Strategies for asymptomatic carotid artery stenosis

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The treatment of asymptomatic carotid artery stenosis (ACAS) has continued to evolve for the past 3 decades. With rapidly advancing technology, the results of old trials have become obsolete. While there has been little change in the efficacy of carotid endarterectomy, there have been vast improvements in both medical management and carotid angioplasty with stenting. Finding the best therapy for a given patient can therefore be difficult. In this article, the authors review the current literature regarding treatment options for ACAS and the methods available for stratifying patients who would benefit from surgical versus medical treatment. (DOI: 10.3171/2011.9.FOCUS11206)

Key Words • asymptomatic carotid artery stenosis • treatment • endarterectomy • carotid stent

Carotid artery stenosis commonly refers to a narrowing of the common carotid artery or the ICA due to atherosclerosis and is most commonly seen in the geriatric population. It is associated with an increased risk of ischemic stroke. In some patients, the stenosis is discovered as a result of transient ischemic attacks or amaurosis fugax (transient blindness in one eye). In these patients, the likelihood of suffering an ischemic stroke in the near future is increased. Surgical intervention, either CEA or CAS, is generally accepted in symptomatic patients. Since the late 1970s and early 1980s when clinical trials were performed to compare the best medical treatment at the time and CAE, the controversy continued in the early 1980s when some physicians believed that conservative medical management was warranted until severe stenosis or symptoms appeared.

Carotid artery stenosis commonly refers to a narrowing of the common carotid artery or the ICA due to atherosclerosis and is most commonly seen in the geriatric population. It is associated with an increased risk of ischemic stroke. In some patients, the stenosis is discovered as a result of transient ischemic attacks or amaurosis fugax (transient blindness in one eye). In these patients, the likelihood of suffering an ischemic stroke in the near future is increased. Surgical intervention, either CEA or CAS, is generally accepted in symptomatic patients.

Given advances in imaging of the cerebral vasculature and the more widespread use of such studies, the frequency of incidentally discovered carotid stenosis is increasing. The severity of stenosis and the development of symptoms are not necessarily directly related, due to collateral circulation from the contralateral carotid artery and the posterior circulation. The management of ACAS has been debated since the late 1970s and early 1980s when clinical trials were performed to compare the best medical treatment at the time and CAE. The controversy continued in the early 1980s when some physicians believed that conservative medical management was warranted until severe stenosis or symptoms appeared.

Abbreviations used in this study: ACAS = asymptomatic carotid artery stenosis; CAE = carotid endarterectomy; CAS = carotid angioplasty with stenting; ECST = European Carotid Surgery Trial; hs-CRP = high-sensitivity C-reactive protein; ICA = internal carotid artery; NASCET = North American Symptomatic Carotid Endarterectomy Trial; TCD = transcranial Doppler.

Current American Heart Association and American Stroke Guidelines indicate that endarterectomy and aggressive management of risk factors is the best course of treatment for ACAS in patients with ≥ 60% stenosis if surgery is not otherwise contraindicated due to comorbidities and other risk factors. Polling in the US indicates that about 47% of patients are treated medically, 36% with CEA, and the remainder with CAS. International statistics are similar regarding treatment choice. The clinical reasoning behind the predominance of medical management is that many physicians are treating individuals with atherosclerotic disease in other areas of the body and are uncomfortable with the risks of surgery, despite the proven long-term success of endarterectomy. However, the choice of aggressive medical management alone may not necessarily be incorrect given the recent advances and emerging evidence.

Multiple trials have been performed to help elucidate the best treatment strategy for ACAS. In the 1980s and 1990s, trials were designed to examine CEA and medical management. Examples of these trials include the NASCET and the ECST. Although focused on symptomatic stenosis, both NASCET and ECST included information regarding the nonsymptomatic artery. These data have been used for analyses of the efficacy of CEA in asymptomatic stenosis; however, the data cannot be generalized to the truly asymptomatic population as these trials involved patients who were symptomatic in the contralateral artery.
In the 1990s and early 2000s, trials specifically focused on asymptomatic patients were conducted, the most notable being the Asymptomatic Carotid Atherosclerosis Study and the Asymptomatic Carotid Surgery Trial. These studies examined ACAS directly by following the long-term effects of medical management and CEA; however, these trials were performed at a time when medical management consisted mainly of aspirin. Therefore, these trials may now be outdated due to improvements in medical management, including lipid-lowering medications, antihypertension medications, and antiplatelet agents.

