in asymptomatic patients with HSR features should be re-evaluated. Previous guidelines state that selection of asymptomatic patients for carotid revascularization should be guided by an “assessment of comorbid conditions, life expectancy, and other individual factors” (Class I, Level of Evidence: C). The SAPPHIRE trial also found that a large proportion of patients (24.2%) with HSR features will die within 3 years of carotid revascularization. This finding obviates the potential benefit, especially for asymptomatic patients, in whom a minimum 5-year life expectancy is recommended.

Our study’s limitations include its retrospective nature. Outcomes measures are limited to in-hospital outcomes only. In addition, patients were not routinely evaluated by neurologists postoperatively.

Conclusions
Over one third of CEA operations are performed in high surgical risk patients. This suggests that surgeons remain skeptical about the concept of high surgical risk features for CEA and the value of carotid artery stenting or optimal medical therapy as alternatives.

Disclosures
One of the authors (Dr Chaturvedi) is a consultant for Abbott Vascular and Thornhill Research.

References
Variability in Carotid Endarterectomy Practice Patterns Within a Metropolitan Area
Amit Kansara, Daniel Miller, Rahul Damani, Darren Fuerst, Brian Silver and Seemant Chaturvedi

Stroke. 2012;43:3105-3107; originally published online August 28, 2012;
doi: 10.1161/STROKEAHA.112.669622
Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2012 American Heart Association, Inc. All rights reserved.
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:
http://stroke.ahajournals.org/content/43/11/3105

Data Supplement (unedited) at:
http://stroke.ahajournals.org/content/suppl/2012/08/28/STROKEAHA.112.669622.DC1

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Stroke can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Stroke is online at:
http://stroke.ahajournals.org//subscriptions/
Table: Carotid case conference description (participants, processes, and rules)

- **Participants**
  - Representatives from cardiology, neurology, neuroradiology (diagnostic and interventional), neurosurgery, vascular surgery
  - Representatives include attending staff, house officers, and nursing

- **Processes**
  - Weekly meetings to discuss referrals of patients with carotid artery disease, both asymptomatic and symptomatic
  - Case presentations with imaging are reviewed
  - Alternative management strategies are discussed (e.g. aggressive medical management, procedural intervention)
  - Technical issues around proposed interventions are discussed

- **Rules**
  - A consensus opinion from all members present at the meeting must be reached on a decision to do a procedural intervention including the type of intervention (e.g. endarterectomy, stent)
  - Hospital leadership approves one interventionalist from each department