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ACCF/ACR/AIUM/ASE/ASN/ICAVL/SCAI/SCCT/SIR/SVM/SVS 2012 appropriate use criteria for peripheral vascular ultrasound and physiological testing part I: Arterial ultrasound and physiological testing:

A Report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, American College of Radiology, American Institute of Ultrasound in Medicine, American Society of Echocardiography, American Society of Nephrology, Intersocietal Commission for the Accreditation of Vascular Laboratories, Society for Cardiovascular

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Abstract

The American College of Cardiology Foundation (ACCF), in partnership with key specialty and subspecialty societies, conducted a review of common clinical scenarios where noninvasive vascular testing (ultrasound and physiological testing) is frequently considered. The indications (clinical scenarios) were derived from common applications or anticipated uses, as well as from current clinical practice guidelines and results of studies examining the implementation of the original appropriate use criteria (AUC). The 159 indications in this document were developed by a diverse writing group and scored by a separate independent technical panel on a scale of 1 to 9, to designate appropriate use (median 7 to 9), uncertain use (median 4 to 6), and inappropriate use (median 1 to 3).

A total of 255 indications (with the inclusion of surveillance timeframes) were rated. One hundred and seventeen indications were rated as appropriate, 84 were rated as uncertain, and 54 were rated as inappropriate. The AUC for peripheral vascular disease have the potential to impact physician decision making, healthcare delivery, and reimbursement policy. Furthermore, recognition of uncertain clinical scenarios facilitates identification of areas that would benefit from future research.

PREFACE

In an effort to respond to the need for the rational use of imaging services in the delivery of high-quality care, the ACCF has undertaken a process to determine the appropriate use of cardiovascular imaging for selected patient indications. AUC publications reflect an ongoing effort by the ACCF to critically and systematically create, review, and categorize clinical situations where diagnostic tests and procedures are utilized by physicians caring for patients with cardiovascular diseases. The process is based on current understanding of the technical capabilities of the imaging modalities examined. Although impossible to be entirely comprehensive given the wide diversity of clinical disease, the indications are meant to identify common scenarios encompassing the majority of situations encountered in contemporary practice. Given the breadth of information they convey, the indications do not directly correspond to the *Ninth Revision of the International Classification of Diseases* (ICD-9) system as these codes do not include clinical information, such as symptom status.

The ACCF believes that careful blending of a broad range of clinical experiences and available evidence-based information will help guide a more efficient and equitable allocation of healthcare resources in cardiovascular imaging. The ultimate objective of AUC

is to improve patient care and health outcomes in a cost-effective manner, but it is not intended to ignore ambiguity and nuance intrinsic to clinical decision making. AUC thus should not be considered substitutes for sound clinical judgment and practice experience.

We are grateful to the technical panel, a professional group with a wide range of skills and insights, for their thoughtful and thorough deliberation of the merits of peripheral vascular ultrasound for various indications. We would also like to thank the 24 individuals who provided a careful review of the draft of indications, the parent AUC Task Force, and the ACC staff, Joseph Allen and Jenissa Haidari for their exceptionally skilled support in the generation of this document.

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1. INTRODUCTION

Improvements in cardiovascular imaging technology and their application, coupled with increasing therapeutic options for cardiovascular disease, have led to an increase in cardiovascular imaging. Diagnostic imaging services reimbursed under Medicare's physician fee schedule grew more rapidly than any other type of physician service from 1999 to 2003, although more recently, the rate of imaging volume growth in Medicare has been slowing. Still, the armamentarium of noninvasive diagnostic tools has expanded greatly, offering a variety of new and more sophisticated imaging techniques. As imaging technology and clinical applications continue to advance, the healthcare community needs to understand how to best incorporate these technologies into daily clinical care and how to choose between new and long-standing established imaging technologies. In an effort to respond to this need and to ensure the effective use of advanced diagnostic imaging tools, the Appropriate Use Criteria (AUC) project was initiated.

2. METHODS

The indications included in this publication cover a wide array of cardiovascular signs and symptoms as well as clinical judgments as to the likelihood of cardiovascular findings. Within each main disease category, a standardized approach was used to capture the majority of clinical scenarios without making the list of indications excessive.

The indications were constructed by experts in peripheral vascular disease and in other fields and were modified on the basis of discussions among the task force and feedback from independent reviewers and the technical panel. Wherever possible, indications were mapped to relevant clinical guidelines and key publications/references where available in the medical literature (Online Appendix).

A detailed description of the methods used for ranking the selected clinical indications is found in a previous publication, "ACCF Proposed Method for Evaluating the Appropriateness of Cardiovascular Imaging".[1] Briefly, this process combines evidence-based medicine and practice experience by engaging a technical panel in a modified Delphi exercise.

The technical panel first rated indications independently. Then, the panel was convened for a face-to-face meeting for discussion of each indication. At this meeting, panel members were provided with their scores and a blinded summary of their peers' scores. After the meeting, panel members were then asked to independently provide their final scores for each indication.

Although panel members were not provided explicit cost information to help determine their appropriate use ratings, they were asked to implicitly consider cost as an additional factor in their evaluation of appropriate use. In rating these criteria, the technical panel was asked to assess whether the use of the test for each indication is appropriate, uncertain, or inappropriate, and was provided the following definition of appropriate use:

> An appropriate imaging study is one in which the expected incremental information, combined with clinical judgment, exceeds the expected negative consequence* by a sufficiently wide margin for a specific indication that the procedure is generally considered acceptable care and a reasonable approach for the indication.

The technical panel scored each indication as follows:

> Median Score 7 to 9
>
> Appropriate test for specific indication (test **is** generally acceptable and **is** a reasonable approach for the indication).
>
> Median Score 4 to 6
>
> Uncertain for specific indication (test **may** be generally acceptable and **may** be a reasonable approach for the indication). Uncertainty also implies that more research and/or patient information is needed to classify the indication definitively.
>
> Median Score 1 to 3
>
> Inappropriate test for that indication (test **is not** generally acceptable and **is not** a reasonable approach for the indication).

The division of these scores into 3 levels of appropriateness is somewhat arbitrary, and the numeric designations should be viewed as a continuum. Further, there is diversity in clinical opinion for particular clinical scenarios, such that scores in the intermediate level of appropriate use should be labeled "uncertain," as critical patient or research data may be lacking or discordant. This designation should be a prompt to the field to carry out definitive research investigations whenever possible. It is anticipated that the AUC reports will

*Negative consequences include the risks of the procedure (ie, radiation or contrast exposure) and the downstream impact of poor test performance such as delay in diagnosis (false negatives) or inappropriate diagnosis (false positives).

continue to be revised as further data are generated and information from the implementation of the criteria is accumulated.

To prevent bias in the scoring process, the technical panel was deliberately comprised of a minority of specialists in vascular noninvasive testing. Specialists, although offering important clinical and technical insights, might have a natural tendency to rate the indications within their specialty as more appropriate than nonspecialists.[1] In addition, care was taken in providing objective, nonbiased information, including guidelines and key references, to the technical panel.

The level of agreement among panelists as defined by RAND[2] was analyzed based on the BIOMED rule for a panel of 14 to 16 members. As such, agreement was defined as an indication where 4 or fewer panelists' ratings fell outside the 3-point region containing the median score.

Disagreement was defined as where at least 5 panelists' ratings fell in both the appropriate and the inappropriate categories. Any indication having disagreement was categorized as uncertain regardless of the final median score. Indications that met neither definition for agreement or disagreement are in a third, unlabeled category.

3. ASSUMPTIONS

To prevent any inconsistencies in interpretation, specific assumptions are provided that were considered by the technical panel in rating the relevant clinical indications for the appropriate use of peripheral vascular ultrasound and physiological testing.

A peripheral vascular ultrasound and physiological testing examination and report will include:

1. Performance of the vascular ultrasound or physiological testing examination using a standardized **scanning protocol** and standardized documentation of gray-scale (B-mode) color flow and spectral Doppler waveform images as required for the specific test type. Scanning protocols may be developed by the laboratory based upon laboratory-specific considerations and techniques as well as recommended technical elements per appropriate organizations (eg, American Institute of Ultrasound in Medicine, Society of Vascular Ultrasound) or laboratory accrediting organizations (Intersocietal Commission for the Accreditation of Vascular Laboratories, ICAVL, or American College of Radiology, ACR).[3]
2. Interpretation of the vascular ultrasound or physiological testing examination by a physician interpreter using **standard, laboratory specific diagnostic criteria** that have been developed by the laboratory or adapted from the ultrasound literature and are validated internally for accuracy as part of ongoing quality assurance programs. It is implicit that diagnostic criteria will vary across laboratories, but adherence to pre-defined criteria within a laboratory is required. Laboratory-specific protocols should be compiled in written policy and procedure manuals that are made available to medical and technical staff for review and discussion.

3. Appropriate equipment is used for each specific type of testing, including appropriate frequency ultrasound transducers and appropriately sized cuffs for physiological testing.

4. Documentation that the vascular sonographer used optimal angle correction techniques to ensure accurate angle of insonation for reporting of Doppler velocity measurements. In general, an angle of insonation of 60 degrees or less is used with appropriate sample volume placement.

5. All standard vascular ultrasound and physiological testing techniques have a sensitivity and specificity similar to those found in the published literature for the specific examination type.

6. Testing should be performed by a credentialed technologist (RVT or RVS) and interpreted by a credentialed physician (RPVI or ACR). Finally, the testing should be done in an accredited facility (ICAVL or ACR).

7. If prior testing is of poor technical quality, repeat imaging may sometimes be appropriate in a different facility or after the conditions that restricted the prior testing are no longer present (eg, bowel gas, open wounds) prior to the specified timeframes.

8. The appropriate use of testing is assumed to have the potential to impact clinical decision making and to direct therapeutic interventions.

9. The range of potential indications for vascular ultrasound and physiological testing is quite large, particularly in comparison with other cardiovascular imaging tests. Thus, the indications are, at times, purposefully broad to cover an array of vascular signs and symptoms as well as the ordering physician’s best judgment as to the presence of vascular abnormalities. Additionally, there are likely clinical scenarios that are not covered by the current indications in this document.

10. For all stress physiological testing, the mode of stress testing is assumed to be exercise for patients able to exercise. Laboratory-specific protocols should specify the precise form of exercise protocol used (eg, treadmill walking exercise protocol indicating speed and grade of treadmill settings and the specifics of other forms of exercise testing).

