

# 2011 ASA/ACCF/AHA/AANN/ AANS/ACR/ASNR/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



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# Citation

This slide set was adapted from the 2010 ACCF/AHA Guideline for Assessment of Cardiovascular Risk in Asymptomatic Adults (*Journal of the American College of Cardiology*). Published on January 31, 2011, available at:

<http://content.onlinejacc.org/cgi/content/full/j.jacc.2010.11.006>

The full-text guidelines are also available on the following Web sites:

ACC ([www.cardiosource.org](http://www.cardiosource.org)) and,

AHA ([www.my.americanheart.org](http://www.my.americanheart.org))



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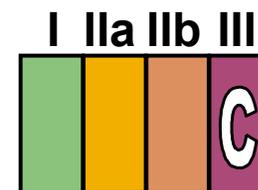
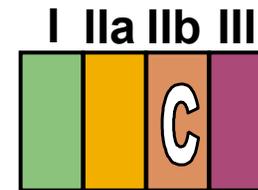
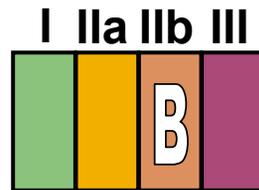
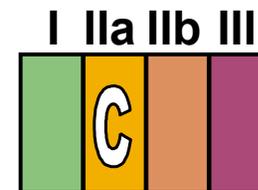
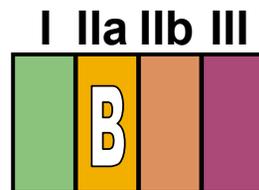
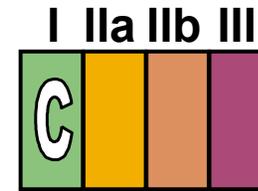
# Classification of Recommendations and Levels of Evidence

		SIZE OF TREATMENT EFFECT											
		CLASS I <i>Benefit &gt;&gt;&gt; Risk</i> Procedure/Treatment <b>SHOULD</b> be performed/administered	CLASS IIa <i>Benefit &gt;&gt; Risk</i> Additional studies with <i>focused objectives needed</i> <b>IT IS REASONABLE</b> to perform procedure/administer treatment	CLASS IIb <i>Benefit ≥ Risk</i> Additional studies with <i>broad objectives needed; additional registry data would be helpful</i> Procedure/Treatment <b>MAY BE CONSIDERED</b>	CLASS III <i>No Benefit</i> or CLASS III <i>Harm</i>								
				<table border="1"> <thead> <tr> <th></th> <th>Procedure/ Test</th> <th>Treatment</th> </tr> </thead> <tbody> <tr> <td>COR III: No benefit</td> <td>Not Helpful</td> <td>No Proven Benefit</td> </tr> <tr> <td>COR III: Harm</td> <td>Excess Cost w/o Benefit or Harmful</td> <td>Harmful to Patients or Harmful</td> </tr> </tbody> </table>		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 or Harmful
	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 or Harmful											
ESTIMATE OF CERTAINTY (PRECISION) OF TREATMENT EFFECT	LEVEL A Multiple populations evaluated* Data derived from multiple randomized clinical trials or meta-analyses	<ul style="list-style-type: none"> <li>Recommendation that procedure or treatment is useful/effective</li> <li>Sufficient evidence from multiple randomized trials or meta-analyses</li> </ul>	<ul style="list-style-type: none"> <li>Recommendation in favor of treatment or procedure being useful/effective</li> <li>Some conflicting evidence from multiple randomized trials or meta-analyses</li> </ul>	<ul style="list-style-type: none"> <li>Recommendation's usefulness/efficacy less well established</li> <li>Greater conflicting evidence from multiple randomized trials or meta-analyses</li> </ul>	<ul style="list-style-type: none"> <li>Recommendation that procedure or treatment is not useful/effective and may be harmful</li> <li>Sufficient evidence from multiple randomized trials or meta-analyses</li> </ul>								
	LEVEL B Limited populations evaluated* Data derived from a single randomized trial or nonrandomized studies	<ul style="list-style-type: none"> <li>Recommendation that procedure or treatment is useful/effective</li> <li>Evidence from single randomized trial or nonrandomized studies</li> </ul>	<ul style="list-style-type: none"> <li>Recommendation in favor of treatment or procedure being useful/effective</li> <li>Some conflicting evidence from single randomized trial or nonrandomized studies</li> </ul>	<ul style="list-style-type: none"> <li>Recommendation's usefulness/efficacy less well established</li> <li>Greater conflicting evidence from single randomized trial or nonrandomized studies</li> </ul>	<ul style="list-style-type: none"> <li>Recommendation that procedure or treatment is not useful/effective and may be harmful</li> <li>Evidence from single randomized trial or nonrandomized studies</li> </ul>								
	LEVEL C Very limited populations evaluated* Only consensus opinion of experts, case studies, or standard of care	<ul style="list-style-type: none"> <li>Recommendation that procedure or treatment is useful/effective</li> <li>Only expert opinion, case studies, or standard of care</li> </ul>	<ul style="list-style-type: none"> <li>Recommendation in favor of treatment or procedure being useful/effective</li> <li>Only diverging expert opinion, case studies, or standard of care</li> </ul>	<ul style="list-style-type: none"> <li>Recommendation's usefulness/efficacy less well established</li> <li>Only diverging expert opinion, case studies, or standard of care</li> </ul>	<ul style="list-style-type: none"> <li>Recommendation that procedure or treatment is not useful/effective and may be harmful</li> <li>Only expert opinion, case studies, or standard of care</li> </ul>								
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	may/might be considered may/might be reasonable usefulness/effectiveness is unknown/unclear/uncertain or not well established	COR III: No Benefit is not recommended is not indicated should not be done is not useful/beneficial/effective	COR III: Harm potentially harmful causes harm associated with excess morbidity/mortality should not be done							
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										

\*Data available from clinical trials or registries about the usefulness/efficacy in different subpopulations, such as gender, 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. Even though randomized trials are not available, 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.

