AMERICAN COLLEGE of CARDIOLOGY FOUNDATION

American Heart Association | American Stroke Association®

ACCF/AHA Pocket Guideline

Based on the 2011 ASA/ACCF/AHA/AANN/AANS/ACR/ CNS/SAIP/SCAI/SIR/SNIS/SVM/SVS

Guideline on the Management of Patients With Extracranial Carotid and Vertebral Artery Disease

Developed in Collaboration With the American Academy of Neurology and Society of Cardiovascular Computed Tomography

January 2011

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The following material was adapted from the 2011 ASA/ ACCF/AHA/AANN/AANS/ ACR/CNS/SAIP/SCAI/SIR/ SNIS/SVM/SVS Guideline on the Management of Patients With Extracranial Carotid and Vertebral Artery Disease. (Executive Summary: Circulation. 2011;124:489–532; Full-Text: Circulation. 2011;124:e54–e130; Executive Summary: Stroke. 2011;42:e420–e463; Full-Text: Stroke. 2011;42:e464–e540). This pocket guideline is available on the World Wide Web sites of the American College of Cardiology (www.cardiosource.org) and the American Heart Association (my.americanheart.org).

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Contents

1. Introduction 3

2. Duplex Ultrasonography to Evaluate Asymptomatic Patients With Known or Suspected Carotid Stenosis 4

3. Diagnostic Testing in Patients With Symptoms or Signs of ECVD 5

4. Treatment of Hypertension 6

5. Cessation of Tobacco Smoking 6

6. Control of Hyperlipidemia 6

7. Management of Diabetes Mellitus in Patients With Atherosclerosis of the Extracranial Carotid or Vertebral Arteries 6

8. Antithrombotic Therapy in Patients With Extracranial Carotid Atherosclerotic Disease Not Undergoing Revascularization 7

9. Selection of Patients for Carotid Revascularization 8

10. Periprocedural Management of Patients Undergoing CEA 9

11. Management of Patients Undergoing CAS 10

12. Management of Patients Experiencing Restenosis After CEA or CAS 10

13. Vascular Imaging in Patients With Vertebral Artery Disease 11

14. Management of Atherosclerotic Risk Factors in Patients With Vertebral Artery Disease 11

15. Management of Patients With Occlusive Disease of the Subclavian and Brachiocephalic Arteries 12

16. Carotid Artery Evaluation and Revascularization Before Cardiac Surgery 13

17. Management of Patients With FMD of the Extracranial Carotid Arteries 13

18. Management of Patients With Cervical Artery Dissection 13

1. Introduction

Extracranial carotid and vertebral artery disease (ECVD) encompasses several disorders that affect the arteries that supply the brain and is an important cause of stroke and transient cerebral ischemic attack. The most frequent cause is atherosclerosis, but other causes include fibromuscular dysplasia (FMD), cystic medial necrosis, arteritis, and dissection. Atherosclerosis is a systemic disease, and patients with ECVD typically face an escalated risk of other adverse cardiovascular events, including myocardial infarction, peripheral arterial disease and death. To improve survival, neurological and functional outcomes and quality of life, preventive and therapeutic strategies must address both cerebral and systemic risk.


Lead
Follow-up

Table 1. Applying Classification of Recommendations and Level of Evidence

SIZE OF

	CLASS I *Benefit >>> Risk* Procedure/Treatment **SHOULD** be performed/ administered	CLASS IIa *Benefit >> Risk* *Additional studies with focused objectives needed* **IT IS REASONABLE** to perform procedure/administer treatment
LEVEL A Multiple populations evaluated* Data derived from multiple randomized clinical trials or meta-analyses	■ Recommendation that procedure or treatment is useful/effective ■ Sufficient evidence from multiple randomized trials or meta-analyses	■ Recommendation in favor of treatment or procedure being useful/effective ■ Some conflicting evidence from multiple randomized trials or meta-analyses
LEVEL B Limited populations evaluated* Data derived from a single randomized trial or nonrandomized studies	■ Recommendation that procedure or treatment is useful/effective ■ Evidence from single randomized trial or nonrandomized studies	■ Recommendation in favor of treatment or procedure being useful/effective ■ Some conflicting evidence from single randomized trial or nonrandomized studies
LEVEL C Very limited populations evaluated* Only consensus opinion of experts, case studies, or standard of care	■ Recommendation that procedure or treatment is useful/effective ■ Only expert opinion, case studies, or standard of care	■ Recommendation in favor of treatment or procedure being useful/effective ■ Only diverging expert opinion, case studies, or standard of care
Suggested phrases for writing recommendations	should is recommended is indicated is useful/effective/beneficial	is reasonable can be useful/effective/beneficial is probably recommended or indicated
Comparative effectiveness phrases†	treatment/strategy A is recommended/indicated in preference to treatment B treatment A should be chosen over treatment B	treatment/strategy A is probably recommended/indicated in preference to treatment B it is reasonable to choose treatment A over treatment B