11. Complete vascular examinations, vascular ultrasound and physiological testing, require bilateral studies in the majority of clinical cases (such as carotid duplex examination, renal duplex examination, lower extremity physiologic testing), unless specific clinical indications warrant a limited study (eg, surveillance following unilateral lower extremity revascularization).

12. Carotid duplex ultrasound refers to testing protocols for evaluation of the extracranial cerebrovasculature only and does not include transcranial Doppler or transcranial duplex examinations.

13. To optimize patient care and minimize need for unnecessary repeat studies, it is generally recommended that repeat or serial scans (eg, for surveillance of asymptomatic carotid artery stenosis) be performed in the same facility.

14. Raters were instructed to consider cost implicitly when making the appropriate use determination.
15. Raters were instructed to consider patient safety implicitly in the appropriate use determination.
16. If the reason for a test can be assigned to more than 1 clinical indication, it should be matched to the indication with the highest appropriate use score.
17. For each indication, the rating should reflect whether the test is reasonable for the patient according to the appropriate use definition, not whether the test is the better or worse than another.
18. The category of “uncertain” should be used when insufficient clinical data are available for a definitive categorization or when there is disagreement as defined in the Methods section. The designation of “uncertain” is assumed to not provide grounds for denial of reimbursement.
19. When multiple timeframes are presented for surveillance examinations within the indications, the shortest timeframe scored as either uncertain or appropriate marks the start of the period during which testing may be considered reasonable. It is important that clinical judgment be used during the period in which surveillance is considered either uncertain or appropriate to determine the optimal time of surveillance.
20. Unless explicitly stated, the indications in this document indicate only whether vascular ultrasound or physiological testing by itself is reasonable. The indications do not address whether it is reasonable to perform vascular ultrasound or physiological testing instead of or in conjunction with another test, either before or after the test.
21. Surveillance indications require consideration of several timeframes. Unlike other indications, the rater should consider the **comparative** utility of surveillance at the various frequencies specified.
22. New or worsening symptoms during a surveillance period should be considered similar to the initial presentation and assumed to be covered by the earlier relevant indications rather than the surveillance tables.

4. DEFINITIONS

1. Claudication:

   Reproducible muscle discomfort or fatigue occurring with exertion at the same workload and relieved with rest, typically due to arterial obstruction.

2. Cold extremity:

   Reduced temperature from patient history or observed on physical examination by physician.

3. Physiological testing:

Evaluation of the peripheral circulation based on measurement of limb blood pressures with pulse volume recordings or Doppler waveforms, or other parameters without utilizing data from direct imaging of the blood vessels.

4. Resistant hypertension:

   The failure to normalize blood pressure on 3 or more drug regimen with medications at maximum doses and at least 1 of the medications being a diuretic agent.

5. Malignant hypertension:

   Uncontrolled hypertension causing acute heart failure, acute renal failure, or acute visual or mental status changes.

6. Disease surveillance:

   Baseline physiological testing or imaging:

   Testing conducted for initial diagnosis or for initial clinical evaluation post surgical or percutaneous intervention.

   Surveillance:

   Physiological testing or imaging conducted to monitor disease progression based solely on the passage of time since initial diagnosis or revascularization. It is assumed that baseline testing has already been conducted.

6. PERIPHERAL VASCULAR ULTRASOUND AND PHYSIOLOGICAL TESTING APPROPRIATE USE CRITERIA (BY INDICATION)

Section 1. Extracranial Cerebrovascular Ultrasound

Table 1.1

Evaluation for Cerebrovascular Disease—Potential Signs and/or Symptoms

	Indication	Appropriate Use Score (1–9)
1.	• New or worsening hemispheric neurological symptoms (eg, unilateral motor or sensory deficit, speech impairment, or amaurosis fugax) • Evaluation of transient ischemic attack or stroke	**A (9)**
2.	• Hollenhorst plaque visualized on retinal examination	**A (8)**
3.	• Lightheadedness or impaired vision in the setting of upper extremity exertion • Evaluation for subclavian–vertebral steal phenomenon	**A (7)**
4.	• Syncope of uncertain cause after initial cardiovascular evaluation	**U (5)**
5.	• Suspected symptomatic vertebrobasilar occlusive disease in the symptomatic patient (eg, vertigo, ataxia, diplopia, dysphagia, dysarthria)	**A (7)**
6.	• Evaluation for suspected carotid artery dissection	**A (8)**
7.	• Pulsatile neck mass	**A (8)**
8.	• Cervical bruit • No prior carotid artery assessment	**A (7)**

A = appropriate; I = inappropriate; U = uncertain.

Table 1.2

Evaluation for Cerebrovascular Disease—Asymptomatic With Comorbidities or Risk Factors for Carotid Artery Stenosis

	Indication	Appropriate Use Score (1–9)
9.	• No cervical bruit • Atherosclerotic disease in other vascular beds (eg, lower extremity PAD, coronary artery disease, abdominal aortic aneurysm)	**A (7)**
10.	• No cervical bruit • History of neck irradiation ≥10 years ago	**U (5)**
11.	• Known renal fibromuscular dysplasia	**U (5)**
	Prior to Open Heart Surgery	
12.	• Planned coronary artery bypass grafting (CABG)	**U (6)**
13.	• Atherosclerotic disease in other vascular beds (eg, lower extremity PAD, coronary artery disease, abdominal aortic aneurysm), or history of neck irradiation ≥10 years ago • Planned valve repair/replacement surgery (without CABG)	**U (6)**
14.	• Atherosclerotic risk factors present • Planned valve repair/replacement surgery (without CABG)	**U (6)**
15.	• No atherosclerotic risk factors • Planned valve repair/replacement surgery (without CABG)	**U (4)**

A = appropriate; CABG = coronary artery bypass graft; I = inappropriate; PAD = peripheral artery disease; U = uncertain.

Table 1.3

Follow-Up or Surveillance for Carotid Artery Stenosis—Asymptomatic[*†]

	Indication	Appropriate Use Score (1–9)		
16.	• Normal prior examination (no plaque, no stenosis)	**I (1)**		
	Surveillance Frequency During First Year	**At 3 to 5 months**	**At 6 to 8 months**	**At 9 to 12 months**
17.	• Plaque without significant stenosis of the ICA (plaque, normal ICA velocity)	**I (1)**	**I (1)**	**I (1)**
18.	• Mild ICA stenosis (eg, <50%)	**I (1)**	**I (1)**	**I (1)**
19.	• Moderate ICA stenosis (eg, 50% to 69%)	**I (2)**	**U (6)**	**U (6)**
20.	• Severe ICA stenosis (eg, 70% to 99%)	**U (5)**	**A (7)**	**U (6)**
	Surveillance Frequency After First Year	**Every 6 months**	**Every 12 months**	**Every 24 months or greater**
21.	• Plaque without significant stenosis of the ICA (plaque, normal ICA velocity)	**I (1)**	**I (3)**	**I (1)**
22.	• Mild ICA stenosis (eg, <50%)	**I (2)**	**U (5)**	**U (6)**
23.	• Moderate ICA stenosis (eg, 50% to 69%)	**I (3)**	**A (7)**	**U (6)**
24.	• Severe ICA stenosis (eg, 70% to 99%)	**A (7)**	**A (7)**	**U (6)**

A = appropriate; I = inappropriate; ICA = internal carotid artery; U = uncertain.

[*] In the setting of interval development of clinical symptoms in a previously asymptomatic patient or for rapid progression of stenosis during subsequent follow-up (eg, stenosis category change during a limited period of time), more intensive surveillance may be indicated.

[†] Carotid artery occlusion to be addressed in the text of the document. Periodic surveillance duplex ultrasound should be performed according to the severity of stenosis of the contralateral side.

Table 1.4

Surveillance After Carotid Artery Intervention

Indication		Appropriate Use Score (1–9)		
25.	• Baseline (within 1 month) after carotid intervention	**A (8)**		
Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency During First Year		**At 3 to 5 months**	**At 6 to 8 months**	**At 9 to 12 months**
26.	• Following normal ipsilateral ICA baseline study	**I (2)**	**A (7)**	**A (7)**
27.	• Following abnormal ipsilateral ICA baseline study	**U (4)**	**A (7)**	**U (5)**
Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency After First Year		**Every 6 months**	**Every 12 months**	**Every 24 months or greater**
28.	• Following normal ipsilateral ICA baseline study	**I (2)**	**A (7)**	**U (5)**
29.	• Following abnormal ipsilateral ICA baseline study	**U (4)**	**A (7)**	**U (5)**

A = appropriate; I = inappropriate; ICA = internal carotid artery; U = uncertain.

Section 2. Carotid Duplex Screening Ultrasound

Table 2.1

Limited Screening Study for Carotid Artery Plaque—Asymptomatic*

Indication		Appropriate Use Score (1–9)
30.	• Low Framingham risk score • No prior risk assessment imaging study, such as coronary calcium scoring or carotid IMT measurement	**I (2)**
31.	• Intermediate Framingham risk score • No prior risk assessment imaging study, such as coronary calcium scoring or carotid IMT measurement	**U (4)**
32.	• Low or intermediate Framingham risk score • Normal prior risk assessment imaging study, such as coronary calcium scoring or carotid IMT measurement	**I (3)**
33.	• High Framingham risk score	**U (5)**

A = appropriate; I = inappropriate; IMT = intima-media thickness; U = uncertain.

* A screening carotid duplex examination includes assessment for the presence of atherosclerotic plaque within the common and internal carotid arteries using grey-scale imaging and assessment for stenosis of the proximal internal carotid artery using spectral Doppler. The screening carotid duplex examination is performed using a limited but clearly defined screening protocol (see ICAVL 2010 standards 5.1.5).[3] A screening study for carotid artery plaque does *not* include formal measurement of carotid intimal medial thickness.

Summary: Extracranial Cerebrovascular and Carotid Duplex Screening Ultrasound—There was significant consensus regarding the appropriateness of cerebrovascular duplex ultrasound for evaluation of the patient with signs or clinical symptoms of cerebrovascular disease (Table 1.1) with 7 of 8 clinical indications rated as appropriate and 1 clinical indication rated as uncertain.