# Icons representing the Classification and Evidence Levels for Recommendations



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# Challenges of ECVD

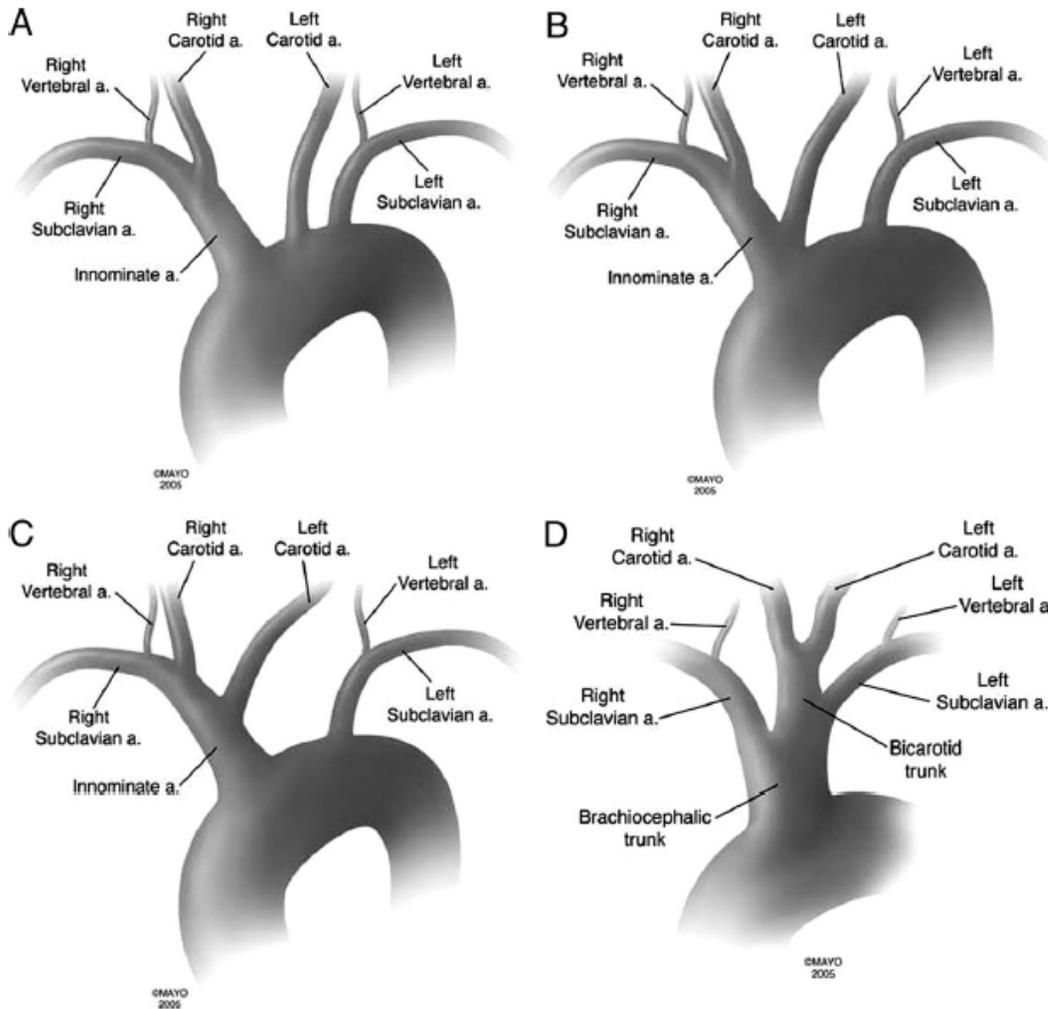
- Carotid disease causes **5 – 10 %** of all strokes
- Nearly **40,000 CAS** and **100,000 CEA** are performed annually in the U.S.



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# Aortic Arch Types



**Panel A.** The most common aortic arch branching pattern found in humans has separate origins for the innominate, left common carotid, and left subclavian arteries. **Panel B.** The second most common pattern of human aortic arch branching has a common origin for the innominate and left common carotid arteries. This pattern has erroneously been referred to as a “bovine arch.” **Panel C.** In this variant of aortic arch branching, the left common carotid artery originates separately from the innominate artery. This pattern has also been erroneously referred to as a “bovine arch.” **Panel D.** The aortic arch branching pattern found in cattle has a single brachiocephalic trunk originating from the aortic arch that eventually splits into the bilateral subclavian arteries and a bicarotid trunk. a indicates artery. Reprinted with permission from Layton et al. (6).

Reprinted with permission from Layton et al. *Am J Neuroradiol.* 2006;27:1541–2



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# Guideline for Patients With Extracranial Carotid and Vertebral Artery Disease

## Evaluation of Asymptomatic Patients at Risk of Extracranial Carotid Artery Disease



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# Evaluation of Asymptomatic Patients at Risk of Extracranial Carotid Artery Disease

## Recommendations for Duplex Ultrasonography to Evaluate Asymptomatic Patients With Known or Suspected Carotid Stenosis



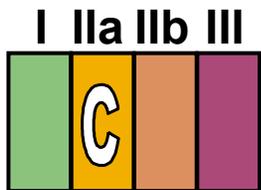
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# Recommendations for Duplex Ultrasonography to Evaluate Asymptomatic Patients With Known or Suspected Carotid Stenosis



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 diagnostic test to detect hemodynamically significant carotid stenosis.



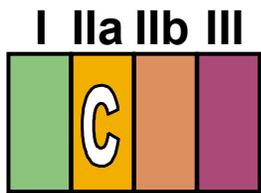
It is reasonable to perform duplex ultrasonography to detect hemodynamically significant carotid stenosis in asymptomatic patients with carotid bruit.