TREATMENT EFFECT

CLASS IIb ***Benefit ≥ Risk*** ***Additional studies with broad objectives needed; additional registry data would be helpful*** **Procedure/Treatment MAY BE CONSIDERED**	**CLASS III** ***No Benefit*** **or CLASS III** ***Harm*** **Procedure/Test** / **Treatment** **COR III: No benefit** — **Not Helpful** / **No Proven Benefit** **COR III: Harm** — **Excess Cost w/o Benefit or Harmful** / **Harmful to Patients**
■ **Recommendation's usefulness/efficacy less well established** ■ **Greater conflicting evidence from multiple randomized trials or meta-analyses**	■ **Recommendation that procedure or treatment is not useful/effective and may be harmful** ■ **Sufficient evidence from multiple randomized trials or meta-analyses**
■ **Recommendation's usefulness/efficacy less well established** ■ **Greater conflicting evidence from single randomized trial or nonrandomized studies**	■ **Recommendation that procedure or treatment is not useful/effective and may be harmful** ■ **Evidence from single randomized trial or nonrandomized studies**
■ **Recommendation's usefulness/efficacy less well established** ■ **Only diverging expert opinion, case studies, or standard of care**	■ **Recommendation that procedure or treatment is not useful/effective and may be harmful** ■ **Only expert opinion, case studies, or standard of care**

may/might be considered
may/might be reasonable
usefulness/effectiveness is unknown/unclear/uncertain or not well established

COR III: No Benefit	COR III: Harm
is not recommended	potentially harmful
is not indicated	causes harm
should not be done	associated with excess morbidity/mortality
is not useful/beneficial/effective	should not be done

* Data available from clinical trials or registries about the usefulness/efficacy in different subpopulations, such as sex, age, history of diabetes, history of prior myocardial infarction, history of heart failure, and prior aspirin use. A recommendation with Level of Evidence B or C does not imply that the recommendation is weak. Many important clinical questions addressed in the guidelines do not lend themselves to clinical trials. Although randomized trials are unavailable, there may be a very clear clinical consensus that a particular test or therapy is useful or effective.

† For comparative effectiveness recommendations (Class I and IIa; Level of Evidence A and B only), studies that support the use of comparator verbs should involve direct comparisons of the treatments or strategies being evaluated.

2. Duplex Ultrasonography to Evaluate Asymptomatic Patients With Known or Suspected Carotid Stenosis

Class I

1. In asymptomatic patients with known or suspected carotid stenosis, duplex ultrasonography, performed by a qualified technologist in a certified laboratory, is recommended as the initial test to detect hemodynamically significant carotid stenosis. (Level of Evidence: C)

Class IIa

1. It is reasonable to

- perform duplex ultrasonography to detect hemodynamically significant carotid stenosis in asymptomatic patients with carotid bruit. (Level of Evidence: C)
- repeat duplex ultrasonography annually, by a qualified technologist in a certified laboratory, to assess progression or regression of disease and response to therapy in patients with previous atherosclerotic stenosis greater than 50%. Once stability is established over an extended period or candidacy for intervention has changed, longer intervals or termination of surveillance may be appropriate. (Level of Evidence: C)

Class IIb **1.** Duplex ultrasonography to detect hemodynamically significant carotid stenosis may be considered

- in asymptomatic patients with symptomatic peripheral arterial disease, coronary artery disease or atherosclerotic aortic aneurysm. (Level of Evidence: C)

- to detect carotid stenosis in asymptomatic patients without evidence of atherosclerosis who have greater than or equal to 2 of the following: hypertension, hyperlipidemia, tobacco smoking, or family history of atherosclerosis before age 60 in a first degree relative or ischemic stroke. (Level of Evidence: C)

  It is unclear whether establishing a diagnosis of ECVD would justify actions that affect clinical outcomes. (Level of Evidence: C)

Class III: No Benefit

1. Carotid duplex ultrasonography is not recommended

- for routine screening of asymptomatic patients who have no risk factors for atherosclerosis. (Level of Evidence: C)
- for routine evaluation of patients with neurological or psychiatric disorders unrelated to focal cerebral ischemia. (Level of Evidence: C)
- for patients without risk factors for atherosclerotic carotid disease and no disease on initial vascular testing. (Level of Evidence: C)

3. Diagnostic Testing in Patients With Symptoms or Signs of Extracranial Carotid Artery Disease

Class I

1. Noninvasive imaging for detection of ECVD is recommended in the initial evaluation of patients with transient retinal or hemispheric neurological symptoms of possible ischemic origin. (Level of Evidence: C)