Use of cerebrovascular ultrasound was rated as appropriate for evaluation of the patient with suspected vertebrobasilar occlusive disease with posterior circulation symptoms; although a customized cerebrovascular scanning protocol and supplemental use of transcranial Doppler may be needed for complete assessment of such patients. The multisocietal consensus guidelines for the management of patients with extracranial carotid and vertebral artery disease recommend other imaging modalities (ie, magnetic resonance angiogram or computed tomography angiography) rather than ultrasound as the initial imaging test for suspected vertebral artery stenosis.[4] Though carotid ultrasound was rated as appropriated for evaluation of suspected carotid artery dissection, its use is best suited for evaluation of suspected carotid dissection arising from dissection of the aortic arch and extending into the arch vessels (eg, common carotid artery). Carotid ultrasound is not recommended to diagnose carotid dissection in the setting of trauma as a distal dissection of the internal carotid artery may not be detected by duplex scanning. In such cases, another other imaging modality (ie, MRA or CTA) should be used.

Appropriateness of the use of cerebrovascular duplex ultrasound to assess for carotid stenosis in the patient with syncope with no obvious cardiac cause was rated as uncertain by the panel. Cerebrovascular disease is an unlikely cause of syncope but has been reported in cases of severe (especially bilateral) internal carotid artery stenosis or severe vertebrobasilar occlusive disease or subclavian–vertebral artery steal. The yield of cerebrovascular ultrasound in the evaluation of syncope has been low in published case series, but the uncertain rating for this indication reflects the need for additional research, including cost effectiveness data, in this area.[5,6]

In contrast to the evaluation of the symptomatic patient or patient with signs of cerebrovascular disease, there was uncertainty regarding the use of cerebrovascular duplex for assessment of the asymptomatic patient with risk factors or comorbidities associated with carotid artery stenosis (Table 1.2), with 6 of 7 indications receiving an uncertain rating and only 1 indication receiving an appropriate rating. The technical panel rated as uncertain all clinical scenarios for cerebrovascular duplex examination prior to cardiac surgery, including evaluation of any asymptomatic patient (ie, no prior hemispheric symptoms, no bruit) prior to CABG and evaluation of an asymptomatic patient prior to valvular heart surgery, including patients with or without risk factors or comorbidities associated with cerebrovascular disease. These findings reflect a need for more research in this arena, particularly cost effectiveness data.

Clinical management of the asymptomatic patient with atherosclerotic carotid disease typically includes periodic ultrasound surveillance for progressive carotid artery stenosis with the objective of referral for surgical (endarterectomy) or interventional (carotid artery stenting) therapy for severe stenosis of the internal carotid artery.[7] The technical panel reviewed the appropriateness of time points for such surveillance studies (Table 1.3) during the first year after initial diagnosis of carotid stenosis and during subsequent follow-up across all severity categories. Any follow-up was deemed inappropriate following a normal baseline carotid examination (ie, absent plaque or narrowing). For surveillance of the patient with plaque without narrowing noted on initial duplex examination or mild stenosis of <50%, any surveillance during the first year of follow-up was also deemed inappropriate,

and surveillance beyond the first year was uncertain. Ratings for time points for surveillance of moderate (50% to 69%) and severe (≥70%) ICA lesions likely reflect the lack of substantial clinical effectiveness data in this arena, with the majority of indications rated as uncertain. For moderate ICA lesions, repeat ultrasound studies within the first year after diagnosis were rated as inappropriate (at 3 to 5 months) or uncertain, with annual studies rated as appropriate. For severe ICA lesions, an ultrasound study at 6 months and then every 6 or 12 months were rated as appropriate, although it should be emphasized that at this severity of stenosis, the risks versus benefits of revascularization (carotid artery endarterectomy or stenting) should be considered.[7]

The panel reviewed indications for cerebrovascular duplex ultrasound after carotid artery revascularization (endarterectomy or stenting). Obtaining a baseline bilateral cerebrovascular duplex examination was highly rated as appropriate by the technical panel. The panel rated indications for follow-up during the first year after revascularization and beyond based upon whether the initial postrevascularization duplex demonstrated normal, expected postprocedural findings, or indicated a postprocedural abnormality (eg, significantly elevated velocities) in Table 1.4. Though not included in the rated clinical indications, it is likely that frequency and appropriateness of testing intervals would change in the setting of new abnormalities identified on a surveillance duplex examination, such as significant in-stent restenosis or significant restenosis at a carotid endarterectomy site.

The presence of carotid artery plaque with or without stenosis has been associated with increased cardiovascular risk in epidemiological studies, including increased risk of myocardial infarction.[8–11] The technical panel reviewed the appropriateness of a carotid duplex screening ultrasound examination to screen plaque and significant narrowing of the proximal internal carotid arteries. However, these ratings do not include the appropriateness of carotid intima-medial thickness (IMT) assessment, a procedure that requires additional technological capabilities and is not widely nor routinely performed in the clinical vascular laboratory setting. The technical panel rated 2 indications as inappropriate for carotid screening ultrasound: assessment of the patient with low Framingham risk score and assessment of the patient with low or intermediate Framingham risk score who has already undergone another imaging risk assessment (eg, carotid IMT or coronary artery calcium scoring). The technical panel rated assessment of the patient with intermediate or high Framingham risk score and without prior imaging risk assessment study as uncertain indications for carotid ultrasound, reflecting again the need for outcome and clinical effectiveness data for these screening indications.

Section 3. Renal and Mesenteric Artery Duplex

Table 3.1

Evaluation for Renal Artery Stenosis—Potential Signs and/or Symptoms

	Indication	Appropriate Use Score (1–9)
	Creatinine Elevation and/or Hypertension	
34.	• Malignant hypertension (see Assumptions)	**A (8)**
35.	• Resistant hypertension (see Assumptions)	**A (8)**

Indication		Appropriate Use Score (1–9)
36.	• Worsening blood pressure control in long-standing hypertensive patient	**A (8)**
37.	• Hypertension in young person (age <35 years)	**A (8)**
38.	• Unexplained size discrepancy between kidneys (>1.5 cm; in longest dimension)	**A (7)**
39.	• Unknown cause of azotemia (eg, unexplained increase in creatinine)	**A (7)**
40.	• Increased creatinine (>50% baseline or above normal levels) after the administration of ACE/ARBs	**A (8)**
41.	• Acute renal failure with aortic dissection	**A (8)**
42.	• Epigastric bruit	**A (7)**
	Heart Failure of Unknown Origin	
43.	• Refractory CHF	**A (7)**
44.	• "Flash" pulmonary edema	**A (8)**

ACE = angiotensin-converting enzyme inhibitor; ARB = angiotensin II receptor blocker; CHF = congestive heart failure.

Table 3.2

Screening for Renal Artery Stenosis—Asymptomatic

Indication		Appropriate Use Score (1–9)
45.	• Atherosclerotic vascular disease in other beds (eg, peripheral artery disease) and well-controlled hypertension	**I (3)**
46.	• Unexplained size discrepancy between kidneys (>1.5 cm; in longest dimension) as discovered by CT or ultrasound	**U (4)**

CT = computed tomography; I = inappropriate; U = uncertain.

Table 3.3

Evaluation for Mesenteric Artery Stenosis—Potential Signs and/or Symptoms

Indication		Appropriate Use Score (1–9)
	Symptomatic	
47.	• Evaluate for acute abdominal pain "out of proportion to exam" • Leukocytosis, "thumbprinting," pneumatosis or hemoconcentration, and acidosis with or without elevated amylase, alkaline phosphatase, or CPK	**I (3)**
48.	• Postprandial pain or weight loss not otherwise explained • GI evaluation previously completed	**A (8)**
49.	• Postprandial pain or discomfort • GI evaluation not yet undertaken	**U (5)**
50.	• Chronic constipation or diarrhea • GI evaluation not yet undertaken	**I (3)**
51.	• Unexplained or unintended weight loss	**U (5)**
52.	• Abdominal or epigastric bruit	**U (4)**

A = appropriate; CPK = creatine phosphokinase; GI = gastrointestinal; I = inappropriate; U = uncertain.

Table 3.4

Follow–Up Testing for Renal Artery Stenosis—Asymptomatic

Indication		Appropriate Use Score (1–9)
53.	• Prior imaging indicates renal artery stenosis	**A (7)**

Indication		Appropriate Use Score (1–9)
	• Determine hemodynamic significance	
54.	• Surveillance of known renal artery stenosis	**U (6)**

A = appropriate; U = uncertain.

Table 3.5

Surveillance After Renal or Mesenteric Artery Revascularization

Indication		Appropriate Use Score (1–9)		
	Asymptomatic			
55.	• Baseline surveillance (within 1 month) after revascularization	**A (8)**		
	New or Worsening Symptoms After Baseline			
56.	• After renal or mesenteric artery revascularization	**A (8)**		
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency During First Year	**At 3 to 5 months**	**At 6 to 8 months**	**At 9 to 12 months**
57.	• During first 12 months after endovascular revascularization	**I (3)**	**U (6)**	**U (6)**
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency After First Year	**Every 6 months**	**Every 12 months**	**Every 24 months or greater**
58.	• After first 12 months after endovascular revascularization	**I (3)**	**A (7)**	**U (5)**

A = appropriate; I = inappropriate; U = uncertain.

Summary: Renal and Mesenteric Artery Ultrasound—In this section, the ratings were found to be appropriate for the hypertension, creatinine, and heart failure indications in evaluating for renal artery stenosis. The only appropriate indication for duplex investigation of mesenteric artery stenosis was for the patients with symptoms of postprandial pain and weight loss and who have undergone a gastrointestinal (GI) evaluation. Surveillance after renal or mesenteric artery revascularization was deemed to be appropriate at 1 month following the procedure to establish a baseline and any time there are new signs or symptoms. Surveillance every 12 months was the only follow-up time frame rated appropriate after endovascular and surgical revascularization. Routine surveillance following surgical renal or mesenteric revascularization is generally not required in the absence of recurrent or worsening symptoms.

Section 4. Aortic and Aortoiliac Duplex

Table 4.1

Evaluation for Abdominal Aortic Disease—Signs and/or Symptoms

Indication		Appropriate Use Score (1–9)
59.	• Lower extremity claudication	**A (7)**
60.	• Nonspecific lower extremity discomfort	**I (3)**
61.	• New onset abdominal or back pain	**U (6)**

Indication		Appropriate Use Score (1–9)
62.	• Aneurysmal femoral or popliteal pulse	**A (8)**
63.	• Pulsatile abdominal mass	**A (9)**
64.	• Decreased or absent femoral pulse	**A (7)**
65.	• Abdominal or femoral bruit	**A (7)**
66.	• Fever of unknown origin	**I (3)**
67.	• Lower extremity swelling	**I (2)**
68.	• Evidence of atheroemboli in the lower extremities, including ischemic toes	**A (8)**
69.	• Erectile dysfunction	**U (4)**
70.	• Abnormal physiologic testing indicating aortoiliac occlusive disease	**A (8)**
71.	• Hypertension	**I (3)**
72.	• Abnormal abdominal x-ray suggestive of aneurysm	**A (8)**
73.	• Presence of a lower extremity arterial aneurysm (eg, femoral or popliteal)	**A (8)**
74.	• Presence of a thoracic aortic aneurysm	**A (8)**

A = appropriate; I = inappropriate; U = uncertain.