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# Recommendations for Duplex Ultrasonography to Evaluate Asymptomatic Patients With Known or Suspected Carotid Stenosis (continued)



It is reasonable to repeat duplex ultrasonography annually by a qualified technologist in a certified laboratory to assess the progression or regression of disease and response to therapeutic interventions in patients with atherosclerosis who have had stenosis greater than 50% detected previously. Once stability has been established over an extended period or the patient's candidacy for further intervention has changed, longer intervals or termination of surveillance may be appropriate.



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# Recommendations for Duplex Ultrasonography to Evaluate Asymptomatic Patients With Known or Suspected Carotid Stenosis (continued)



Duplex ultrasonography to detect hemodynamically significant carotid stenosis may be considered in asymptomatic patients with symptomatic PAD, coronary artery disease (CAD), or atherosclerotic aortic aneurysm, but because such patients already have an indication for medical therapy to prevent ischemic symptoms, it is unclear whether establishing the additional diagnosis of ECVD in those without carotid bruit would justify actions that affect clinical outcomes.



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# Recommendations for Duplex Ultrasonography to Evaluate Asymptomatic Patients With Known or Suspected Carotid Stenosis (continued)



Duplex ultrasonography might be considered to detect carotid stenosis in asymptomatic patients without clinical evidence of atherosclerosis who have 2 or more of the following risk factors: hypertension, hyperlipidemia, tobacco smoking, a family history in a firstdegree relative of atherosclerosis manifested before age 60 years, or a family history of ischemic stroke. However, it is unclear whether establishing a diagnosis of ECVD would justify actions that affect clinical outcomes.



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# Recommendations for Duplex Ultrasonography to Evaluate Asymptomatic Patients With Known or Suspected Carotid Stenosis (continued)



Carotid duplex ultrasonography is **not recommended** for routine screening of asymptomatic patients who have no clinical manifestations of or risk factors for atherosclerosis.



Carotid duplex ultrasonography is **not recommended** for routine evaluation of patients with neurological or psychiatric disorders unrelated to focal cerebral ischemia, such as brain tumors, familial or degenerative cerebral or motor neuron disorders, infectious and inflammatory conditions affecting the brain, psychiatric disorders, or epilepsy.



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# Recommendations for Duplex Ultrasonography to Evaluate Asymptomatic Patients With Known or Suspected Carotid Stenosis (continued)



Routine serial imaging of the extracranial carotid arteries is **not recommended** for patients who have no risk factors for development of atherosclerotic carotid disease and no disease evident on initial vascular testing.



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# Guideline for Patients With Extracranial Carotid and Vertebral Artery Disease

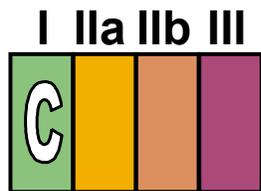
## Recommendations for Diagnostic Testing in Patients With Symptoms or Signs of Extracranial Carotid Artery Disease



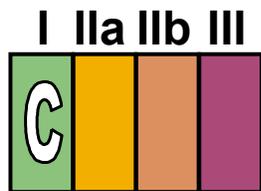
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# Recommendations for Diagnostic Testing in Patients With Symptoms or Signs of ECVD



The initial evaluation of patients with transient retinal or hemispheric neurological symptoms of possible ischemic origin should include noninvasive imaging for the detection of ECVD.



Duplex ultrasonography is recommended to detect carotid stenosis in patients who develop focal neurological symptoms corresponding to the territory supplied by the left or right internal carotid artery.



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# Recommendations for Diagnostic Testing in Patients With Symptoms or Signs of ECVD (continued)



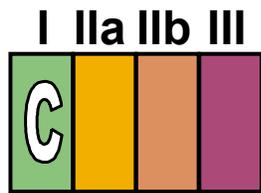
In patients with acute, focal ischemic neurological symptoms corresponding to the territory supplied by the left or right internal carotid artery, magnetic resonance angiography (MRA) or computed tomography angiography (CTA) is indicated to detect carotid stenosis when sonography either cannot be obtained or yields equivocal or otherwise nondiagnostic results.



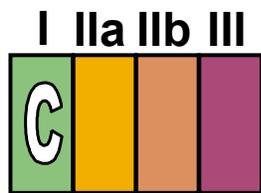
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# Recommendations for Diagnostic Testing in Patients With Symptoms or Signs of ECVD (continued)



When extracranial or intracranial cerebrovascular disease is not severe enough to account for neurological symptoms of suspected ischemic origin, echocardiography should be performed to search for a source of cardiogenic embolism.



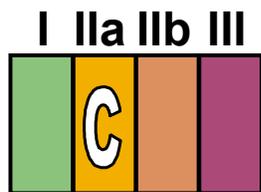
Correlation of findings obtained by several carotid imaging modalities should be part of a program of quality assurance in each laboratory that performs such diagnostic testing.



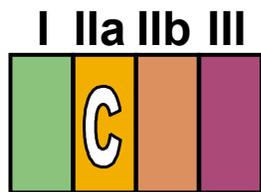
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# Recommendations for Diagnostic Testing in Patients With Symptoms or Signs of ECVD (continued)



When an extracranial source of ischemia is not identified in patients with transient retinal or hemispheric neurological symptoms of suspected ischemic origin, CTA, MRA, or selective cerebral angiography can be useful to search for intracranial vascular disease.



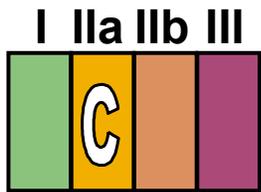
When the results of initial noninvasive imaging are inconclusive, additional examination by use of another imaging method is reasonable. In candidates for revascularization, MRA or CTA can be useful when results of carotid duplex ultrasonography are equivocal or indeterminate.