2. Duplex ultrasonography is recommended to detect carotid stenosis in patients who develop focal neurological symptoms corresponding to the internal carotid artery territory. (Level of Evidence: C)

3. In patients with acute, focal ischemic neurological symptoms corresponding to the territory supplied by the left or right internal carotid artery, magnetic resonance angiography (MRA) or computed tomography angiography (CTA) is indicated to detect carotid stenosis when definitive sonography cannot be obtained. (Level of Evidence: C)

4. When intracranial or ECVD is not severe enough to account for neurological symptoms of suspected ischemic origin, echocardiography should be performed seeking a source of cardiogenic embolism. (Level of Evidence: C)

Class IIa **1.** In revascularization candidates,

- MRA or CTA can be useful when carotid duplex ultrasonography is nondiagnostic. (Level of Evidence: C)
- CTA, MRA or elective cerebral angiography can be useful to search for intracranial vascular disease when an extracranial source of ischemia is not identified or to evaluate severity of stenosis and identify intrathoracic or intracranial vascular lesions not adequately assessed by ultrasonography. (Level of Evidence: C)
- catheter-based angiography can be useful when noninvasive imaging is not sufficient. (Level of Evidence: C)
- MRA without contrast is reasonable to assess extent of disease in patients with renal insufficiency or extensive vascular calcification. (Level of Evidence: C)
- CTA is reasonable in patients who are not candidates for MRA because of claustrophobia, implanted pacemakers, or other incompatible devices. (Level of Evidence: C)

Class IIb

1. Duplex carotid ultrasonography might be considered for patients with nonspecific neurological symptoms when cerebral ischemia is a plausible cause. (Level of Evidence: C)

2. When complete carotid arterial occlusion is suggested by duplex ultrasonography, MRA, or CTA, catheter-based angiography may be considered to determine whether the arterial lumen is sufficient to permit carotid revascularization. (Level of Evidence: C)

3. Catheter-based angiography may be reasonable in patients with renal dysfunction to limit the amount of radiographic contrast material required for definitive imaging for evaluation of a single vascular territory. (Level of Evidence: C)

4. Treatment of Hypertension

Class I

1. Antihypertensive treatment is recommended for patients with hypertension and asymptomatic atherosclerotic ECVD to maintain blood pressure (BP) less than 140/90 mmHg. (Level of Evidence: A)

Class IIa

1. Except during the hyperacute period, antihypertensive treatment is probably indicated in patients with hypertension and symptomatic atherosclerotic ECVD, but the benefit of treatment to a specific BP has not been established in relation to the risk of exacerbating cerebral ischemia. (Level of Evidence: C)

5. Cessation of Tobacco Smoking

Class I

1. Patients with atherosclerotic ECVD who smoke cigarettes should be advised to quit and offered cessation interventions to reduce risk. (Level of Evidence: B)

6. Control of Hyperlipidemia

Class I

1. Treatment with a statin is recommended for all patients with atherosclerotic ECVD to lower low-density lipoprotein cholesterol to less than 100 mg/dL. (Level of Evidence: B)

Class IIa

1. Treatment with a statin is reasonable for all patients with atherosclerotic ECVD who sustain ischemic stroke to reduce low-density lipoprotein cholesterol to a level less than or equal to 70 mg/dL. (Level of Evidence: B)

2. If treatment with a statin does not achieve the goal, intensifying therapy with an additional drug from among those with evidence of improving outcomes can be effective. (Level of Evidence: B)

3. For patients who do not tolerate statins, therapy with bile acid sequestrants and/or niacin is reasonable. (Level of Evidence: B)

7. Management of Diabetes Mellitus in Patients With Atherosclerosis of the Extracranial Carotid or Vertebral Arteries

Class IIa

1. Diet, exercise, and glucose-lowering drugs can be useful for patients with diabetes mellitus and atherosclerotic ECVD. The stroke prevention benefit, however, of intensive glucose-lowering therapy to a glycosylated hemoglobin A1c level less than 7.0% has not been established. (Level of Evidence: A)

2. Administration of a statin to reduce low-density lipoprotein cholesterol less than or equal to 70 mg/dL is reasonable in patients with diabetes mellitus and atherosclerotic ECVD for prevention of stroke and other ischemic events. (Level of Evidence: B)

8. Antithrombotic Therapy in Patients With Extracranial Carotid Atherosclerotic Disease Not Undergoing Revascularization

Class I

1. Antiplatelet therapy with aspirin, 75 to 325 mg daily, is recommended for patients with obstructive or nonobstructive atherosclerotic ECVD for prevention of myocardial infarction and other ischemic events, though benefit has not been established for prevention of stroke in asymptomatic patients. (Level of Evidence: A)

2. In patients with obstructive or nonobstructive atherosclerotic ECVD who have sustained ischemic stroke or transient ischemic stroke (TIA), antiplatelet therapy with aspirin (75 to 325 mg daily), clopidogrel (75 mg daily), or the combination of aspirin and extended-release dipyridamole (25 and 200 mg twice daily, respectively) is recommended (Level of Evidence: B) and preferred over the combination of aspirin and clopidogrel (Level of Evidence: B). The antiplatelet regimen should be individualized based on risk factors, cost, tolerance, other clinical characteristics, and guidance from regulatory agencies.