In the early 2000s, CAS became a viable treatment option for patients with carotid stenosis. Percutaneous angioplasty and stenting gained popularity due to the less invasive nature of endovascular procedures. Carotid angioplasty with stenting was believed to be a particularly good option for patients with a high surgical risk. Specific trials investigating the efficacy and safety of CAS were organized, including the Stenting and Angioplasty with Protection in Patients at High Risk for Endarterectomy trial and the Stent-Protected Angioplasty in Asymptomatic Carotid Stenosis (SPACE) trials. These trials have led to little consensus as to where CAS should fall in the treatment paradigm for patients with ACAS. Additionally, these trials examined CAS against CEA and rarely included a branch for medical management alone. An ongoing trial, SPACE-2, has an arm for CEA, CAS, and purely medical treatment, making it unique.

The management of ACAS remains debatable due to the inherent risks posed by surgical procedures, both CEA and CAS, and the improvements in medical management. A consensus on the prognosis for ACAS needs to be developed to properly stratify patients who would benefit from either surgical intervention or medical management.

**Diagnosis**

It is estimated that 15%–30% of all ischemic strokes are related to carotid atherosclerotic disease, highlighting the importance of early diagnosis. A thorough history and physical examination are the initial steps in evaluating a patient with potential ACAS. Risk factors for carotid stenosis are similar to those for coronary artery disease and include hypertension, diabetes mellitus, smoking, and elevated blood cholesterol levels, but may include patient age and sex as well. A carotid bruit is an often overlooked sign that can easily be identified on routine physical examination; although it is not necessarily indicative of carotid stenosis, its presence should raise suspicion. A carotid bruit should be followed up with TCD, which is currently the most cost-effective means of diagnosing carotid stenosis. Doppler ultrasonography is also capable of determining the degree of stenosis, which is a major factor in determining the risks associated with carotid stenosis. The NASCET and ECST trials were important in helping to establish the methods by which stenosis is measured for consistency among observers. Both trials used the formula: percent stenosis = (1 – D/N) × 100, where D is the diameter of the vessel at the most stenotic segment and N is the normal diameter of the vessel. The difference between the 2 trials is how the normal diameter was measured. According to NASCET criteria the normal diameter was measured in the ICA distal to the stenosis, whereas according to ECST criteria the normal diameter was measured at the predicted outline of the carotid bulb. Figure 1 illustrates the differences in these methodologies. Although the methods are different, they both have been effective in minimizing interobserver variability.

Patients with significant findings on Doppler ultrasonography should undergo further workup with advanced imaging of the cerebral vasculature using conventional angiography, CT angiography, or MR angiography. The greater definition of the anatomy, collateral circulation, and plaque morphology is helpful in designing treatment options, particularly if an intervention is being considered.

Depending on the degree of stenosis, the 7-year risk of an ipsilateral stroke varies from 8% to 35%. In an earlier study, patients with moderate to severe stenosis of...
more than 50% had a 9.3% risk of ipsilateral stroke at 10 years. Since a significant proportion of strokes can be attributed to carotid stenosis, some physicians believe that screening for ACAS in the general population could be beneficial. In the general population, the prevalence of moderate (≥ 50%) and severe (≥ 70%) stenosis ranges from 0% to 7.5% and 0% to 3.1%, respectively, depending on patient age and sex. Accounting for the time and costs associated with screening using TCD, it has been estimated that the prevalence of severe ACAS would need to surpass 20% to be cost-effective. Given these figures, it seems that screening the general population is not warranted; however, some authors have pointed out that there may be a cost-benefit to screening populations with multiple risk factors.

Medical Management

The medical treatment of ACAS has evolved greatly since the major trials of the 1980s. At that time, aspirin was the only major component of medical management. However, medical management now involves lipid-lowering drugs, a greater variety of antihypertension medications, and antiplatelet agents. Clinical trials indicate that statins may even go so far as to decrease atherosclerotic plaques in individuals who do not yet have significant stenosis. Maintenance of adequate high-density lipoprotein levels is also important since they help to reduce plaque volume. Antiplatelet drugs have also been developed to decrease the risk of thromboembolic events, which could lead to ischemic stroke. When CEA was followed by antiplatelet therapy, there was a decreased stroke risk as compared with CEA alone. It would be expected that antiplatelet medications would similarly decrease stroke risk within a strictly medical management option as well. The increase in the quality of these drugs is cause enough to perform new trials comparing their efficacy to that of CEA and CAS.