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# Recommendations for Diagnostic Testing in Patients With Symptoms or Signs of ECVD (continued)



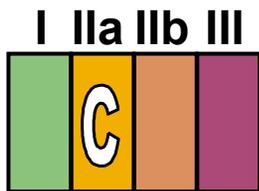
When intervention for significant carotid stenosis detected by carotid duplex ultrasonography is planned, MRA, CTA, or catheterbased contrast angiography can be useful to evaluate the severity of stenosis and to identify intrathoracic or intracranial vascular lesions that are not adequately assessed by duplex ultrasonography.



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# Recommendations for Diagnostic Testing in Patients With Symptoms or Signs of ECVD (continued)



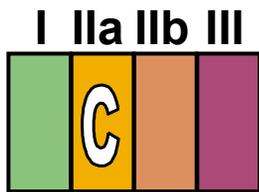
When noninvasive imaging is inconclusive or not feasible because of technical limitations or contraindications in patients with transient retinal or hemispheric neurological symptoms of suspected ischemic origin, or when noninvasive imaging studies yield discordant results, it is reasonable to perform catheter-based contrast angiography to detect and characterize extracranial and/or intracranial cerebrovascular disease.



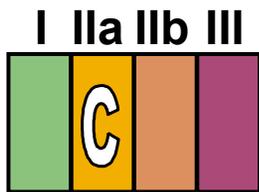
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# Recommendations for Diagnostic Testing in Patients With Symptoms or Signs of ECVD (continued)



MRA without contrast is reasonable to assess the extent of disease in patients with symptomatic carotid atherosclerosis and renal insufficiency or extensive vascular calcification.



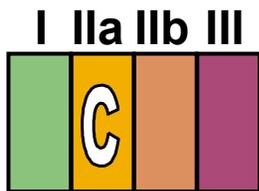
It is reasonable to use MRI systems capable of consistently generating high-quality images while avoiding low-field systems that do not yield diagnostically accurate results.



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# Recommendations for Diagnostic Testing in Patients With Symptoms or Signs of ECVD (continued)



CTA is reasonable for evaluation of patients with clinically suspected significant carotid atherosclerosis who are not suitable candidates for MRA because of claustrophobia, implanted pacemakers, or other incompatible devices.



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# Recommendations for Diagnostic Testing in Patients With Symptoms or Signs of ECVD (continued)



Duplex carotid ultrasonography might be considered for patients with nonspecific neurological symptoms when cerebral ischemia is a plausible cause.



When complete carotid arterial occlusion is suggested by duplex ultrasonography, MRA, or CTA in patients with retinal or hemispheric neurological symptoms of suspected ischemic origin, catheter-based contrast angiography may be considered to determine whether the arterial lumen is sufficiently patent to permit carotid revascularization.



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# Guideline for Patients With Extracranial Carotid and Vertebral Artery Disease

## Medical Therapy for Patients With Atherosclerotic Disease of the Extracranial Carotid or Vertebral Arteries



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# Medical Therapy for Patients with ECVD

## Recommendations for the Treatment of Hypertension



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# Recommendations for the Treatment of Hypertension



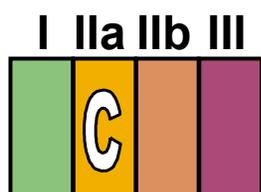
Antihypertensive treatment is recommended for patients with hypertension and asymptomatic extracranial carotid or vertebral atherosclerosis to maintain blood pressure below 140/90 mm Hg (111,228–231).



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# Recommendations for the Treatment of Hypertension (continued)



Except during the hyperacute period, antihypertensive treatment is probably indicated in patients with hypertension and symptomatic extracranial carotid or vertebral atherosclerosis, but the benefit of treatment to a specific target blood pressure (e.g., below 140/90 mm Hg) has not been established in relation to the risk of exacerbating cerebral ischemia.



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# Medical Therapy for Patients with ECVD

## Recommendation for the Cessation of Tobacco Smoking



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# Recommendation for the Cessation of Tobacco Smoking



Patients with extracranial carotid or vertebral atherosclerosis who smoke cigarettes should be advised to quit smoking and offered smoking cessation interventions to reduce the risks of atherosclerosis progression and stroke.



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# Medical Therapy for Patients with ECVD

## Recommendations for Control of Hyperlipidemia



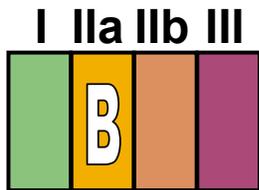
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# Recommendations for Control of Hyperlipidemia



Treatment with a statin medication is recommended for all patients with extracranial carotid or vertebral atherosclerosis to reduce low-density lipoprotein (LDL) cholesterol below 100 mg/dL.



Treatment with a statin medication is reasonable for all patients with extracranial carotid or vertebral atherosclerosis who sustain ischemic stroke to reduce LDL-cholesterol to a level near or below 70 mg/dL.



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# Recommendations for Control of Hyperlipidemia (continued)



If treatment with a statin (including trials of higher-dose statins and higher-potency statins) does not achieve the goal selected for a patient, intensifying LDL-lowering drug therapy with an additional drug from among those with evidence of improving outcomes (i.e., bile acid sequestrants or niacin) can be effective.



For patients who do not tolerate statins, LDL-lowering therapy with bile acid sequestrants and/or niacin is reasonable.



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# Medical Therapy for Patients with ECVD

## Recommendations for Management of Diabetes Mellitus



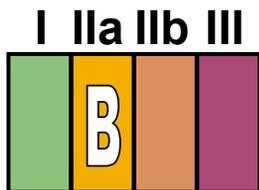
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# Recommendations for Management of Diabetes Mellitus



Diet, exercise, and glucose-lowering drugs can be useful for patients with diabetes mellitus and extracranial carotid or vertebral artery atherosclerosis. The stroke prevention benefit, however, of intensive glucose-lowering therapy to a glycosylated hemoglobin A1c level less than 7.0% has not been established.