Table 4.2

Screening for Abdominal Aortic Aneurysm—Asymptomatic

Indication		Appropriate Use Score (1–9)
75.	• Men age >60 years • First degree relative with an abdominal aortic aneurysm	**A (8)**
76.	• Women age >60 years • First degree relative with an abdominal aortic aneurysm	**A (8)**
77.	• Men age 65 to 75 years • Current or former smoker	**A (8)**
78.	• Women age 65 to 75 years • Current or former smoker	**A (7)**
79.	• Age >75 years • Current or former smoker	**A (7)**
80.	• Age ≥65 years • No history of smoking	**U (5)**
81.	• Age <65 years • No history of smoking	**I (3)**

A = appropriate; I = inappropriate; U = uncertain.

Table 4.3

Surveillance of Known Abdominal Aortic Aneurysm

Indication		Appropriate Use Score (1–9)		
	New or Worsening Symptoms			
82.	• Known abdominal aortic aneurysm (any size)	**A (9)**		
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency During First Year	**At 3 to 5 months**	**At 6 to 8 months**	**At 9 to 12 months**
83.	• Men, aneurysm 3.0 to 3.9 cm in diameter	**I (1)**	**U (4)**	**A (7)**
84.	• Women, aneurysm 3.0 to 3.9 cm in diameter	**I (1)**	**U (4)**	**A (7)**

Indication		Appropriate Use Score (1–9)		
85.	• Aneurysm 4.0 to 5.4 cm in diameter	**U (4)**	**A (7)**	**A (7)**
86.	• Aneurysm ≥5.5 cm in diameter	**A (7)**	**A (7)**	**U (6)**
Asymptomatic or Stable Symptoms, No or Slow Progression During First Year, Surveillance Frequency After First Year		**Every 6 months**	**Every 12 months**	**Every 24 months or greater**
87.	• Men, aneurysm 3.0 to 3.9 cm in diameter	**I (2)**	**A (7)**	**A (7)**
88.	• Women, aneurysm 3.0 to 3.9 cm in diameter	**I (2)**	**A (7)**	**A (7)**
89.	• Aneurysm 4.0 to 5.4 cm in diameter	**U (5)**	**A (7)**	**U (6)**
90.	• Aneurysm ≥5.5 cm in diameter	**A (8)**	**A (7)**	**U (5)**
Asymptomatic or Stable Symptoms, Rapid Progression During First Year, Surveillance Frequency After First Year		**Every 6 months**	**Every 12 months**	**Every 24 months or greater**
91.	• Men, aneurysm 3.0 to 3.9 cm in diameter	**A (7)**	**A (7)**	**U (4)**
92.	• Women, aneurysm 3.0 to 3.9 cm in diameter	**A (8)**	**A (7)**	**U (4)**
93.	• Aneurysm 4.0 to 5.4 cm in diameter	**A (8)**	**A (7)**	**U (4)**
94.	• Aneurysm ≥5.5 cm in diameter	**A (9)**	**U (5)**	**I (3)**

A = appropriate; I = inappropriate; U = uncertain.

Table 4.4

Surveillance After Aortic Endograft or Aortoiliac Stenting

Indication		Appropriate Use Score (1–9)		
Baseline (Within 1 Month After the Intervention)				
95.	• Aortic or iliac endograft		**A (8)**	
96.	• Aortic and iliac artery stents		**A (7)**	
New or Worsening Lower Extremity Symptoms After Baseline Exam				
97.	• Aortic or iliac endograft		**A (8)**	
98.	• Aortic and iliac artery stents		**A (8)**	
Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency During First Year		**At 3 to 5 months**	**At 6 to 8 months**	**At 9 to 12 months**
99.	• Aortic endograft without endoleak stable and/or decreasing residual aneurysm sac size	**I (3)**	**U (5)**	**U (6)**
100.	• Aortic endograft with endoleak and/or increasing residual aneurysm sac size	**U (6)**	**A (8)**	**A (7)**
101.	• Aortic or iliac artery stents	**I (2)**	**U (5)**	**U (6)**
Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency After First Year		**Every 6 months**	**Every 12 months**	**Every 24 months or greater**
102.	• Aortic endograft without endoleak stable and/or decreasing residual aneurysm sac size	**I (3)**	**A (7)**	**U (5)**
103.	• Aortic endograft with endoleak and/or increasing residual aneurysm sac size	**A (8)**	**A (7)**	**U (5)**

Indication		Appropriate Use Score (1–9)		
104.	• Aortic or iliac artery stents	**I (2)**	**U (5)**	**U (5)**

A = appropriate; I = inappropriate; U = uncertain.

Summary: Aortic and Aortoiliac Artery Duplex—Signs and symptoms considered as appropriate indications for duplex evaluation of the abdominal aorta and iliac arteries included intermittent claudication, an aneurysmal femoral or popliteal pulse, a pulsatile abdominal mass, a decreased or absent femoral pulse, and an abdominal or femoral bruit. Inappropriate indications included nonspecific lower extremity discomfort, fever of unknown origin, lower extremity swelling, and hypertension. Erectile dysfunction was the only indication rated as uncertain.

Ultrasound screening of asymptomatic individuals for abdominal aortic aneurysms was considered appropriate in men and women over age 60 who were known to have first-degree relatives with an abdominal aortic aneurysm. Screening was also appropriate for men and women between 65 and 75 years of age who were current or former smokers and any current or former smoker over age 75. However, ultrasound screening was inappropriate for individuals under age 65 with no history of smoking. There was uncertainty over the role of screening for those age 65 and older with no history of smoking.

The reviewers concurred with the primary recommendation of the U.S. Preventive Services Task Force (USPSTF) that screening for abdominal aortic aneurysms was appropriate for men aged 65 to 75 years who had ever smoked.[12] However, the reviewers also considered screening appropriate in both men and women who had a first-degree relative with an abdominal aortic aneurysm, a situation that was acknowledged in the USPSTF report by stating that “clinicians must individualize recommendations depending on a patient’s risk and likelihood of benefit.” Although the reviewers rated aneurysm screening as appropriate in women aged 65 to 75 years who were current or former smokers, the USPSTF recommended against routine screening in women, based on the low prevalence of large abdominal aortic aneurysms and concern that the harms of screening outweighed the benefits. The reviewers also considered screening appropriate for patients over 75 years of age who were current or former smokers, even though the USPSTF set an upper age limit for screening of 75 years, since the increased prevalence of comorbidities would decrease the chances that older patients would benefit from screening. It is important to note that the purpose of the USPSTF recommendations differ from that of this AUC document. The USPSTF provides guidance on whether population-based screening is generally recommended whereas AUC look at how reasonable testing may be for specific patient populations.

The reviewers’ ratings were generally consistent with recommendations for aneurysm screening from the Society for Vascular Surgery (SVS) and the American College of Cardiology (ACC)/American Heart Association (AHA) 2005 Practice Guidelines.[13,14] The SVS recommends 1-time ultrasound screening for all men at age 65 or older, or at age 55 or older for men with a positive family history for abdominal aortic aneurysms. For women,

the SVS recommends screening at age 65 or older if they have ever smoked or have a positive family history. The ACC/AHA guidelines recommend aneurysm screening for high-risk populations, defined as men 60 years of age or older with first-degree relatives who have abdominal aortic aneurysms and men 65 to 75 years of age who have ever smoked.

For surveillance of a known abdominal aortic aneurysm of any size, duplex ultrasound was rated as appropriate. When patients who were asymptomatic or had stable symptoms were considered according to aneurysm size and surveillance frequency, follow-up at 9 to 12 months after a baseline study was rated as appropriate for aneurysms 3.0 cm to 3.9 cm in diameter in both men and women. Earlier follow up at 3 to 5 months after a baseline study was inappropriate, and the value of follow-up at 6 to 8 months was uncertain. After the first year, follow-up was rated as appropriate for aneurysms 3.0 cm to 3.9 cm in diameter at either 12-month or 24-month intervals for those patients with no or slow progression during the first year.

For patients with aneurysms of 4.0 cm to 5.4 cm, surveillance at intervals of 6 to 8 months or 9 to 12 months after a baseline study was appropriate. Surveillance for aneurysms of 5.5 cm or more in diameter was appropriate at 3 to 5 months and 6 to 8 months in the first year and intervals of 6 months and 12 months after the first year, assuming no or slow progression. When rapid progression was observed on serial studies, follow-up was appropriate at 6-month and 12-month intervals for aneurysms 3.0 cm to 3.9 cm in diameter and those 4.0 cm to 5.4 cm in diameter. However, for aneurysms of 5.5 cm or more in diameter with rapid progression, follow up was rated as appropriate only at 6-month intervals, whereas the value of follow-up at 12-month intervals was uncertain, and follow-up at 24-month intervals was inappropriate. Since patients with aneurysms of 5.5 cm or more in diameter are usually considered for elective repair, the role of continued surveillance must be individualized. If a patient has reversible or time-limited factors that prevent elective aneurysm repair, then ongoing surveillance may play a role in clinical decision making. However, if a patient declines elective repair, or is not considered a candidate for repair under any circumstances, then the value of surveillance is questionable.

After an aortic endograft or aortoiliac stenting, duplex scanning was appropriate as a baseline study (within 1 month), as well as for any subsequent new or worsening lower extremity symptoms. For aortic endograft patients with stable or decreasing residual aneurysm sac size and without evidence of endoleak during the first year, duplex follow-up was rated as inappropriate at 3 to 5 months and uncertain at both 6 to 8 months and 9 to 12 months. However, in the presence of an endoleak or increasing residual aneurysm sac size during the first year, follow-up was considered appropriate at either at 6 to 8 months or 9 to 12 months. For asymptomatic patients and those with stable symptoms during the first year after aortic or iliac artery stenting, duplex follow-up was rated as inappropriate at 3 to 5 months and uncertain at 6 to 8 months and 9 to 12 months. Similarly, follow-up every 6 months or 12 months was inappropriate and follow-up every 24 months or greater was considered as uncertain for aortic or iliac artery stent patients who were asymptomatic or had stable symptoms after the first year. Follow-up of aortic endografts without evidence of endoleak and stable or decreasing residual aneurysm sac size after the first year was appropriate at 12-month intervals. When there was an endoleak or increasing residual

aneurysm sac size after the first year, follow-up was appropriate at either 6-month or 12-month intervals.

