

From the Society for Vascular Surgery

Regional variation in patient selection and treatment for carotid artery disease in the Vascular Quality Initiative

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ABSTRACT

Objective: Previous studies involving large administrative data sets have revealed regional variation in the demographics of patients selected for carotid endarterectomy (CEA) and carotid artery stenting (CAS) but lacked clinical granularity. This study aimed to evaluate regional variation in patient selection and operative technique for carotid artery revascularization using a detailed clinical registry.

Methods: All patients who underwent CEA or CAS from 2009 to 2015 were identified in the Vascular Quality Initiative (VQI). Deidentified regional groups were used to evaluate variation in patient selection, operative technique, and perioperative management. χ^2 analysis was used to identify significant variation across regions.

Results: A total of 57,555 carotid artery revascularization procedures were identified. Of these, 49,179 patients underwent CEA (asymptomatic: median, 56%; range, 46%-69%; $P < .01$) and 8376 patients underwent CAS (asymptomatic: median, 36%; range, 29%-51%; $P < .01$). There was significant regional variation in the proportion of asymptomatic patients being treated for carotid stenosis $<70\%$ in CEA (3%-9%; $P < .01$) vs CAS (3%-22%; $P < .01$). There was also significant variation in the rates of intervention for asymptomatic patients older than 80 years (CEA, 12%-27% [$P < .01$]; CAS, 8%-26% [$P < .01$]). Preoperative computed tomography angiography or magnetic resonance angiography in the CAS cohort also varied widely (31%-83%; $P < .01$), as did preoperative medical management with combined aspirin and statin (CEA, 53%-77% [$P < .01$]; CAS, 62%-80% [$P < .01$]). In the CEA group, the use of shunt (36%-83%; $P < .01$), protamine (32%-89%; $P < .01$), and patch (87%-99%; $P < .01$) varied widely. Similarly, there was regional variation in frequency of CAS done without a protection device (1%-8%; $P < .01$).

Conclusions: Despite clinical benchmarks aimed at guiding management of carotid disease, wide variation in clinical practice exists, including the proportion of asymptomatic patients being treated by CAS and preoperative medical management. Additional intraoperative variables, including the use of a patch and protamine during CEA and use of a protection device during CAS, displayed similar variation in spite of clear guidelines. Quality improvement projects could be directed toward improved adherence to benchmarks in these areas. (J Vasc Surg 2017;■:1-10.)

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Carotid artery revascularization is one of the most commonly performed procedures, with $>250,000$ performed annually worldwide.¹ Much like with other common vascular procedures, such as abdominal aortic aneurysm repair, previous studies have identified wide variation in patient selection and treatment in these populations.²⁻⁴ Carotid endarterectomy (CEA) has long been the standard approach; however, there has recently been increased implementation of the less invasive alternative, carotid artery stenting (CAS).⁵ Previous studies using administrative databases have identified a trend toward increasing use of CAS and have shown significant geographic variation within it.^{6,7}

According to Birkmeyer et al, variation itself falls into two major categories: acceptable and unwarranted.⁸ Acceptable variation includes variables such as patient comorbidities and operative techniques for which guidelines are unclear or do not exist. Unwarranted variation reflects areas in which best-practice measures have

been created and guidelines are in place to serve as benchmarks for quality care. They reviewed a number of common surgical procedures, including CEA, and determined that discretion of the clinician was the largest factor responsible for variation.

The Dartmouth Atlas evaluated trends in variation, specifically in carotid revascularization, and showed that although there was an increasing use of CAS, there was significant regional variation in its application.⁹ Additional research involving Medicare patients corroborated these results and showed a high degree of variability in practice patterns.^{4,10} This study builds on those previously performed by providing additional data, such as operative details, that the others were lacking.

With the evolution in health care management and greater focus on consistency in quality patient care, there has been a rising interest in establishing solid, evidence-based benchmarks to guide physician care. The Society for Vascular Surgery (SVS) has identified such standards for carotid revascularization procedures.^{11,12} These pertain to patient factors, such as the recommendation for medical management in asymptomatic patients with stenosis <60%. In addition, they have developed technical considerations, such as when to use CEA over CAS, the use of a patch during CEA, and the use of a protection device during CAS. Although these guidelines exist, limited data are available about how routinely they are being used.¹²

Despite the variation in use of CAS, limited data have shown the variation in patient selection, operative technique, and indications for intervention for carotid disease. Moreover, few studies have assessed how treatment compares with current quality benchmarks. We hypothesized that significant variation exists across the regions with regard to patient selection and treatment of carotid artery revascularization. Therefore, this study aimed to evaluate the regional variation in baseline patient characteristics and comorbidities, indications for treatment, procedure selection, and operative characteristics. Furthermore, we aimed to compare current practice with those clinical benchmarks established by the SVS. By evaluating the variation surrounding these factors, we identified areas in which quality improvement efforts can focus on adherence to existing current guidelines as well as direct further research to define best practices.

METHODS

Database. The Vascular Quality Initiative (VQI) was used to identify all patients who underwent CEA or CAS from 2009 to 2015. The VQI is a national clinical registry developed by the SVS to help improve patient care. It represents a collaboration between 17 deidentified regional quality groups, involving >300 hospitals and 1300 physicians. Additional information regarding the registry can be found at www.vascularqualityinitiative.org/. The Beth Israel Deaconess Medical Center Institutional Review

ARTICLE HIGHLIGHTS

- **Type of Research:** Retrospective analysis of prospectively collected Vascular Quality Initiative (VQI) data
- **Take Home Message:** In 57,555 carotid artery revascularizations, there were wide regional variations in the proportion of asymptomatic patients treated with carotid artery stenting, in preoperative medical treatment, and in intraoperative variables.
- **Recommendation:** The authors suggest that quality improvement projects could be directed toward adherence to existing practice guidelines.

Board approved this study, and consent of the patient was waived because of the deidentified nature of this data set.

Variables. Variable definitions were set forth by the VQI and were not able to be altered. Patient demographics, comorbid conditions, preoperative medications, and operative details were identified for all patients. Symptomatic disease was defined as any history of ipsilateral ocular or cortical stroke or transient ischemic attack. The degree of stenosis was obtained from the ipsilateral internal carotid artery stenosis measurement. The modality to obtain this measurement is not listed in the registry.

SVS guidelines were then used to identify a subset of patients for whom CAS is preferred to CEA. This included symptomatic patients with stenosis >50% who were considered at high risk for anatomic reasons (high lesions, tracheal stoma, or a history of previous irradiation or ipsilateral surgery) or stenosis >50% and severe coronary artery disease, congestive heart failure, or chronic obstructive pulmonary disease.

Statistical analysis. Statistical analysis was conducted using SPSS Statistics version 23 (IBM Corp, Armonk, NY), and all figures were produced using GraphPad version 6.0 (GraphPad Software Inc, La Jolla, Calif). χ^2 analysis was used to compare variation across regions. Forest plots were used to represent the range of each variable across the 17 regions, depicted by a line containing symbols, each of which represents an individual region. Each region had a volume of >100 of either procedure, and therefore all were analyzed individually. The vertical line on each plot represents the VQI median. A *P* value of < .05 was considered statistically significant.

RESULTS

A total of 57,555 carotid artery revascularizations were performed, consisting of 49,179 CEA and 8376 CAS procedures.

Patient selection and demographics. As depicted in Fig 1, significant variation was seen in the baseline characteristics among patients who underwent carotid artery

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