Administration of statin-type lipid-lowering medication at a dosage sufficient to reduce LDL cholesterol to a level near or below 70 mg/dL is reasonable in patients with diabetes mellitus and extracranial carotid or vertebral artery atherosclerosis for prevention of ischemic stroke and other ischemic cardiovascular events.



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# Recommendations for Management of Diabetes Mellitus (continued)



Administration of statin-type lipid-lowering medication at a dosage sufficient to reduce LDL cholesterol to a level near or below 70 mg/dL is reasonable in patients with diabetes mellitus and extracranial carotid or vertebral artery atherosclerosis for prevention of ischemic stroke and other ischemic cardiovascular events.



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# Medical Therapy for Patients with ECVD

## Recommendations for Antithrombotic Therapy



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# Recommendations for Antithrombotic Therapy



Antiplatelet therapy with aspirin, 75 to 325 mg daily, is recommended for patients with obstructive or nonobstructive atherosclerosis that involves the extracranial carotid and/or vertebral arteries for prevention of MI and other ischemic cardiovascular events, although the benefit has not been established for prevention of stroke in asymptomatic patients.



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# Recommendations for Antithrombotic Therapy (continued)



In patients with obstructive or nonobstructive extracranial carotid or vertebral atherosclerosis who have sustained ischemic stroke or TIA, antiplatelet therapy with aspirin alone (75 to 325 mg daily), clopidogrel alone (75 mg daily), or the combination of aspirin plus extended-release dipyridamole (25 and 200 mg twice daily, respectively) is recommended and preferred over the combination of aspirin with clopidogrel. Selection of an antiplatelet regimen should be individualized on the basis of patient risk factor profiles, cost, tolerance, and other clinical characteristics, as well as guidance from regulatory agencies.



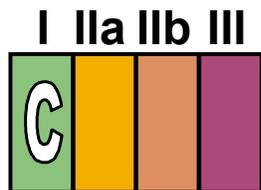
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# Recommendations for Antithrombotic Therapy (continued)



Antiplatelet agents are recommended rather than oral anticoagulation for patients with atherosclerosis of the extracranial carotid or vertebral arteries with ischemic symptoms...



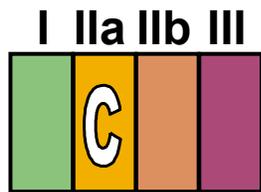
or without ischemic symptoms.



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# Recommendations for Antithrombotic Therapy (continued)



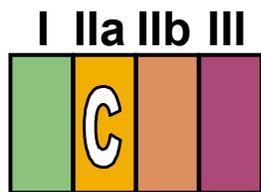
In patients with extracranial cerebrovascular atherosclerosis who have an indication for anticoagulation, such as atrial fibrillation or a mechanical prosthetic heart valve, it can be beneficial to administer a vitamin K antagonist (such as warfarin, dose-adjusted to achieve a target international normalized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



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# Recommendations for Antithrombotic Therapy (continued)



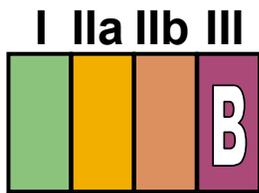
For patients with atherosclerosis of the extracranial carotid or vertebral arteries in whom aspirin is contraindicated by factors other than active bleeding, including allergy, either clopidogrel (75 mg daily) or ticlopidine (250 mg twice daily) is a reasonable alternative.



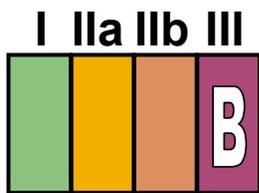
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# Recommendations for Antithrombotic Therapy (continued)



Full-intensity parenteral anticoagulation with unfractionated heparin or low-molecular-weight heparinoids is **not recommended** for patients with extracranial cerebrovascular atherosclerosis who develop transient cerebral ischemia or acute ischemic stroke.



Administration of clopidogrel in combination with aspirin is **not recommended** within 3 months after stroke or TIA.



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# Guideline for Patients With Extracranial Carotid and Vertebral Artery Disease

## Revascularization



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# Revascularization

## Recommendations for Selection of Patients for Carotid Revascularization\*

\*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.



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# Recommendations for Selection of Patients for Carotid Revascularization



Patients at average or low surgical risk who experience nondisabling ischemic stroke<sup>†</sup> or transient cerebral ischemic symptoms, including hemispheric events or amaurosis fugax, within 6 months (symptomatic patients) should undergo CEA if the diameter of the lumen of the ipsilateral internal carotid artery is reduced more than 70%<sup>‡</sup> as documented by noninvasive imaging...



or more than 50% as documented by catheter angiography and the anticipated rate of perioperative stroke or mortality is less than 6%.

<sup>†</sup>Nondisabling stroke is defined by a residual deficit associated with a score  $\leq 2$  according to the Modified Rankin Scale.

<sup>‡</sup>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.



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# Recommendations for Selection of Patients for Carotid Revascularization (continued)



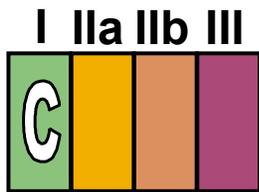
CAS is indicated as an alternative to CEA for symptomatic patients at average or low risk of complications associated with endovascular intervention when the diameter of the lumen of the internal carotid artery is reduced by more than 70% as documented by noninvasive imaging or more than 50% as documented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



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# Recommendations for Selection of Patients for Carotid Revascularization (continued)



Selection of asymptomatic patients for carotid revascularization should be guided by an 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.



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# Recommendations for Selection of Patients for Carotid Revascularization (continued)



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, MI, and death is low.



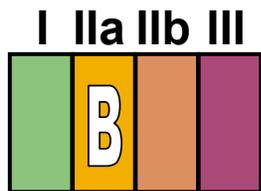
It is reasonable to choose CEA over CAS when revascularization is indicated in older patients, particularly when arterial pathoanatomy is unfavorable for endovascular intervention.