3. Antiplatelet agents are recommended over oral anticoagulation for patients with atherosclerotic ECVD with (Level of Evidence: B) or without (Level of Evidence: C) ischemic symptoms. (For patients with allergy or other contraindications to aspirin, see Class IIa recommendation #2, this section.)

Class IIa

1. In patients with atherosclerotic ECVD who have an indication for anticoagulation, such as atrial fibrillation or mechanical heart valve, it can be beneficial to administer a vitamin K antagonist (such as warfarin, dose-adjusted to achieve a target international normalized ratio of 2.5 [range 2.0 to 3.0]) for prevention of thromboembolic ischemic events. (Level of Evidence: C)

2. For patients with atherosclerotic ECVD in whom aspirin is contraindicated by factors other than active bleeding, including allergy, clopidogrel (75 mg daily) or ticlopidine (250 mg twice daily) are reasonable alternatives. (Level of Evidence: C)

Class III: No Benefit

1. Full-intensity parenteral anticoagulation with unfractionated heparin or low-molecular-weight heparinoids is not recommended for patients with atherosclerotic ECVD who develop TIA or acute ischemic stroke. (Level of Evidence: B)

2. Administration of clopidogrel in combination with aspirin is not recommended within 3 months after stroke or TIA. (Level of Evidence: B)

9. Selection of Patients for Carotid Revascularization[1]

Class I

1. Patients at average or low surgical risk who experience nondisabling ischemic stroke[2] or transient cerebral ischemic symptoms, including hemispheric events or amaurosis fugax, within 6 months (symptomatic patients) should undergo carotid endarterectomy (CEA) if the diameter of the lumen of the ipsilateral internal carotid artery is reduced more than 70%[3] as documented by noninvasive imaging (Level of Evidence A) or more than 50% as documented by catheter angiography (Level of Evidence B) and the anticipated rate of perioperative stroke or mortality is less than 6%

1. Recommendations for revascularization in this section assume that operators are experienced, having successfully performed the procedures in >20 cases with proper technique and a low complication rate based on independent neurological evaluation before and after each procedure.
2. Nondisabling stroke is defined by a residual deficit associated with a score ≤2 according to the Modified Rankin Scale.
3. The degree of stenosis is based on catheter-based or noninvasive vascular imaging compared with the distal arterial lumen or velocity measurements by duplex ultrasonography.

2. Carotid artery stenting (CAS) is indicated as an alternative to CEA for symptomatic patients at average or low risk of complications associated with endovascular intervention when the diameter of the lumen of the internal carotid artery is reduced by more than 70% as documented by noninvasive imaging or more than 50% as documented by catheter angiography and the anticipated rate of periprocedural stroke or mortality is less than 6%. (Level of Evidence: B)

3. Selection of asymptomatic patients for carotid revascularization should be guided by assessment of comorbid conditions, life expectancy, and other individual factors and should include a thorough discussion of the risks and benefits of the procedure with an understanding of patient preferences. (Level of Evidence: C)

Class IIa

1. It is reasonable to perform CEA in asymptomatic patients who have more than 70% stenosis of the internal carotid artery if the risk of perioperative stroke, myocardial infarction, and death is low. (Level of Evidence: A)

2. It is reasonable to choose CEA over CAS when revascularization is indicated in older patients, particularly when arterial pathoanatomy is unfavorable for endovascular intervention. (Level of Evidence: B)

3. It is reasonable to choose CAS over CEA when revascularization is indicated in patients with neck anatomy unfavorable for arterial surgery.[4] (Level of Evidence: B)

4. When revascularization is indicated for patients with TIA or stroke and there are no contraindications to early revascularization, intervention within 2 weeks of the index event is reasonable rather than delaying surgery. (Level of Evidence: B)

4. Conditions that produce unfavorable neck anatomy include but are not limited to arterial stenosis distal to the second cervical vertebra or proximal (intrathoracic) arterial stenosis, previous ipsilateral CEA, contralateral vocal cord paralysis, open tracheostomy, radical surgery, and irradiation.