Section 5. Lower Extremity Artery Testing Using Multilevel Physiological Testing Alone or Duplex Ultrasound With Single-Level ABI and PVR

Table 5.1

Evaluation for Lower Extremity Atherosclerotic Disease—Potential Signs and/or Symptoms

	Indication	Appropriate Use Score (1–9)
105.	• Lower extremity claudication	**A (9)**
106.	• Leg/foot/toe pain at rest	**A (9)**
107.	• Foot or toe ulcer or gangrene	**A (9)**
108.	• Infection of leg/foot without palpable pulses	**A (9)**
109.	• Suspected acute limb ischemia (eg, cold, painful limb with pallor, pulselessness, parasthesias)	**A (9)**
110.	• Nocturnal leg cramps • Normal pulses	**I (2)**
111.	• Lack of hair growth on dorsum of foot or toes • Normal pulses	**I (2)**
112.	• Evidence of atheroemboli in the lower extremities	**A (8)**
113.	• Lower extremity swelling • Normal pulses	**I (2)**
114.	• Diabetes with peripheral neuropathy • Normal pulses	**I (3)**

A = appropriate; I = inappropriate.

Table 5.2

Surveillance of Known Lower Extremity PAD

	Indication	Appropriate Use Score (1–9)		
	New or Worsening Symptoms			
115.	• Normal baseline study	**A (7)**		
116.	• Abnormal baseline ABI (ie, ABI ≤0.90)	**A (8)**		
	No Change in Symptom Status (No revascularization)			
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency During First Year	**At 3 to 5 months**	**At 6 to 8 months**	**At 9 to 12 months**
117.	• Normal baseline ABI (no stenosis)	**I (1)**	**I (1)**	**I (1)**
118.	• Mild or moderate disease (eg, ABI >0.4)	**I (2)**	**I (2)**	**U (4)**
119.	• Severe (eg, ABI <0.4)	**I (3)**	**U (5)**	**U (5)**
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency After First Year	**Every 6 months**	**Every 12 months**	**Every 24 months or greater**
120.	• Normal baseline ABI (no stenosis)	**I (1)**	**I (1)**	**I (2)**
121.	• Mild or moderate disease (eg, ABI >0.4)	**I (2)**	**I (2)**	**U (4)**
122.	• Severe (eg, ABI <0.4)	**U (4)**	**U (4)**	**I (3)**

A = appropriate; ABI = ankle-brachial index; I = inappropriate; PAD = peripheral artery disease; U = uncertain.

Table 5.3

Surveillance of Lower Extremity PAD After Revascularization (Duplex/ABI)

Indication		Appropriate Use Score (1–9)		
123.	• Baseline surveillance (within 1 month)	**A (8)**		
	New or Worsening Symptoms			
124.	• After revascularization (angioplasty ± stent or bypass)	**A (9)**		
	Asymptomatic or Stable Symptoms			
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency During First Year	**At 3 to 5 months**	**At 6 to 8 months**	**At 9 to 12 months**
125.	• After angioplasty ± stent placement	**I (2)**	**U (6)**	**U (6)**
126.	• After vein bypass graft	**U (6)**	**A (8)**	**U (6)**
127.	• After prosthetic bypass graft	**U (5)**	**A (7)**	**U (5)**
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency After First Year	**Every 6 months**	**Every 12 months**	**Every 24 months or greater**
128.	• After angioplasty ± stent placement	**I (3)**	**A (7)**	**U (5)**
129.	• After vein bypass graft	**U (5)**	**A (7)**	**U (5)**
130.	• After prosthetic bypass graft	**I (3)**	**A (7)**	**U (5)**

A = appropriate; I = inappropriate; PAD = peripheral artery disease; U = uncertain.

Section 6. Lower Extremity Artery Testing With ABI Only

Table 6.1

Screening for Lower Extremity Atherosclerotic Disease—Potential Signs

Indication		Appropriate Use Score (1–9)
131.	• Diminished pulses	**A (7)**
132.	• Femoral bruit	**A (7)**

A = appropriate.

Table 6.2

Screening for Lower Extremity Atherosclerotic Disease—Asymptomatic With Comorbidities

Indication		Appropriate Use Score (1–9)
133.	• Age >50 years • With diabetes	**A (7)**
134.	• Age <50 years • With diabetes	**U (5)**
135.	• Age >50 years • Cigarette smoking (current or past)	**A (7)**
136.	• Age >70 years	**A (7)**

A = appropriate; U = uncertain.

Section 7. Lower Extremity Artery Testing With Duplex Ultrasound Only

Table 7.1

Evaluation for Groin Complication After Femoral Access

Indication		Appropriate Use Score (1–9)
137.	• Pulsatile groin mass	**A (9)**
138.	• Bruit or thrill over the groin	**A (8)**
139.	• Ecchymosis	**U (4)**
140.	• Significant hematoma	**A (7)**
141.	• Severe pain within groin post procedure	**A (7)**

A = appropriate; U = uncertain.

Section 8. Upper Extremity Arterial Testing—Physiological Testing or Duplex Ultrasound Study

Table 8.1

Evaluation for Upper Extremity PAD—Potential Signs and/or Symptoms

Indication		Appropriate Use Score (1–9)
142.	• Arm or hand claudication	**A (8)**
143.	• Finger discoloration or ulcer	**A (8)**
144.	• Unilateral cold painful hand	**A (8)**
145.	• Raynaud's phenomenon	**U (5)**
146.	• Suspected positional arterial obstruction (eg, thoracic outlet syndrome)	**A (7)**
147.	• Upper extremity trauma with suspicion of vascular injury	**A (8)**
148.	• Discrepancy in arm pulses or blood pressure discrepancy of >20 mm Hg between arms	**U (6)**
149.	• Periclavicular bruit	**U (5)**
150.	• Pre-op radial artery harvest (eg, for CABG)	**A (7)**
151.	• Presence of pulsatile mass or hand ischemia after upper extremity vascular access	**A (8)**
152.	• Presence of bruit after upper extremity access for intervention	**A (8)**

A = appropriate; CABG = coronary artery bypass graft; PAD = peripheral artery disease; U = uncertain.

Table 8.2

Surveillance of Upper Extremity PAD After Revascularization

Indication		Appropriate Use Score (1–9)		
153.	• Baseline (within 1 month)	**A (8)**		
	New or Worsening Symptoms			
154.	• After revascularization (stent or bypass)	**A (8)**		
155.	• Post trauma	**A (8)**		
Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency During First Year		**At 3 to 5 months**	**At 6 to 8 months**	**At 9 to 12 months**
156.	• After vein bypass graft	**U (6)**	**A (7)**	**U (5)**
157.	• After prosthetic bypass graft	**I (3)**	**U (6)**	**U (4)**

Indication		Appropriate Use Score (1–9)		
Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency After First Year		Every 6 months	Every 12 months	Every 24 months or greater
158.	• After vein bypass graft	**U (4)**	**A (7)**	**U (5)**
159.	• After prosthetic bypass graft	**U (4)**	**A (7)**	**U (4)**

A = appropriate; I = inappropriate; PAD = peripheral artery disease; U = uncertain.

Summary: Upper and Lower Extremity Artery Testing—The screening of asymptomatic individuals with ABI alone in this document is also addressed by the USPSTF. The rating of "uncertain" in this document is not consistent with that of the USPSTF where this type of evaluation was not deemed appropriate, or level D. There have been published responses to the USPSTF stance pointing out that ABI evaluation of certain populations would identify a high-risk group for heart attack, stroke, and death.[15] The ACC/AHA guidelines and the American Diabetes Association Guidelines advocate ABI testing in certain disease populations such as those age >50 years with diabetes or chronic smoking. The designation of "uncertain" in this document is reflective of a paucity of data regarding ABI evaluation alone in asymptomatic individuals and effect on prevention of claudication and limb loss. The designation of "uncertain" is not meant to address the potential impact of ABI evaluation on heart attack and stroke outcome. The AUC ratings are meant to determine when diagnostic testing may be a reasonable option under certain clinical circumstances. They are not intended to endorse or imply population-wide screening protocols that are the focus of the USPSTF.

The appropriate indications for lower extremity testing using multilevel physiological methods alone or duplex ultrasound with single-level ABI and pulse volume recording (PVR) were clearly delineated by the reviewers with 6 appropriate and 4 inappropriate. None of the indications were deemed uncertain. Nocturnal leg cramps, neuropathy, lower extremity swelling or hair loss in the setting of normal pulses are not clinical scenarios that support ordering lower extremity artery tests.

There are 2 clear appropriate indications for surveillance of known lower extremity arterial disease, patients with either a normal ABI or an abnormal ABI with new or worsening symptoms. A short follow-up interval of every 6 months is not indicated, whereas it was uncertain whether every 12 months or every 24 months or greater was appropriate for follow-up testing. A baseline study after lower extremity revascularization was deemed appropriate, as was testing for new or worsening symptoms after revascularization. A follow-up interval for surveillance after baseline evaluation was thought most appropriate at 12 months if the patient is stable without new or worsening symptoms. The most appropriate time for surveillance after lower extremity prosthetic or vein bypass graft was 6to 8 months after the procedure.

The appropriate indications for lower extremity artery testing with ABI only were diminished pulses, femoral bruit, age >50 years with diabetes or smoking, and age >70

years, which is consistent with ACC/AHA peripheral artery disease (PAD) guidelines. The evaluation with ABI only for those age <50 years with diabetes was uncertain.

The appropriate indications for lower extremity duplex ultrasound evaluation only included a pulsatile groin mass, bruit or thrill, significant hematoma, or groin pain postprocedure. The presence of ecchymosis only was an uncertain indication.

The appropriate indications for upper extremity arterial testing included claudication, ulcer, unilateral cold painful hand, suspected positional arterial obstruction, and trauma with suspicion of vascular injury. The presence of Raynaud's phenomenon was an uncertain indication. A preoperative evaluation for a procedure such as radial artery harvest or suspected complication after an upper extremity arterial intervention was also appropriate indications for testing.