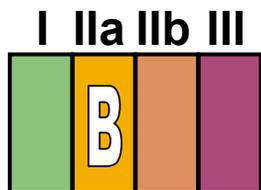
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# Recommendations for Selection of Patients for Carotid Revascularization (continued)



It is reasonable to choose CAS over CEA when revascularization is indicated in patients with neck anatomy unfavorable for arterial surgery.§



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.

§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.



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# Recommendations for Selection of Patients for Carotid Revascularization

## (continued)



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.



In symptomatic or asymptomatic patients at high risk of complications for carotid revascularization by either CEA or CAS because of comorbidities, the effectiveness of revascularization versus medical therapy alone is not well established.



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# Recommendations for Selection of Patients for Carotid Revascularization (continued)



Except in extraordinary circumstances, carotid revascularization by either CEA or CAS is **not recommended** when atherosclerosis narrows the lumen by less than 50%.



Carotid revascularization is **not recommended** for patients with chronic total occlusion of the targeted carotid artery.



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# Recommendations for Selection of Patients for Carotid Revascularization (continued)



Carotid revascularization is **not recommended** for patients with severe disability<sup>¶</sup> caused by cerebral infarction that precludes preservation of useful function.

<sup>¶</sup>In this context, severe disability refers generally to a Modified Rankin Scale score 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.



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# Revascularization

## Recommendations for Periprocedural Management of Patients Undergoing Carotid Endarterectomy



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# Recommendations for Periprocedural Management of Patients Undergoing Carotid Endarterectomy



Aspirin (81 to 325 mg daily) is recommended before CEA and may be continued indefinitely postoperatively.



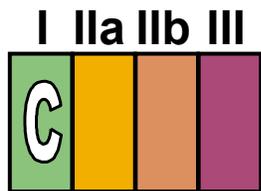
Beyond the first month after CEA, aspirin (75 to 325 mg daily), clopidogrel (75 mg daily), or the combination of low-dose aspirin plus extended-release dipyridamole (25 and 200 mg twice daily, respectively) should be administered for long-term prophylaxis against ischemic cardiovascular events.



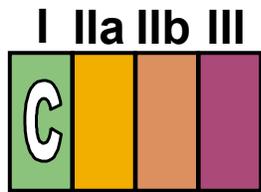
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# Recommendations for Periprocedural Management of Patients Undergoing Carotid Endarterectomy (continued)



Administration of antihypertensive medication is recommended as needed to control blood pressure before and after CEA.



The findings on clinical neurological examination should be documented within 24 hours before and after CEA.



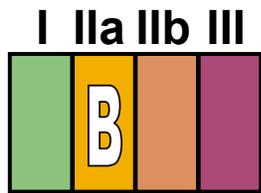
Patch angioplasty can be beneficial for closure of the arteriotomy after CEA.



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# Recommendations for Periprocedural Management of Patients Undergoing Carotid Endarterectomy (continued)



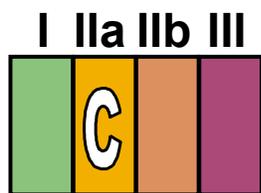
Administration of statin lipid-lowering medication for prevention of ischemic events is reasonable for patients who have undergone CEA irrespective of serum lipid levels, although the optimum agent and dose and the efficacy for prevention of restenosis have not been established.



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# Recommendations for Periprocedural Management of Patients Undergoing Carotid Endarterectomy (continued)



Noninvasive imaging of the extracranial carotid arteries is reasonable 1 month, 6 months, and annually after CEA to assess patency and exclude the development of new or contralateral lesions. 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.



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# Revascularization

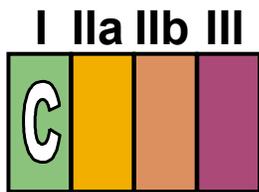
## Management of Patients Undergoing Endovascular Carotid Artery Stenting



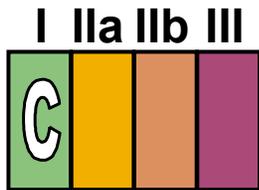
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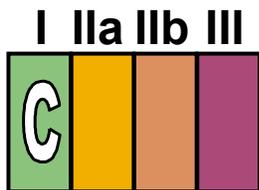
# Recommendations for Management of Patients Undergoing Endovascular Carotid Artery Stenting



Before and for a minimum of 30 days after CAS, dual-antiplatelet therapy with aspirin (81 to 325 mg daily) plus clopidogrel (75 mg daily) is recommended. For patients intolerant of clopidogrel, ticlopidine (250 mg twice daily) may be substituted.



Administration of antihypertensive medication is recommended to control blood pressure before and after CAS.



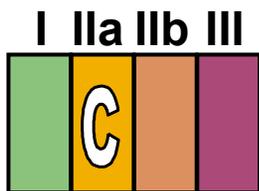
The findings on clinical neurological examination should be documented within 24 hours before and after CAS.



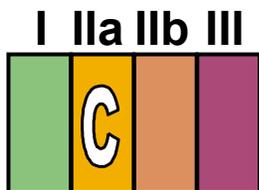
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# Recommendations for Management of Patients Undergoing Endovascular Carotid Artery Stenting (continued)



EPD deployment during CAS can be beneficial to reduce the risk of stroke when the risk of vascular injury is low.



Noninvasive imaging of the extracranial carotid arteries is reasonable 1 month, 6 months, and annually after revascularization to assess patency and exclude the development of new or contralateral lesions. Once stability has been established over an extended period, surveillance at extended intervals may be appropriate. Termination of surveillance is reasonable when the patient is no longer a candidate for intervention.