Hemodynamic studies provide some evidence that medical therapy is becoming more effective in preventing adverse events in ACAS. Transcranial Doppler ultrasonography is capable of detecting the presence microemboli due to carotid stenosis. Microemboli are fragments from emboli from the heart or arteries. It has been shown that these microemboli are extravasated through tissues in a normal perfusion model; however, in the case of hypoperfusion, they are not as readily cleared from the vascular system. This is relevant since stenosis of the carotid artery would affect perfusion of the ipsilateral anterior circulation of the brain and could hinder clearance of these microemboli, eventually leading to stroke. Aged mice were also shown to have delayed removal of microemboli. Since most patients with ACAS are 50 years of age or older, this finding may be relevant. With more widespread use of increasingly effective medical treatment, the presence of microemboli has decreased in patients with ACAS. The rate of plaque progression in treated patients has also significantly decreased. While this provides some evidence that medical treatment is becoming more successful, a clinical trial would be required to validate this claim.

Strokes that occur in patients with carotid stenosis may not necessarily be caused by the stenosis itself. Inzi-tari et al. suggested that 45% of strokes ipsilateral to carotid stenosis are either lacunes or cardioembolic in origin. These statistics have not been used in the methodology of clinical trials for carotid stenosis. Since ACAS is a predictor of cardiovascular disease elsewhere in the body, aggressive medical treatment is beneficial for the long-term health of these patients independent of the carotid artery disease.

The risk of stroke due to carotid stenosis is lower than previously believed according to recent studies. Some physicians believe that medical management should be the mainstay of ACAS therapy and that invasive techniques should only be used in specific cases. There is growing support in the literature for reevaluating the efficacy of medical treatments due to the aforementioned improvements. Some authors believe that no patients with asymptomatic disease warrant surgery due to the generally poor vascular health in this population. In a recent analysis by Abbott, medical management was determined to be the best option for patients with ACAS due to the high costs of surgical intervention and associated complications.

Surgical Treatment

Carotid Endarterectomy

In the early 1950s CEA was developed as a method of removing plaque in the carotid artery and thus decreasing the risk of stroke in patients by improving cerebral perfusion. Carotid endarterectomy is associated with a periprocedural risk of myocardial infarction, cranial nerve injury, and stroke. It is generally accepted that CEA provides an absolute risk reduction in stroke of approximately 1% over the moderate to long term. Based on estimates from older data on medical management, CEA is advocated if the periprocedural risk is 3% or lower. Accordingly, the skill and experience of the surgeon are significant and should be included in the decision regarding CEA. Earlier studies have indicated that CEA should only be considered in patients with a hemodynamically significant stenosis.

Several classification systems exist for risk stratification in patients undergoing CEA. In 1978 Moore et al. developed a classification system based on the extent of plaque ulceration. Grade A indicates a smooth and shallow ulcer; Grade B, a smooth but large and deep ulcer; and Grade C, an irregular, large, and deep ulcer. A more thorough system for stratifying risk in carotid stenosis was introduced by Sundt et al. in 1986. Table 1 shows the essential features of this classification system. Only patients in Groups 1–3 are relevant to the discussion of ACAS, as those in Group 4 are by definition symptomatic. Patients in higher groups have a greater incidence of postoperative neurological complications and death following CEA.

Restenosis following CEA is another consideration when evaluating a patient for endarterectomy and has been reported in up to 15% of cases. Patients experiencing restenosis after CEA have an increased risk of stroke. Several techniques have been developed to reduce the incidence of restenosis. One of these is eversion CEA, in which a transverse incision is made in the artery
as opposed to a standard longitudinal arteriotomy. Eversio CEA has been reported to have a lower restenosis rate compared with a traditional technique while maintaining similar perioperative mortality and morbidity. Another technique is patch angioplasty, which involves the use of a venous or synthetic patch to close the arteriotomy, as opposed to the primary closure utilized in the standard technique. In a recent review by Rerkasem and Rothwell, the incidences of periprocedural stroke and restenosis were both decreased with patch angioplasty as compared with the standard technique, although the sample size was relatively small in the study. Despite the lack of conclusive data regarding the efficacy of patch angioplasty with CEA, it is still commonly used, with the choice of patch material being unimportant.