Class IIb

1. Prophylactic CAS might be considered in highly selected patients with asymptomatic carotid stenosis (minimum 60% by angiography, 70% by validated Doppler ultrasound), but its effectiveness compared with medical therapy alone in this situation is not well established. (Level of Evidence: B)

2. In symptomatic or asymptomatic patients at high risk of complications for carotid revascularization by either CEA or CAS because of comorbidities,[5] the effectiveness of revascularization versus medical therapy alone is not well established. (Level of Evidence: B)

5. Comorbidities that increase the risk of revascularization include but are not limited to age >80 years, New York Heart Association class III or IV heart failure, left ventricular ejection fraction <30%, class III or IV angina pectoris, left main or multivessel coronary artery disease, need for cardiac surgery within 30 days, MI within 4 weeks, and severe chronic lung disease.

Class III: No Benefit

1. Except in extraordinary circumstances, carotid revascularization by either CEA or CAS is not recommended

- when atherosclerosis narrows the lumen by less than 50%. (Level of Evidence: A)
- for patients with chronic total occlusion of the targeted carotid artery. (Level of Evidence: C)
- for patients with severe disability[6] caused by cerebral infarction that precludes preservation of useful function. (Level of Evidence: C)

6. In this context, severe disability refers generally to a Modified Rankin Scale of ≥3, but individual assessment is required, and intervention may be appropriate in selected patients with considerable disability when a worse outcome is projected with continued medical therapy alone.

10. Periprocedural Management of Patients Undergoing CEA

Class I

1. Before CEA, aspirin (81 to 325 mg daily) is recommended. (Level of Evidence: A)

2. Beyond the first month after CEA, aspirin (75 to 325 mg daily), clopidogrel (75 mg daily), or the combination of low-dose aspirin plus extended-release dipyridamole (25 and 200 mg twice daily, respectively) should be administered for long-term prophylaxis against ischemic cardiovascular events. (Level of Evidence: B)

3. Before and after CEA,

- administration of antihypertensive medication is recommended as needed to control BP. (Level of Evidence: C)
- findings on clinical neurological examination should be documented within 24 hours. (Level of Evidence: C)

Class IIa **1.** After CEA,

- patch angioplasty can be beneficial for closure of arteriotomy. (Level of Evidence: B)
- administration of statin lipid-lowering medication is reasonable irrespective of serum lipid levels, although the optimum agent and dose and the efficacy for prevention of restenosis have not been established. (Level of Evidence: B)
- noninvasive imaging of the extracranial carotid arteries is reasonable 1 month, 6 months, and annually. Once stability has been established over an extended period, surveillance at longer intervals may be appropriate. Termination of surveillance is reasonable when the patient is no longer a candidate for intervention. (Level of Evidence: C)

11. Management of Patients Undergoing CAS

Class I

1. Before and after CAS,

- dual-antiplatelet therapy with aspirin (81 to 325 mg daily) plus clopidogrel (75 mg daily) is recommended (for a minimum of 30 days). For patients intolerant of clopidogrel, ticlopidine (250 mg twice daily) may be substituted. (Level of Evidence: C)
- administration of antihypertensive medication is recommended to control BP. (Level of Evidence: C)
- findings on clinical neurological examination should be documented within 24 hours. (Level of Evidence: C)

Class IIa

1. Embolic protection device deployment during CAS can be beneficial to reduce the risk of stroke when the risk of vascular injury is low. (Level of Evidence: C)

2. After CAS, noninvasive imaging of the extracranial carotid arteries is reasonable 1 month, 6 months, and annually after revascularization to assess patency and exclude new or contralateral lesions. Once stability has been established over an extended period, surveillance at extended intervals may be appropriate and termination of surveillance is reasonable when the patient is no longer a candidate for intervention. (Level of Evidence: C)

12. Management of Patients Experiencing Restenosis After CEA or CAS

Class IIa

1. Reoperative CEA or CAS after initial revascularization is reasonable

- in patients with symptomatic cerebral ischemia and recurrent carotid stenosis due to intimal hyperplasia or atherosclerosis, using the same criteria for initial revascularization. (Level of Evidence: C)
- when duplex ultrasound and another confirmatory imaging method identify rapidly progressive restenosis that indicates a threat of complete occlusion. (Level of Evidence: C)

Class IIb

1. In asymptomatic patients who develop recurrent carotid stenosis due to intimal hyperplasia or atherosclerosis, reoperative CEA or CAS may be considered using the same criteria as for initial revascularization. (Level of Evidence: C)

Class III: Harm

1. Reoperative CEA or CAS should not be performed in asymptomatic patients with less than 70% carotid stenosis that has remained stable. (Level of Evidence: C)

13. Vascular Imaging in Patients With Vertebral Artery Disease

Class I

1. Noninvasive imaging by CTA or MRA for detection of vertebral artery disease

- should be part of the initial evaluation of patients with neurological symptoms referable to the posterior circulation and those with subclavian steal syndrome. (Level of Evidence: C)
- should be performed in patients with asymptomatic bilateral carotid occlusions or unilateral carotid artery occlusion and incomplete circle of Willis. (Level of Evidence: C)
- is recommended over ultrasound imaging for evaluation of the vertebral arteries in patients whose symptoms suggest posterior cerebral or cerebellar ischemia. (Level of Evidence: C)