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# Guideline for Patients With Extracranial Carotid and Vertebral Artery Disease

## Durability of Carotid Revascularization



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# Durability of Carotid Revascularization

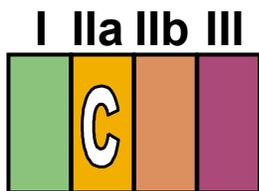
## Recommendations for Management of Patients Experiencing Restenosis After Carotid Endarterectomy or Stenting



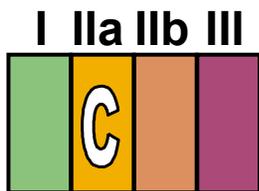
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# Recommendations for Management of Patients Experiencing Restenosis After Carotid Endarterectomy or Stenting



In patients with symptomatic cerebral ischemia and recurrent carotid stenosis due to intimal hyperplasia or atherosclerosis, it is reasonable to repeat CEA or perform CAS using the same criteria as recommended for initial revascularization.



Reoperative CEA or CAS after initial revascularization is reasonable when duplex ultrasound and another confirmatory imaging method identify rapidly progressive restenosis that indicates a threat of complete occlusion.



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# Recommendations for Management of Patients Experiencing Restenosis After Carotid Endarterectomy or Stenting (continued)



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 recommended for initial revascularization.



Reoperative CEA or CAS **should not be performed** in asymptomatic patients with less than 70% carotid stenosis that has remained stable over time.



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# Guideline for Patients With Extracranial Carotid and Vertebral Artery Disease

## Vertebral Artery Disease



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# Durability of Carotid Revascularization

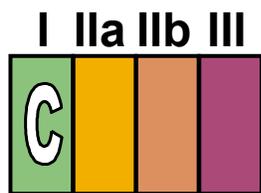
## Recommendations for Vascular Imaging in Patients With Vertebral Artery Disease



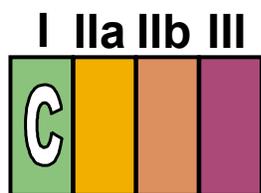
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# Recommendations for Vascular Imaging in Patients with Vertebral Artery Disease



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.



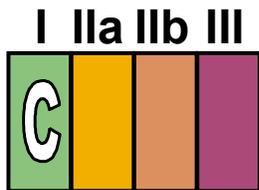
Patients with asymptomatic bilateral carotid occlusions or unilateral carotid artery occlusion and incomplete circle of Willis should undergo noninvasive imaging for detection of vertebral artery obstructive disease.



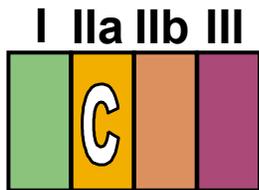
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# Recommendations for Vascular Imaging in Patients with Vertebral Artery Disease (continued)



In patients whose symptoms suggest posterior cerebral or cerebellar ischemia, MRA or CTA is recommended rather than ultrasound imaging for evaluation of the vertebral arteries.



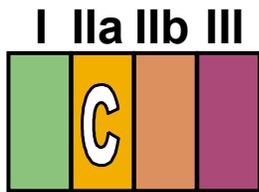
In patients with symptoms of posterior cerebral or cerebellar ischemia, serial noninvasive imaging of the extracranial vertebral arteries is reasonable to assess the progression of atherosclerotic disease and exclude the development of new lesions.



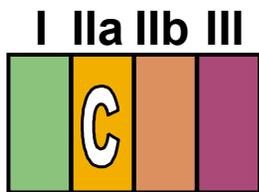
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# Recommendations for Vascular Imaging in Patients with Vertebral Artery Disease (continued)



In patients with posterior cerebral or cerebellar ischemic symptoms who may be candidates for revascularization, catheter-based contrast angiography can be useful to define vertebral artery pathoanatomy when noninvasive imaging fails to define the location or severity of stenosis.



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.



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# Durability of Carotid Revascularization

## Recommendations for Management of Atherosclerotic Risk Factors in Patients With Vertebral Artery Disease



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# Recommendations for Management of Atherosclerotic Risk Factors in Patients with Vertebral Artery Disease



Medical therapy and lifestyle modification to reduce atherosclerotic risk are recommended in patients with vertebral atherosclerosis according to the standards recommended for those with extracranial carotid atherosclerosis.



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 MI and other ischemic events.



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# Recommendations for Management of Atherosclerotic Risk Factors in Patients with Vertebral Artery Disease (continued)



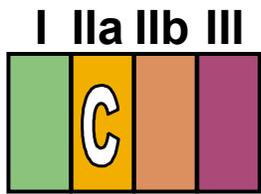
Antiplatelet drug therapy is recommended as part of the initial management for patients who sustain ischemic stroke or TIA associated with extracranial vertebral atherosclerosis. Aspirin (81 to 325 mg daily), the combination of aspirin plus extended-release dipyridamole (25 and 200 mg twice daily, respectively),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



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# Recommendations for Management of Atherosclerotic Risk Factors in Patients with Vertebral Artery Disease (continued)



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) is a reasonable alternative.



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# Guideline for Patients With Extracranial Carotid and Vertebral Artery Disease

## Diseases of the Subclavian and Brachiocephalic Arteries



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# Diseases of the Subclavian and Brachiocephalic Arteries

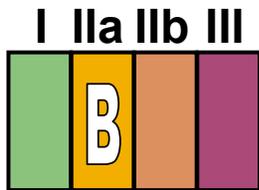
## Recommendations for the Management of Patients With Occlusive Disease of the Subclavian and Brachiocephalic Arteries



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# Recommendations for Management of Patients with Occlusive Disease of the Subclavian & Brachiocephalic Arteries



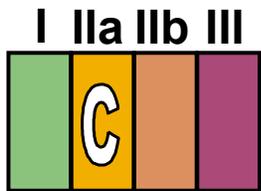
Extra-anatomic carotid-subclavian bypass is reasonable for patients with symptomatic posterior cerebral or cerebellar ischemia caused by subclavian artery stenosis or occlusion (subclavian steal syndrome) in the absence of clinical factors predisposing to surgical morbidity or mortality.