Similar to the lower extremity, a baseline study after revascularization and new or worsening symptoms are appropriate indications for upper extremity arterial testing. The most appropriate initial surveillance time interval after upper extremity revascularization with either vein or prosthetic bypass graft was at 12 months. A surveillance period of every 6 months after initial postoperative evaluation was most inappropriate for asymptomatic patients.

7. PERIPHERAL VASCULAR ULTRASOUND AND PHYSIOLOGICAL TESTING APPROPRIATE USE CRITERIA (BY RATING)

Table 9

Appropriate Indications (Median Rating 7–9)

	Indication	Appropriate Use Score (1–9)
	Extracranial Cerebrovascular Ultrasound	
	Evaluation for Cerebrovascular Disease—Potential Signs and/or Symptoms	
1.	• New or worsening hemispheric neurological symptoms (eg, unilateral motor or sensory deficit, speech impairment, or amaurosis fugax) • Evaluation of transient ischemic attack or stroke	**A (9)**
2.	• Hollenhorst plaque visualized on retinal examination	**A (8)**
3.	• Lightheadedness or impaired vision in the setting of upper extremity exertion • Evaluation for subclavian-vertebral steal phenomenon	**A (7)**
5.	• Suspected symptomatic vertebrobasilar occlusive disease in the symptomatic patient (eg, vertigo, ataxia, diplopia, dysphagia, dysarthria)	**A (7)**
6.	• Evaluation for suspected carotid artery dissection	**A (8)**
7.	• Pulsatile neck mass	**A (8)**
8.	• Cervical bruit • No prior carotid artery assessment	**A (7)**
	Evaluation for Cerebrovascular Disease—Asymptomatic With Comorbidities or Risk Factors for Carotid Artery Stenosis	
9.	• No cervical bruit • Atherosclerotic disease in other vascular beds (eg, lower extremity PAD, coronary artery disease, abdominal aortic aneurysm)	**A (7)**
	Follow-up or Surveillance for Carotid Artery Stenosis—Asymptomatic[*†]	

	Indication	Appropriate Use Score (1–9)
	Surveillance Frequency During First Year	
20.	• Severe ICA stenosis (eg, 70% to 99%) • At 6 to 8 months	**A (7)**
	Surveillance Frequency After First Year	
23.	• Moderate ICA stenosis (eg, 50% to 69%) • Every 12 months	**A (7)**
24.	• Severe ICA stenosis (eg, 70% to 99%) • Every 6 months	**A (7)**
24.	• Severe ICA stenosis (eg, 70% to 99%) • Every 12 months	**A (7)**
	Surveillance After Carotid Artery Intervention	
	Surveillance Frequency During First Year	
25.	• Baseline (within 1 month) after carotid intervention	**A (8)**
26.	• Following normal ipsilateral ICA baseline study • Surveillance at 6 to 8 months	**A (7)**
26.	• Following normal ipsilateral ICA baseline study • Surveillance at 9 to 12 months	**A (7)**
27.	• Following abnormal ipsilateral ICA baseline study • Surveillance at 6 to 8 months	**A (7)**
	Surveillance Frequency After First Year	
28.	• Following normal ipsilateral ICA baseline study • Surveillance every 12 months	**A (7)**
29.	• Following abnormal ipsilateral ICA baseline study • Surveillance every 12 months	**A (7)**
	Renal and Mesenteric Artery Duplex	
	Evaluation for Renal Artery Stenosis—Potential Signs and/or Symptoms	
	Creatinine Elevation and/or Hypertension	
34.	• Malignant hypertension (>160/80 mm Hg)	**A (8)**
35.	• Resistant hypertension (>140/90 mm Hg on ≥3 meds)	**A (8)**
36.	• Worsening blood pressure control in long-standing hypertensive patient	**A (8)**
37.	• Hypertension in young person (age <35 years)	**A (8)**
38.	• Unexplained size discrepancy between kidneys (>1.5 cm; in longest dimension)	**A (7)**
39.	• Unknown cause of azotemia (eg, unexplained increase in creatinine)	**A (7)**
40.	• Increased creatinine (>50% baseline or above normal levels) after the administration of ACE/ARBs	**A (8)**
41.	• Acute renal failure with aortic dissection	**A (8)**
42.	• Epigastric bruit	**A (7)**
	Heart Failure of Unknown Origin	
43.	• Refractory heart failure	**A (7)**
44.	• “Flash” pulmonary edema	**A (8)**
	Evaluation for Mesenteric Artery Stenosis—Potential Signs and/or Symptoms	
	Symptomatic	
48.	• Post prandial pain or weight loss not otherwise explained • GI evaluation previously completed	**A (8)**
	Follow-up Testing for Renal Artery Stenosis—Asymptomatic	
53.	• Prior imaging indicates renal artery stenosis • Determine hemodynamic significance	**A (7)**

	Indication	Appropriate Use Score (1–9)
	Surveillance After Renal or Mesenteric Artery Revascularization	
	Asymptomatic	
55.	• Baseline surveillance (within 1 month) after revascularization	**A (8)**
	New or Worsening Symptoms After Baseline	
56.	• After renal or mesenteric artery revascularization	**A (8)**
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency After First Year	
58.	• After first 12 months after endovascular revascularization • Surveillance every 12 months	**A (7)**
	Aortic and Aortoiliac Duplex	
	Evaluation for Abdominal Aortic Disease—Signs and/or Symptoms	
59.	• Lower extremity claudication	**A (7)**
62.	• Aneurysmal femoral or popliteal pulse	**A (8)**
63.	• Pulsatile abdominal mass	**A (9)**
64.	• Decreased or absent femoral pulse	**A (7)**
65.	• Abdominal or femoral bruit	**A (7)**
68.	• Evidence of atheroemboli in the lower extremities, including ischemic toes	**A (8)**
70.	• Abnormal physiologic testing indicating aortoiliac occlusive disease	**A (8)**
72.	• Abnormal abdominal x-ray suggestive of aneurysm	**A (8)**
73.	• Presence of a lower extremity arterial aneurysm (eg, femoral or popliteal)	**A (8)**
74.	• Presence of a thoracic aortic aneurysm	**A (8)**
	Screening for Abdominal Aortic Aneurysm—Asymptomatic	
75.	• Men age >60 years • First degree relative with an abdominal aortic aneurysm	**A (8)**
76.	• Women age >60 years • First degree relative with an abdominal aortic aneurysm	**A (8)**
77.	• Men age 65 to 75 years • Current or former smoker	**A (8)**
78.	• Women age 65 to 75 years • Current or former smoker	**A (7)**
79.	• Age >75 years • Current or former smoker	**A (7)**
	Surveillance of Known Abdominal Aortic Aneurysm	
	New or Worsening Symptoms	
82.	• Known abdominal aortic aneurysm (any size)	**A (9)**
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency During First Year	
83.	• Men, aneurysm 3.0 to 3.9 cm in diameter • Surveillance at 9 to 12 months	**A (7)**
84.	• Women, aneurysm 3.0 to 3.9 cm in diameter • Surveillance at 9 to 12 months	**A (7)**
85.	• Aneurysm 4.0 to 5.4 cm in diameter • Surveillance at 6 to 8 months	**A (7)**
85.	• Aneurysm 4.0 to 5.4 cm in diameter • Surveillance at 9 to 12 months	**A (7)**
86.	• Aneurysm ≥5.5 cm in diameter • Surveillance at 3 to 5 months	**A (7)**
86.	• Aneurysm ≥5.5 cm in diameter • Surveillance at 6 to 8 months	**A (7)**

	Indication	Appropriate Use Score (1–9)
	Asymptomatic or Stable Symptoms, No or Slow Progression During First Year, Surveillance Frequency After First Year	
87.	• Men, aneurysm 3.0 to 3.9 cm in diameter • Surveillance every 12 months	**A (7)**
87.	• Men, aneurysm 3.0 to 3.9 cm in diameter • Surveillance every 24 months or greater	**A (7)**
88.	• Women, aneurysm 3.0 to 3.9 cm in diameter • Surveillance every 12 months	**A (7)**
88.	• Women, aneurysm 3.0 to 3.9 cm in diameter • Surveillance every 24 months or greater	**A (7)**
89.	• Aneurysm 4.0 to 5.4 cm in diameter • Surveillance every 12 months	**A (7)**
90.	• Aneurysm ≥5.5 cm in diameter • Surveillance every 6 months	**A (8)**
90.	• Aneurysm ≥5.5 cm in diameter • Surveillance every 12 months	**A (7)**
	Asymptomatic or Stable Symptoms, Rapid Progression During First Year, Surveillance Frequency After First Year	
91.	• Men, aneurysm 3.0 to 3.9 cm in diameter • Surveillance every 6 months	**A (7)**
91.	• Men, aneurysm 3.0 to 3.9 cm in diameter • Surveillance every 12 months	**A (7)**
92.	• Women, aneurysm 3.0 to 3.9 cm in diameter • Surveillance every 6 months	**A (8)**
92.	• Women, aneurysm 3.0 to 3.9 cm in diameter • Surveillance every 12 months	**A (7)**
93.	• Aneurysm 4.0 to 5.4 cm in diameter • Surveillance every 6 months	**A (8)**
93.	• Aneurysm 4.0 to 5.4 cm in diameter • Surveillance every 12 months	**A (7)**
94.	• Aneurysm ≥5.5 cm in diameter • Surveillance every 6 months	**A (9)**
	Surveillance After Aortic Endograft or Aortoiliac Stenting	
	Baseline (Within 1 Month After the Intervention)	
95.	• Aortic or iliac endograft	**A (8)**
96.	• Aortic and iliac artery stents	**A (7)**
	New or Worsening Lower Extremity Symptoms After Baseline Exam	
97.	• Aortic or iliac endograft	**A (8)**
98.	• Aortic and iliac artery stents	**A (8)**
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency During First Year	
100.	• Aortic endograft with endoleak and/or increasing residual aneurysm sac size • Surveillance at 6 to 8 months	**A (8)**
100.	• Aortic endograft with endoleak and/or increasing residual aneurysm sac size • Surveillance at 9 to 12 months	**A (7)**
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency After First Year	
102.	• Aortic endograft without endoleak stable and/or decreasing residual aneurysm sac size • Surveillance every 12 months	**A (7)**
103.	• Aortic endograft with endoleak and/or increasing residual aneurysm sac size • Surveillance every 6 months	**A (8)**