Class IIa

1. In patients with symptoms of posterior cerebral or cerebellar ischemia

- serial noninvasive imaging of the extracranial vertebral arteries is reasonable to assess progression of atherosclerotic disease and exclude the development of new lesions. (Level of Evidence: C)

- catheter-based contrast angiography can be useful to define vertebral artery pathoanatomy when noninvasive imaging fails to define the location or severity of stenosis. (Level of Evidence: C)

2. In patients who have undergone vertebral artery revascularization, serial noninvasive imaging of the extracranial vertebral arteries is reasonable at intervals similar to those for carotid revascularization. (Level of Evidence: C)

14. Management of Atherosclerotic Risk Factors in Patients With Vertebral Artery Disease

Class I

1. Medical therapy and lifestyle modification to reduce atherosclerotic risk are recommended in patients with vertebral atherosclerosis as recommended for those with extracranial carotid atherosclerosis. (Level of Evidence: B)

2. In the absence of contraindications, patients with atherosclerosis involving the vertebral arteries should receive antiplatelet therapy with aspirin (75 to 325 mg daily) to prevent myocardial infarction and other ischemic events. (Level of Evidence: B)

3. Antiplatelet drug therapy is recommended as part of the initial management for patients who sustain ischemic stroke or TIA associated with extracranial vertebral atherosclerosis. Aspirin (81 to 325 mg daily), the combination of aspirin plus extended-release dipyridamole (25 and 200 mg twice daily, respectively), and clopidogrel (75 mg daily) are acceptable options. The antiplatelet regimen should be individualized based on risk factor profiles, cost, tolerance, and other clinical characteristics, and guidance from regulatory agencies. (Level of Evidence: B)

Class IIa

1. For patients with atherosclerosis of the extracranial vertebral arteries in whom aspirin is contraindicated by factors other than active bleeding, including those with allergy to aspirin, either clopidogrel (75 mg daily) or ticlopidine (250 mg twice daily) are reasonable alternatives. (Level of Evidence: C)

15. Management of Patients With Occlusive Disease of the Subclavian and Brachiocephalic Arteries

Class IIa

1. Extra-anatomic carotid-subclavian bypass is reasonable for patients with symptomatic posterior cerebral or cerebellar ischemia caused by subclavian artery stenosis or occlusion (subclavian steal syndrome) in the absence of clinical factors predisposing to surgical morbidity or mortality. (Level of Evidence: B)

2. Percutaneous endovascular angioplasty and stenting is reasonable for patients with symptomatic posterior cerebral or cerebellar ischemia caused by subclavian artery stenosis (subclavian steal syndrome) who are at high risk of surgical complications. (Level of Evidence: C)

3. Revascularization by percutaneous angioplasty and stenting, direct arterial reconstruction, or extra-anatomic bypass surgery is reasonable

- for patients with symptomatic ischemia involving the anterior cerebral circulation caused by common carotid or brachiocephalic artery occlusive disease. (Level of Evidence: C)

- for patients with symptomatic ischemia involving upper-extremity claudication caused by subclavian or brachiocephalic arterial occlusive disease. (Level of Evidence: C)

2. Revascularization is reasonable for asymptomatic patients with subclavian artery stenosis when the ipsilateral internal mammary artery is required as a conduit for myocardial revascularization. (Level of Evidence: C)

Class III: No Benefit

1. Asymptomatic patients with asymmetrical upper limb BP, periclavicular bruit, or flow reversal in a vertebral artery caused by subclavian artery stenosis should not undergo revascularization unless the internal mammary artery is required for myocardial revascularization. (Level of Evidence: C)

16. Carotid Artery Evaluation and Revascularization Before Cardiac Surgery

Class IIa

1. Carotid duplex ultrasound is reasonable before elective coronary artery bypass graft surgery in patients greater than 65 years of age and in those with left main coronary stenosis, peripheral arterial disease, history of cigarette smoking, history of stroke or TIA, or carotid bruit. (Level of Evidence: C)

2. Carotid revascularization by CEA or CAS with embolic protection before or concurrent with myocardial revascularization surgery is reasonable in patients with greater than 80% carotid stenosis who have experienced ipsilateral retinal or hemispheric cerebral ischemic symptoms within 6 months. (Level of Evidence: C)

Class IIb

1. In patients with asymptomatic carotid stenosis, even if severe, the safety and efficacy of carotid revascularization before or concurrent with myocardial revascularization are not well established. (Level of Evidence: C)

17. Management of Patients With FMD of the Extracranial Carotid Arteries

Class IIa

1. Annual noninvasive imaging of the carotid arteries is reasonable initially for patients with FMD to detect changes in disease severity, although the effect on outcomes is unclear. Studies may be repeated less frequently once stability is confirmed. (Level of Evidence: C)