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# Recommendations for Management of Patients with Occlusive Disease of the Subclavian & Brachiocephalic Arteries (continued)



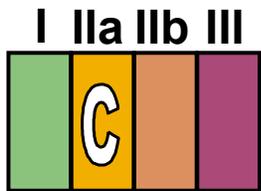
Percutaneous endovascular angioplasty and stenting is reasonable for patients with symptomatic posterior cerebral or cerebellar ischemia caused by subclavian artery stenosis (subclavian steal syndrome) who are at high risk of surgical complications.



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# Recommendations for Management of Patients with Occlusive Disease of the Subclavian & Brachiocephalic Arteries (continued)



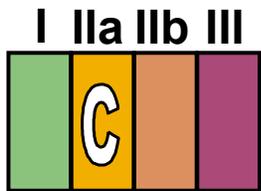
Revascularization by percutaneous angioplasty and stenting, direct arterial reconstruction, or extra-anatomic bypass surgery is reasonable for patients with symptomatic ischemia involving the anterior cerebral circulation caused by common carotid or brachiocephalic artery occlusive disease.



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# Recommendations for Management of Patients with Occlusive Disease of the Subclavian & Brachiocephalic Arteries (continued)



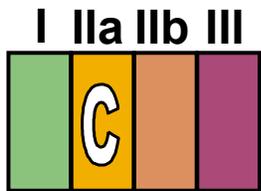
Revascularization by percutaneous angioplasty and stenting, direct arterial reconstruction, or extra-anatomic bypass surgery is reasonable for patients with symptomatic ischemia involving upperextremity claudication caused by subclavian or brachiocephalic arterial occlusive disease.



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# Recommendations for Management of Patients with Occlusive Disease of the Subclavian & Brachiocephalic Arteries (continued)



Revascularization by either extra-anatomic bypass surgery or subclavian angioplasty and stenting is reasonable for asymptomatic patients with subclavian artery stenosis when the ipsilateral internal mammary artery is required as a conduit for myocardial revascularization.



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# Recommendations for Management of Patients with Occlusive Disease of the Subclavian & Brachiocephalic Arteries (continued)



Asymptomatic patients with asymmetrical upper-limb blood pressure, 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.



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# Guideline for Patients With Extracranial Carotid and Vertebral Artery Disease

## Special Populations



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# Special Populations

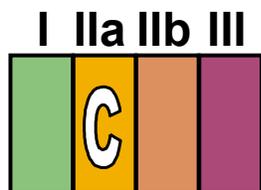
## Recommendations for Carotid Artery Evaluation and Revascularization Before Cardiac Surgery



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# Recommendations for Carotid Artery Evaluation and Revascularization Before Cardiac Surgery



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.



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# Recommendations for Carotid Artery Evaluation and Revascularization Before Cardiac Surgery (continued)



Carotid duplex ultrasound screening is reasonable before elective CABG surgery in patients older than 65 years of age and in those with left main coronary stenosis, PAD, a history of cigarette smoking, a history of stroke or TIA, or carotid bruit.



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.



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# Guideline for Patients With Extracranial Carotid and Vertebral Artery Disease

## Nonatherosclerotic Carotid and Vertebral Artery Diseases



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# Nonatherosclerotic Carotid and Vertebral Artery Diseases

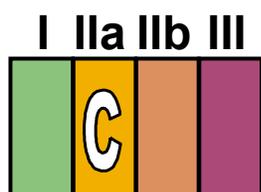
## Recommendations for Management of Patients With Fibromuscular Dysplasia of the Extracranial Carotid Arteries



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# Recommendations for Management of Patients with Fibromuscular Dysplasia of the Extracranial Carotid Arteries



Annual noninvasive imaging of the carotid arteries is reasonable initially for patients with FMD to detect changes in the extent or severity of disease, although the effect on outcomes is unclear. Studies may be repeated less frequently once stability has been confirmed.



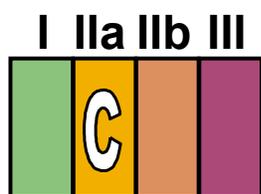
Administration of platelet-inhibitor medication can be beneficial in patients with FMD of the carotid arteries to prevent thromboembolism, but the optimum drug and dosing regimen have not been established.



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# Recommendations for Management of Patients with Fibromuscular Dysplasia of the Extracranial Carotid Arteries (continued)



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 these methods of revascularization are not available.



Revascularization is **not recommended** for patients with asymptomatic FMD of a carotid artery, regardless of the severity of stenosis.



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# Nonatherosclerotic Carotid and Vertebral Artery Diseases

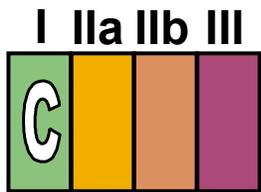
## Recommendations for Management of Patients With Cervical Artery Dissection



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# Recommendations for Management of Patients with Cervical Artery Dissection



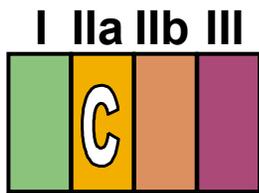
Contrast-enhanced CTA, MRA, and catheter-based contrast angiography are useful for diagnosis of cervical artery dissection.



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# Recommendations for Management of Patients with Cervical Artery Dissection (continued)



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



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# Recommendations for Management of Patients with Cervical Artery Dissection (continued)



Carotid angioplasty and stenting might be considered when ischemic neurological symptoms have not responded to antithrombotic therapy after acute carotid dissection.



The safety and effectiveness of pharmacological therapy with a beta-adrenergic antagonist, angiotensin inhibitor, or nondihydropyridine calcium channel antagonist (verapamil or diltiazem) to lower blood pressure to the normal range and reduce arterial wall stress are not well established.



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