Although it is recognized that performing CEA in all patients with moderate to severe stenosis is not cost-effective, there are clinicians who would still recommend it to all patients with ACAS as long as a skilled surgeon is available. Small studies done in single centers have demonstrated that endarterectomy is still superior to medical management. Lutz et al. studied data from patients receiving lipid-lowering medications and antiplatelet agents, as well as treatment for diabetes and hypertension. The sample size of this study was small, and a larger scale, multicenter clinical trial is needed to determine whether CEA is truly superior to current medical management. It is also important to note that although it is easy to argue for medical management as a better possible option, there is no Level I evidence to indicate that this is necessarily true. Without further trials to prove otherwise, CEA should be accepted as the standard of care in patients with moderate to severe ACAS.

Figure 2 shows representative images from a patient with asymptomatic stenosis of the right ICA and near-complete occlusion of the left ICA that was treated with right-sided endarterectomy.

**Carotid Angioplasty With Stenting**

Carotid angioplasty with stenting is a newer option in the treatment of ACAS, and due to its less invasive nature it has garnered a great deal of interest. Several trials, such as the Carotid Revascularization Endarterectomy Versus Stenting Trial (CREST), have been designed to compare the efficacy of CAS as compared with CEA. Patient selection for the CAS trials was aimed at patients with a high surgical risk. It is important to note that although the Sundt classification is often used to stratify patients for CAS, the system was not designed with this application in mind and may not be applicable. The trials comparing CAS and CEA suggest that CAS is at best equal to CEA in patients with ACAS in terms of efficacy. There is common agreement that CAS has a decreased risk of myocardial infarction and cranial nerve injury and an increased risk of periprocedural stroke. However, there is little consensus beyond that. A lack of consensus occurs even when the same data are analyzed because of the use of different statistical strategies. Even within a single meta-analysis of CAS, there are few conclusions that can be made given the heterogeneity of the data. The use of a distal protection device during a CAS procedure has shown questionable benefit, although it is still a common practice when placing a carotid stent. The CREST was the first trial to evaluate the efficacy of CEA and CAS in a similar population and showed that the prognosis following the 2 procedures was similar, although they had different periprocedural risks, as previously mentioned. Moreover, it was concluded that older patients (age ≥ 70 years) encountered worse outcomes with CAS. In another study, which focused on patients 80 years of age or older, CAS results approached those of the natural history (approximately 3%).

Much like with CEA, patients who have undergone CAS are at risk for restenosis; however, the rates are typically lower than those seen with CEA. In a study by González et al., restenosis occurred in 4.3% of patients. Even in patients with a high surgical risk, restenosis after CAS occurs less frequently than after CEA.

**TABLE 1: Sundt classification system**

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<thead>
<tr>
<th>Group</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>neurologically stable w/ no major medical or angiographic risks w/ unilat or bilat carotid disease</td>
</tr>
<tr>
<td>2</td>
<td>neurologically stable w/ no major medical factor but significant angiographic risks</td>
</tr>
<tr>
<td>3</td>
<td>major medical risks regardless of angiographic findings</td>
</tr>
<tr>
<td>4</td>
<td>neurologically unstable</td>
</tr>
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* Medical risk factors: angina pectoris, myocardial infarction within 6 months, congestive heart failure, obesity, chronic obstructive pulmonary disease, or age > 70 years. Neurological risk factors: progressive deficit, deficit within 24 hours, crescendo transient ischemic attacks, and multiple cerebral infarcts associated with deficits. Angiographic risk factors: contralateral ICA occlusion, coexisting carotid siphon stenosis, high bifurcation, long plaque length, or evidence of thrombus from an ulcer.

**Fig. 2.** Images obtained in a 77-year-old woman who was found to have near-occlusion of the left ICA and severe stenosis of the right cervical ICA. A: Lateral view angiogram showing focal stenosis in the proximal cervical ICA. B: A 3D reconstruction of a rotational angiogram further highlighting the stenosis. The patient was treated with CEA.
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Economically, CAS has a much greater material cost as compared with CEA. Although there is a decreased hospital stay for those undergoing CAS, the high cost of equipment from the procedure itself offsets the savings. There also appears to be an age-linked benefit to CAS that should be factored in, as perioperative risks of CAS are reduced in younger patients.

Operator experience is a factor that has led to inconsistency in interpreting data from these trials. The entry criteria for surgeons performing CEA were more stringent than for those performing CAS. This may help to explain the lack of consensus and disagreement found in the carotid stenting literature. Furthermore, the stratification of patients recommended for either CAS or CEA is significant. Since many patients with a high surgical risk undergo CAS, they should be considered inherently riskier. Because of this bias, it may be hard to objectively compare CEA and CAS. The early CAS trials did not include these factors in their designs and thus are flawed.