2. Administration of platelet-inhibitor medication can be beneficial in patients with FMD of the carotid arteries, but the optimum drug and dosing regimen has not been established. (Level of Evidence: C)

3. Carotid angioplasty with or without stenting is reasonable for patients with retinal or hemispheric cerebral ischemic symptoms related to FMD of the ipsilateral carotid artery, but comparative data addressing methods of revascularization are not available. (Level of Evidence: C)

Class III: No Benefit

1. Revascularization is not recommended for patients with asymptomatic FMD of a carotid artery, regardless of the severity of stenosis. (Level of Evidence: C)

18. Management of Patients With Cervical Artery Dissection

Class I	**1.** Contrast-enhanced CTA, MRA and catheter-based angiography are useful for diagnosis of cervical artery dissection. (Level of Evidence: C)
Class IIa	**1.** Antithrombotic treatment with either an anticoagulant (heparin, low molecular weight heparin or warfarin*) or a platelet inhibitor (aspirin, clopidogrel or the combination of extended-release dipyridamole plus aspirin*) for at least 3 to 6 months is reasonable for patients with extracranial carotid or vertebral arterial dissection associated with ischemic stroke or TIA. (Level of Evidence B) * Drugs are not listed in order of preference.
Class IIb	**1.** CAS might be considered when ischemic neurological symptoms have not responded to antithrombotic therapy after acute carotid dissection. (Level of Evidence: C) **2.** The safety and effectiveness of therapy with a-adrenergic antagonist, angiotensin inhibitor, or nondihydropyridine calcium channel antagonist to lower BP to normal and reduce arterial wall stress are not well established. (Level of Evidence: C)

Table 2. American Heart Association/American Stroke Association Guidelines for Antithrombotic Therapy in Patients With Ischemic Stroke of Noncardioembolic Origin (Secondary Prevention)

Guideline	Classification of Recommendation, Level of Evidence*
Antiplatelet agents recommended over oral anticoagulants	I, A
For initial treatment, aspirin (50-325 mg/d),† the combination of aspirin and extended-release dipyridamole, or clopidogrel	I, A
Combination of aspirin and extended-release dipyridamole recommended over aspirin alone	I, B
Clopidogrel may be considered instead of aspirin alone	IIb, B
For patients hypersensitive to aspirin, clopidogrel is a reasonable choice	IIa, B
Addition of aspirin to clopidogrel increases risk of hemorrhage	III, A

*Recommendation: I indicates treatment is useful and effective; IIa, conflicting evidence or divergence of opinion regarding treatment usefulness and effectiveness; IIb, usefulness/efficacy of treatment is less well established; and III, treatment is not useful or effective. Level of Evidence: A indicates data from randomized clinical trials; and B, data from a single randomized clinical trial or nonrandomized studies. †Insufficient data are available to make evidence-based recommendations about antiplatelet agents other than aspirin. Modified from Sacco RL, Adams R, Albers G, et al., Guidelines for prevention of stroke in patients with ischemic stroke or transient ischemic attack. Stroke. 2006;37:577– 617.

Table 3. Comparative Utility of Various Management Strategies for Patients With Carotid Stenosis in Clinical Trials

Trial, Year	Patient Population	Intervention
Symptomatic CEA		
NASCET (1991)	Symptomatic, 70% to 99% stenosis	CEA
ECST (2003)	Symptomatic, 70% to 99% stenosis	CEA
ECST (2003)	Symptomatic, 70% to 99% stenosis	CEA
NASCET (1998)	Symptomatic, 50% to 69% stenosis	CEA
ECST (2003)	Symptomatic, 50% to 69% stenosis	CEA
ECST (2003)	Symptomatic, 50% to 69% stenosis	CEA
Asymptomatic CEA		
ACAS (1995)	Asymptomatic	CEA
ACAS (1995)	Asymptomatic	CEA
ACST (2004)	Asymptomatic	Immediate CEA
ACST (2004)	Asymptomatic	Immediate CEA

Comparator	Event Used to Calculate NNT	ARR, %	NNT*
Medical therapy	Ipsilateral stroke	17.00	12
Medical therapy	Ipsilateral ischemic stroke and surgical stroke or death; ARR provided in study	18.70	27
Medical therapy	Stroke or surgical death; ARR provided in study	21.20	24
Medical therapy	Ipsilateral stroke	6.50	77
Medical therapy	Ipsilateral ischemic stroke and surgical stroke or death; ARR provided in study	2.90	173
Medical therapy	All stroke or surgical death; ARR provided in study	5.70	88
Medical therapy	Ipsilateral stroke and periprocedural stroke or death	6	84
Medical therapy	Stroke or death	0.20	1,351
Deferred CEA	Ipsilateral stroke in carotid artery territory	0.17	2,000
Deferred CEA	Stroke risks	7.20	70