Indication		Appropriate Use Score (1–9)
103.	• Aortic endograft with endoleak and/or increasing residual aneurysm sac size • Surveillance every 12 months	**A (7)**
Lower Extremity Artery Testing Using Multilevel Physiological Testing Alone or Duplex Ultrasound With Single Level ABI and PVR Evaluation for Lower Extremity Atherosclerotic Disease—Potential Signs and/or Symptoms		
105.	• Lower extremity claudication	**A (9)**
106.	• Leg/foot/toe pain at rest	**A (9)**
107.	• Foot or toe ulcer or gangrene	**A (9)**
108.	• Infection of leg/foot without palpable pulses	**A (9)**
109.	• Suspected acute limb ischemia (eg, cold, painful limb with pallor, pulselessness, parasthesias)	**A (9)**
112.	• Evidence of atheroemboli in the lower extremities	**A (8)**
Surveillance of Known Lower Extremity PAD		
New or Worsening Symptoms		
115.	• Normal baseline study	**A (7)**
116.	• Abnormal baseline ABI (ie, ABI <0.90)	**A (8)**
Surveillance of Lower Extremity PAD After Revascularization (Duplex/ABI)		
123.	• Baseline Surveillance (within 1 month)	**A (8)**
New or Worsening Symptoms		
124.	• After revascularization (angioplasty ± stent or bypass)	**A (9)**
Asymptomatic or Stable Symptoms		
Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency During First Year		
126.	• After vein bypass graft • Surveillance at 6 to 8 months	**A (8)**
127.	• After prosthetic bypass graft • Surveillance at 6 to 8 months	**A (7)**
Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency After First Year		
128.	• After angioplasty ± stent placement • Surveillance every 12 months	**A (7)**
129.	• After vein bypass graft • Surveillance every 12 months	**A (7)**
130.	• After prosthetic bypass graft • Surveillance every 12 months	**A (7)**
Lower Extremity Artery Testing With ABI Only		
Screening for Lower Extremity Atherosclerotic Disease—Potential Signs		
131.	• Diminished pulses	**A (7)**
132.	• Femoral bruit	**A (7)**
Lower Extremity Artery Testing With ABI Only		
Screening for Lower Extremity Atherosclerotic Disease—Asymptomatic With Comorbidities		
133.	• Age >50 years • With diabetes	**A (7)**
135.	• Age >50 years • Cigarette smoking (current or past)	**A (7)**
136.	• Age >70 years	**A (7)**
Lower Extremity Artery Testing With Duplex Ultrasound Only		
Evaluation for Groin Complication After Femoral Access		
137.	• Pulsatile groin mass	**A (9)**

Indication		Appropriate Use Score (1–9)
138.	• Bruit or thrill over the groin	**A (8)**
140.	• Significant hematoma	**A (7)**
141.	• Severe pain within groin post procedure	**A (7)**
	Upper Extremity Arterial Testing—Physiological Testing or Duplex Ultrasound Study	
	Evaluation for Upper Extremity PAD—Potential Signs and/or Symptoms	
142.	• Arm or hand claudication	**A (8)**
143.	• Finger discoloration or ulcer	**A (8)**
144.	• Unilateral cold painful hand	**A (8)**
146.	• Suspected positional arterial obstruction (eg, thoracic outlet syndrome)	**A (7)**
147.	• Upper extremity trauma with suspicion of vascular injury	**A (8)**
150.	• Pre-op radial artery harvest (eg, for CABG)	**A (7)**
151.	• Presence of pulsatile mass or hand ischemia after upper extremity vascular access	**A (8)**
152.	• Presence of bruit after upper extremity access for intervention	**A (8)**
	Upper Extremity Arterial Testing—Physiological Testing or Duplex Ultrasound Study	
	Surveillance of Upper Extremity PAD After Revascularization	
153.	Baseline (within 1 month)	**A (8)**
	New or Worsening Symptoms	
154.	• After revascularization (stent or bypass)	**A (8)**
155.	• Post trauma	**A (8)**
156.	• After vein bypass graft • Surveillance at 6 to 8 months	**A (7)**
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency After First Year	
158.	• After vein bypass graft • Surveillance every 12 months	**A (7)**
159.	• After prosthetic bypass graft • Surveillance every 12 months	**A (7)**

A = appropriate; ABI = ankle-brachial index; ACE = angiotensin-converting enzyme inhibitor; ARB = angiotensin II receptor blocker; CABG = coronary artery bypass graft; CHF = congestive heart failure; CT = computed tomography; GI = gastrointestinal; ICA = internal carotid artery; PAD = peripheral artery disease; PVR = pulse volume recording.

*In the setting of interval development of clinical symptoms in a previously asymptomatic patient or for rapid progression of stenosis during subsequent follow-up (eg, stenosis category change during a limited period of time), more intensive surveillance may be indicated.

†Carotid artery occlusion to be addressed in the text of the document. Periodic surveillance duplex ultrasound should be performed according to the severity of stenosis of the contralateral side.

Table 10

Uncertain Indications (Median Score 4–6)

Indication		Appropriate Use Score (1–9)
	Extracranial Cerebrovascular Ultrasound	
	Evaluation for Cerebrovascular Disease—Potential Signs and/or Symptoms	
4.	• Syncope of uncertain cause after initial cardiovascular evaluation	**U (5)**
	Evaluation for Cerebrovascular Disease—Asymptomatic with Comorbidities or Risk Factors for Carotid Artery Stenosis	
10.	• No cervical bruit • History of neck irradiation ≥10 years ago	**U (5)**

	Indication	Appropriate Use Score (1–9)
11.	• Known renal fibromuscular dysplasia	**U (5)**
	Prior to Open Heart Surgery	
12.	• Planned coronary artery bypass grafting (CABG)	**U (6)**
13.	• Atherosclerotic disease in other vascular beds (eg, lower extremity PAD, coronary artery disease, abdominal aortic aneurysm), or history of neck irradiation ≥10 years ago • Planned valve repair/replacement surgery (without CABG)	**U (6)**
14.	• Atherosclerotic risk factors present • Planned valve repair/replacement surgery (without CABG)	**U (6)**
15.	• No atherosclerotic risk factors • Planned valve repair/replacement surgery (without CABG)	**U (4)**
	Follow-Up or Surveillance for Carotid Artery Stenosis—Asymptomatic[*†]	
	Surveillance Frequency During First Year	
19.	• Moderate ICA stenosis (eg, 50% to 69%) • At 6 to 8 months	**U (6)**
19.	• Moderate ICA stenosis (eg, 50% to 69%) • At 9 to 12 months	**U (6)**
20.	• Severe ICA stenosis (eg, 70% to 99%) • At 3 to 5 months	**U (5)**
20.	• Severe ICA stenosis (eg, 70% to 99%) • At 9 to 12 months	**U (6)**
	Surveillance Frequency After First Year	
21.	• Plaque without significant stenosis of the ICA (plaque, normal ICA velocity) • Every 24 months or greater	**U (5)**
22.	• Mild ICA stenosis (eg, <50%) • Every 12 months	**U (5)**
22.	• Mild ICA stenosis (eg, <50%) • Every 24 months or greater	**U (6)**
23.	• Moderate ICA stenosis (eg, 50% to 69%) • Every 24 months or greater	**U (6)**
24.	• Severe ICA stenosis (eg, 70% to 99%) • Every 24 months or greater	**U (6)**
	Surveillance After Carotid Artery Intervention	
27.	• Following abnormal ipsilateral ICA baseline study • Surveillance at 3 to 5 months	**U (4)**
27.	• Following abnormal ipsilateral ICA baseline study • Surveillance at 9 to 12 months	**U (5)**
	Surveillance Frequency After First Year	
28.	• Following normal ipsilateral ICA baseline study • Surveillance every 24 months or greater	**U (5)**
29.	• Following abnormal ipsilateral ICA baseline study • Surveillance every 6 months	**U (4)**
29.	• Following abnormal ipsilateral ICA baseline study • Surveillance every 24 months or greater	**U (5)**
	Carotid Duplex Screening Ultrasound	
	Limited Screening Study for Carotid Artery Plaque—Asymptomatic[‡]	
31.	• Intermediate Framingham risk score • No prior risk assessment imaging study, such as coronary calcium scoring or carotid IMT measurement	**U (4)**
33.	• High Framingham risk score	**U (5)**
	Screening for Renal Artery Stenosis—Asymptomatic	

Indication		Appropriate Use Score (1–9)
46.	• Unexplained size discrepancy between kidneys (>1.5 cm; in longest dimension) as discovered by CT or ultrasound	**U (4)**
	Evaluation for Mesenteric Artery Stenosis—Potential Signs and/or Symptoms	
	Symptomatic	
49.	• Post prandial pain or discomfort • GI evaluation not yet undertaken	**U (5)**
51.	• Unexplained or unintended weight loss	**U (5)**
52.	• Abdominal or epigastric bruit	**U (4)**
	Follow-up Testing for Renal Artery Stenosis—Asymptomatic	
54.	• Surveillance of known renal artery stenosis	**U (6)**
	Surveillance After Renal or Mesenteric Artery Revascularization	
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency During First Year	
57.	• During first 12 months after endovascular revascularization • Surveillance at 6 to 8 months	**U (6)**
57.	• During first 12 months after endovascular revascularization • Surveillance at 9 to 12 months	**U (6)**
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency After First Year	
58.	• After first 12 months after endovascular revascularization • Surveillance every 24 months or greater	**U (5)**
	Aortic and Aorto-Iliac Duplex	
	Evaluation for Abdominal Aortic Disease—Signs and/or Symptoms	
61.	• New onset abdominal or back pain	**U (6)**
69.	• Erectile dysfunction	**U (4)**
	Screening for Abdominal Aortic Aneurysm—Asymptomatic	
80.	• Age ≥65 years • No history of smoking	**U (5)**
	Surveillance of Known Abdominal Aortic Aneurysm	
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency During First Year	
83.	• Men, aneurysm 3.0 to 3.9 cm in diameter • Surveillance at 6 to 8 months	**U (4)**
84.	• Women, aneurysm 3.0 to 3.9 cm in diameter • Surveillance at 6 to 8 months	**U (4)**
85.	• Aneurysm 4.0 to 5.4 cm in diameter • Surveillance at 3 to 5 months	**U (4)**
86.	• Aneurysm ≥5.5 cm in diameter • Surveillance at 9 to 12 months	**U (6)**
	Asymptomatic or Stable Symptoms, No or Slow Progression During First Year, Surveillance Frequency After First Year	
89.	• Aneurysm 4.0 to 5.4 cm in diameter • Surveillance every 6 months	**U (5)**
89.	• Aneurysm 4.0 to 5.4 cm in diameter • Surveillance every 24 months or greater	**U (6)**
90.	• Aneurysm ≥5.5 cm in diameter • Surveillance every 24 months or greater	**U (5)**
	Asymptomatic or Stable Symptoms, Rapid Progression During First Year, Surveillance Frequency After First Year	
91.	• Men, aneurysm 3.0 to 3.9 cm in diameter • Surveillance every 24 months or greater	**U (4)**