These trials also had issues with patient recruitment as well as trial suspensions due to risks, ultimately leading to debate of their validity. Although CEA is equal or better in long-term benefit depending on the trial, even the proponents of CEA recognize the situational benefit of CAS for those who are at a particular risk for surgery. Carotid angioplasty with stenting is currently used in high risk surgical patients with asymptomatic disease and > 80% stenosis; however, in May 2011 the FDA approved CAS for standard surgical risk patients with > 60% stenosis. Table 2 illustrates various factors that should be considered when deciding between CEA and CAS for a patient with ACAS.

Figure 3 illustrates a patient with complete right ICA occlusion and severe stenosis of the left ICA that was treated with carotid stent placement, with subsequent improvement in cerebral blood flow.

**Risk Stratification**

Identifying patients who would benefit from an intervention and those who can be treated with medical treatment alone is likely more useful than classifying any one treatment method as superior. The importance of identifying asymptomatic patients who are at particularly high risk has been realized since the 1970s. If patients can be risk stratified using noninvasive and cost-effective tests, then patients with ACAS can remain on medical treatment and undergo surgery only when there is a specific need.

Transcranial Doppler ultrasonography can be used to identify the presence of microemboli. Their presence is a positive marker for future stroke. Patients positive for embolic signals are 5.6 times more likely to experience ipsilateral stroke compared with those without the embolic signals. Patients without the signals have a low absolute risk of stroke. Based on detection of microemboli, it is estimated that as few as 5% of patients with ACAS stand to benefit from surgical revascularization. In utilizing TCD ultrasonography to better understand the hemodynamics of the cerebral vasculature and the affected carotid artery, patient selection for surgery can be improved. Patients with ACAS who have microemboli on TCD ultrasonography are more likely to benefit from surgery, whereas those without microemboli can be maintained on medical treatment.

Ultrasonography has also been used in stratifying patients with ACAS. It has been observed that patients with progressively increasing stenosis are at highest risk for adverse events affecting not only the cerebral, but also the coronary and peripheral vasculature. Ultrasonography can also be useful in understanding the histology of the plaque. Echoluent plaques are indicative of high lipid levels with more inflammatory cells and thin cap, whereas echogenic plaques are indicative of fibrous struc-

![Fig. 3. Images obtained in a 55-year-old woman who was found to have complete occlusion of the right ICA and severe stenosis (> 80%) of the left ICA during medical clearance for femur fixation. The patient was deemed high risk for surgery and was treated with carotid stenting. A: Preintervention lateral angiogram showing flow-limiting stenosis of the left ICA and complete occlusion of the left ECA from an atherosclerotic plaque. B: Poststenting lateral angiogram showing improvement in vessel diameter as well as blood flow.](image-url)
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Patients with echolucent plaques are therefore at increased risk for neurological events. It is also possible to determine the homo- or heterogeneity of a plaque with ultrasonography. Heterogeneous plaques have been shown to be more unstable than plaques that are more homogeneous.

Thrombin production is associated with inflammation, which is helpful in understanding the utility of another test. Increased levels of hs-CRP have been identified as being indicative of plaque instability since it marks the presence of macrophages and T lymphocytes. If hs-CRP is monitored in patients with ACAS, the need for surgical intervention could be identified earlier in those most at risk for thromboembolic events from the atherosclerotic plaque.

Another factor when considering an intervention for asymptomatic patients is cerebral hemodynamics. Single photon emission computed tomography with an acetazolamide challenge is a common method for measuring a patient’s cerebral reserve. A radioisotope (technetium-99) that is conjugated to a compound capable of crossing the blood-brain barrier (hexamethylpropyleneamine oxime) is injected intravenously. The isotope then gives off gamma rays, which can be detected by CT and translated to a map of cerebral blood flow. Administration of acetazolamide causes vasodilation and can help to determine cerebral reserve in the areas of interest after obtaining a baseline scan. Patients with diminished cerebral reserve may benefit from an interventional procedure over those with adequate reserve. At our institution, we are investigating the use of SPECT data when it is unclear on imaging alone whether a patient should undergo an intervention or remain on medical therapy. Figure 4 shows a flow diagram of our institutional protocol for caring for patients with ACAS.

Patient compliance and costs are important considerations when weighing the different treatment options. Medication can be expensive and must be maintained for long periods. At the same time, myocardial infarction is more common in patients with ACAS than stroke. This is due to atherosclerosis present elsewhere in the vasculature. Thus, patients who undergo CEA or CAS are generally asked to maintain these medications for cardiac protective reasons. Carotid angioplasty with stenting is more expensive initially due to the high material input.