Trial, Year	Patient Population	Intervention
Symptomatic		
SPACE 2-y data (2008)	Symptomatic	CEA
SPACE 2-y data (2008)	Symptomatic	CEA
SPACE 2-y data (2008)	Symptomatic	CEA
EVA-3S 4-y data (2008)	Symptomatic	CEA
EVA-3S 4-y data (2008)	Symptomatic	CEA
EVA-3S 4-y data (2008)	Symptomatic	CEA
Mixed patient populations		
SAPPHIRE 1-y data (2004)	Mixed population: Symptomatic, ≥50% stenosis; Asymptomatic, ≥80% stenosis	CEA
SAPPHIRE 1-y data (2004)	Mixed population: Symptomatic, ≥50% stenosis; Asymptomatic, ≥80% stenosis	CEA
SAPPHIRE 1-y data (2004)†	Mixed population: Symptomatic, ≥50% stenosis; Asymptomatic, ≥80% stenosis	CEA
SAPPHIRE 3-y data (2008)	Mixed population: Symptomatic, ≥50% stenosis; Asymptomatic, ≥80% stenosis	CEA
SAPPHIRE 3-y data (2008)	Mixed population: Symptomatic, ≥50% stenosis; Asymptomatic, ≥80% stenosis	CEA
SAPPHIRE 3-y data (2008)	Mixed population: Symptomatic, ≥50% stenosis; Asymptomatic, ≥80% stenosis	CEA

Comparator	Event Used to Calculate NNT	ARR, %	NNT*
CAS	All periprocedural strokes or deaths and ipsilateral ischemic strokes up to 2 y after the procedure	0.70	286
CAS	Ipsilateral ischemic stroke within 31 d and 2 y	0.30	667
CAS	All stroke	0.80	250
CAS	Ipsilateral stroke	0	~
CAS	Composite of periprocedural stroke, death, and nonprocedural ipsilateral stroke during 4 y of follow-up	4.90	82
CAS	All strokes	5.70	71
CAS	Stroke	1.70	58
CAS	Ipsilateral stroke	0.60	167
CAS	Cumulative incidence of death, stroke, or MI within 30 d after the procedure or death or ipsilateral stroke between 31 d and 1 y	7.90	13
CAS	Composite of death, stroke, or MI within 30 d after the procedure; death or ipsilateral stroke between 31 d and 1,080 d;1,080 d was converted to 3 y for normalization and NNT calculation	2.30	130
CAS	Stroke	0	~
CAS	Ipsilateral stroke	1.20	250

Trial, Year	Patient Population	Intervention
Symptomatic		
ICSS (2010)	Symptomatic	CEA
ICSS (2010)	Symptomatic	CEA
CREST symptomatic		
CREST 4-y data (2010)	Symptomatic	CEA
CREST 4-y data (2010)	Symptomatic	CEA
CREST 4-y data (2010)	Symptomatic	CEA
CREST asymptomatic		
CREST 4-y data (2010)	Asymptomatic	CEA
CREST 4-y data (2010)	Asymptomatic	CEA
CREST 4-y data (2010)	Asymptomatic	CEA
CREST mixed population		
CREST 4-y data (2010)	Patient population not separated in table; mixed patient population	CEA

See 2011 full text for references and more information.

*NNT indicates number of patients needed to treat over the course of 1 year with the indicated therapy as opposed to the comparator 2009;361:424-5. †The 1-year data from the SAPPHIRE trial included the primary endpoint; long-term data were used to calculate

ARR indicates absolute risk reduction; CAS, carotid artery stenting; CEA, carotid endarterectomy; NNT, number needed to treat;

Comparator	Event Used to Calculate NNT	ARR, %	NNT*
CAS	All strokes within 120 d after randomization‡	3.60	7
CAS	All strokes within 30 d after randomization‡	3.70	2
CAS	All strokes, MIs, or deaths within periprocedural period and postprocedural ipsilateral strokes	0.20	2,000
CAS	All periprocedural strokes or deaths or postprocedural ipsilateral strokes	1.60	250
CAS	All periprocedural strokes or postprocedural ipsilateral strokes	1.20	333
CAS	All strokes, MIs, or deaths within periprocedural period and postprocedural ipsilateral strokes	0.70	571
CAS	All periprocedural strokes or postprocedural ipsilateral strokes	1.80	223
CAS	All periprocedural strokes or deaths or postprocedural ipsilateral strokes	1.80	223
CAS	All stroke	2.30	174

to prevent the specified event(s). All NNT calculations have been annualized. For details of methodology, please see N Engl J Med. rates of the major secondary endpoint. ‡Annualized data. ~Cannot be calculated because ARR is 0.

N/A, not applicable.