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**Fig. 4.** Flowchart illustrating our institutional approach to patients with ACAS. CTA = CT angiography; MRA = MR angiography; SPECT = single-photon emission CT with acetazolamide challenge. Refer to Table 2 for factors influencing the choice of CEA or carotid artery stenting.
required relative to CEA. Long-term follow-up in patients both undergoing surgical intervention and receiving medical treatment is crucial. Restenosis occurs in a significant proportion of the population and is associated with an increased risk of stroke. Monitoring the contralateral carotid artery is also important since stenosis can develop following surgical treatment.

When deciding on treatment, it is important to consider all risk factors. Manageable cardiovascular risk factors, such as hypertension, hyperlipidemia, diabetes mellitus, and smoking, should be controlled. Patient age and sex are both important when considering treatment options. Several studies have noted an apparent surgical benefit for younger cohorts as opposed to older ones, especially in the case of CAS. Men are also more likely to have ACAS and garner a greater benefit from surgery. The contralateral carotid artery should also be observed since patients with even moderate stenosis have been shown to have a significantly increased risk of stroke if the other carotid is occluded. Specific surgical risks are also important to consider. It has been recognized that although CEA does reduce stroke risk, this reduction must be measured carefully against procedural risks, as these patients are generally high-risk surgical candidates. The Asymptomatic Carotid Surgery Trial suggests that surgery is only beneficial to patients with an age < 75 years due to life expectancy. A life expectancy of approximately 3–5 years is necessary to warrant surgical intervention in all cases; patients who have a generally decreased life expectancy due to age or comorbidities should be treated with medical management. In a Cochrane-based meta-analysis of the ACAS trials from the 1990s, the perioperative stroke and death rate was 2.9% and the absolute reduction of stroke risk was about 1%. In these trials, the enrollment of patients was highly at risk for stroke, physicians treating patients with ACAS must understand these factors, as well as the natural history of the disease and procedural risks to better select patients for either surgical or medical treatment.

Conclusions

Since there is no definitive evidence that CEA has become inferior to medical treatment or CAS, it should remain the standard for treatment. Physicians and patients alike can find it difficult to manage ACAS, especially given the current evidence. This is further complicated by the fact that there is some evidence in support of current medical management as a better and more cost-effective method of treating ACAS. Since medical treatment has improved over the past 3 decades while CEA has had little change in efficacy and operative risk, medical treatment must be compared again in more updated trials. The role of CAS remains uncertain in this patient population, but the recent FDA approval for patients with a standard surgical risk may result in increased acceptance.

Creating effective strategies for identifying those who would benefit from surgery is another area of development. If hs-CRP, TCD ultrasonography, SPECT, and carotid ultrasonography can be used to identify patients at high risk for stroke, medical treatment can become the initial treatment choice, with surgical intervention used strictly for those who would gain the most benefit from it. There has been a general trend toward this style of care. This strategy may have the secondary benefit of decreasing the number of strokes attributable to surgery. Although the best treatment for ACAS is still debated, it is generally accepted that aggressive medical therapy and risk management are warranted in all cases, regardless of the decision to intervene surgically or not. Since ACAS is almost entirely seen in the elderly population, it is important to take into account all risk factors for cardiovascular disease and surgical risk, as well as the anticipated lifespan in deciding a treatment plan. Doctors must learn to help patients make judgments based on circumstances and experience.

The therapies available for treating ACAS continue to evolve. Trials evaluating CAS and current medical management against CEA are underway and will help to elucidate the best treatment strategy for patients with asymptomatic carotid disease. Additionally, there are diagnostic studies capable of identifying patients with ACAS who are at higher risk for stroke. Physicians treating patients with ACAS must understand these factors, as well as the natural history of the disease and procedural risks to better select patients for either surgical or medical treatment.

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Disclosure

Dr. Prestigiacomo is a consultant for Aesculap, Inc., Thermopetix, Inc., and Edge Therapeutics, Inc., and is a board member of the International Brain Research Foundation, Inc.

Author contributions to the study and manuscript preparation include the following. Conception and design: Prestigiacomo, Doe, Jethwa. Acquisition of data: Doe, Jethwa. Analysis and interpretation of data: all authors. Drafting the article: all authors. Critically revising the article: all authors. Reviewed submitted version of manuscript: Prestigiacomo, Jethwa, Gandhi. Approved the final version of the manuscript on behalf of all authors: Prestigiacomo. Study supervision: Prestigiacomo.
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