Indication		Appropriate Use Score (1–9)
92.	• Women, aneurysm 3.0 to 3.9 cm in diameter • Surveillance every 24 months or greater	**U (4)**
93.	• Aneurysm 4.0 to 5.4 cm in diameter • Surveillance every 24 months or greater	**U (4)**
94.	• Aneurysm ≥5.5 cm in diameter • Surveillance every 12 months	**U (5)**
	Surveillance After Aortic Endograft or Aortoiliac Stenting	
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency During First Year	
99.	• Aortic endograft without endoleak stable and/or decreasing residual aneurysm sac size • Surveillance at 6 to 8 months	**U (5)**
99.	• Aortic endograft without endoleak stable and/or decreasing residual aneurysm sac size • Surveillance at 9 to 12 months	**U (6)**
100.	• Aortic endograft with endoleak and/or increasing residual aneurysm sac size • Surveillance at 3 to 5 months	**U (6)**
101.	• Aortic or iliac artery stents • Surveillance at 6 to 8 months	**U (5)**
101.	• Aortic or iliac artery stents • Surveillance at 9 to 12 months	**U (6)**
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency After First Year	
102.	• Aortic endograft without endoleak stable and/or decreasing residual aneurysm sac size • Surveillance every 24 months or greater	**U (5)**
103.	• Aortic endograft with endoleak and/or increasing residual aneurysm sac size • Surveillance every 24 months or greater	**U (5)**
104.	• Aortic or iliac artery stents • Surveillance every 12 months	**U (5)**
104.	• Aortic or iliac artery stents • Surveillance every 24 months or greater	**U (5)**
	Surveillance of Known Lower Extremity PAD	
	No Change in Symptom Status (No Revascularization)	
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency During First Year	
118.	• Mild or moderate disease (eg, ABI >0.4) • Surveillance at 9 to 12 months	**U (4)**
119.	• Severe (eg, ABI <0.4) • Surveillance at 6 to 8 months	**U (5)**
119.	• Severe (eg, ABI <0.4) • Surveillance at 9 to 12 months	**U (5)**
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency After First Year	
121.	• Mild or moderate disease (eg, ABI >0.4) • Surveillance every 24 months or greater	**U (4)**
122.	• Severe (eg, ABI <0.4) • Surveillance every 6 months	**U (4)**
122.	• Severe (eg, ABI <0.4) • Surveillance every 12 months	**U (4)**
	Surveillance of Lower Extremity PAD After Revascularization (Duplex/ABI)	
	Asymptomatic or Stable Symptoms	
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency During First Year	
125.	• After angioplasty ± stent placement • Surveillance at 6 to 8 months	**U (6)**
125.	• After angioplasty ± stent placement	**U (6)**

	Indication	Appropriate Use Score (1–9)
	• Surveillance at 9 to 12 months or greater	
126.	• After vein bypass graft • Surveillance at 3 to 5 months	**U (6)**
126.	• After vein bypass graft • Surveillance at 9 to 12 months	**U (6)**
127.	• After prosthetic bypass graft • Surveillance at 3 to 5 months	**U (5)**
127.	• After prosthetic bypass graft • Surveillance at 9 to 12 months	**U (5)**
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency After First Year	
128.	• After angioplasty ± stent placemen • Surveillance every 24 months or greater	**U (5)**
129.	• After vein bypass graft • Surveillance every 6 months	**U (5)**
129.	• After vein bypass graft • Surveillance every 24 months or greater	**U (5)**
130.	• After prosthetic bypass graft • Surveillance every 24 months or greater	**U (5)**
	Lower Extremity Artery Testing With ABI Only	
	Screening for Lower Extremity Atherosclerotic Disease—Asymptomatic With Comorbidities	
134.	• Age <50 years • With diabetes	**U (5)**
	Lower Extremity Artery Testing with Duplex Ultrasound Only	
	Evaluation for Groin Complication After Femoral Access	
139.	• Ecchymosis	**U (4)**
	Upper Extremity Arterial Testing—Physiological Testing or Duplex Ultrasound Study	
	Evaluation for Upper Extremity PAD—Potential Signs and/or Symptoms	
145.	• Raynaud's phenomenon	**U (5)**
148.	• Discrepancy in arm pulses or blood pressure discrepancy of >20 mm Hg between arms	**U (6)**
149.	• Periclavicular bruit	**U (5)**
	Upper Extremity Arterial Testing—Physiological Testing or Duplex Ultrasound Study	
	Surveillance of Upper Extremity PAD After Revascularization	
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency During First Year	
156.	• After vein bypass graft • Surveillance at 3 to 5 months	**U (6)**
156.	• After vein bypass graft • Surveillance at 9 to 12 months	**U (5)**
157.	• After prosthetic bypass graft • Surveillance at 6 to 8 months	**U (6)**
157.	• After prosthetic bypass graft • Surveillance at 9 to 12 months	**U (4)**
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency After First Year	
158.	• After vein bypass graft • Surveillance every 6 months	**U (4)**
158.	• After vein bypass graft • Surveillance every 24 months or greater	**U (5)**
159.	• After prosthetic bypass graft • Surveillance every 6 months	**U (4)**
159.	• After prosthetic bypass graft	**U (4)**

Indication	Appropriate Use Score (1–9)
• Surveillance every 24 months or greater	

ABI = ankle-brachial index; CABG = coronary artery bypass graft; CT = computed tomography; GI = gastrointestinal; ICA = internal carotid artery; IMT = intima-media thickness; PAD = peripheral artery disease; PVR = pulse volume recording; U = uncertain.

* In the setting of interval development of clinical symptoms in a previously asymptomatic patient or for rapid progression of stenosis during subsequent follow-up (eg, stenosis category change during a limited period of time), more intensive surveillance may be indicated.

† Carotid artery occlusion to be addressed in the text of the document. Periodic surveillance duplex ultrasound should be performed according to the severity of stenosis of the contralateral side.

‡ A screening carotid duplex examination includes assessment for the presence of atherosclerotic plaque within the common and internal carotid arteries using grey-scale imaging and assessment for stenosis of the proximal internal carotid artery using spectral Doppler. The screening carotid duplex examination is performed using a limited but clearly defined screening protocol (see ICAVL 2010 standards 5.1.5).[3] A screening study for carotid artery plaque does not include formal measurement of carotid IMT.

Table 11

Inappropriate Indications (Median Score 1–3)

	Indication	Appropriate Use Score (1–9)
	Extracranial Cerebrovascular Ultrasound	
	Follow-Up or Surveillance for Carotid Artery Stenosis—Asymptomatic	
16.	• Normal prior examination (no plaque, no stenosis)	**I (1)**
	Surveillance Frequency During First Year	
17.	• Plaque without significant stenosis of the ICA (plaque, normal ICA velocity) • At 3 to 5 months	**I (1)**
17.	• Plaque without significant stenosis of the ICA (plaque, normal ICA velocity) • At 6 to 8 months	**I (1)**
17.	• Plaque without significant stenosis of the ICA (plaque, normal ICA velocity) • At 9 to 12 months	**I (1)**
18.	• Mild ICA stenosis (eg, <50%) • At 3 to 5 months	**I (1)**
18.	• Mild ICA stenosis (eg, <50%) • At 6 to 8 months	**I (1)**
18.	• Mild ICA stenosis (eg, <50%) • At 9 to 12 months	**I (1)**
19.	• Moderate ICA stenosis (eg, 50% to 69%) • At 3 to 5 months	**I (2)**
	Surveillance Frequency After First Year	
21.	• Plaque without significant stenosis of the ICA (plaque, normal ICA velocity) • Every 6 months	**I (1)**
21.	• Plaque without significant stenosis of the ICA (plaque, normal ICA velocity) • Every 12 months	**I (3)**
22.	• Mild ICA stenosis (eg, <50%) • Every 6 months	**I (2)**
23.	• Moderate ICA stenosis (eg, 50% to 69%) • Every 6 months	**I (3)**
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency During First Year	
26.	• Following normal ipsilateral ICA baseline study • Surveillance at 3 to 5 months	**I (2)**
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency After First Year	
28.	• Following normal ipsilateral ICA baseline study	**I (2)**

	Indication	Appropriate Use Score (1–9)
	• Surveillance every 6 months	
	Carotid Duplex Screening Ultrasound	
	Limited Screening Study for Carotid Artery Plaque—Asymptomatic*	
30.	• Low Framingham risk score • No prior risk assessment imaging study, such as coronary calcium scoring or carotid IMT measurement	**I (2)**
32.	• Low or intermediate Framingham risk score • Normal prior risk assessment imaging study, such as coronary calcium scoring or carotid IMT measurement	**I (3)**
	Screening for Renal Artery Stenosis—Asymptomatic	
45.	• Atherosclerotic vascular disease in other beds (eg, peripheral artery disease) and well controlled hypertension	**I (3)**
	Evaluation for Mesenteric Artery Stenosis—Potential Signs and/or Symptoms Symptomatic	
47.	• Evaluate for acute abdominal pain ‘out of proportion to exam’ • Leukocytosis, ‘thumbprinting’, pnuematosis or hemoconcentration and acidosis with or without elevated amylase, alkaline phosphatase or CPK	**I (3)**
50.	• Chronic constipation or diarrhea • GI evaluation not yet undertaken	**I (3)**
	Surveillance After Renal or Mesenteric Artery Revascularization Asymptomatic	
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency During First Year	
57.	• During first 12 months after endovascular revascularization • Surveillance at 3 to 5 months	**I (3)**
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency After First Year	
58.	• After first 12 months after endovascular revascularization • Surveillance every 6 months	**I (3)**
	Aortic and Aorto-Iliac Duplex	
	Evaluation for Abdominal Aortic Disease—Signs and/or Symptoms	
60.	• Nonspecific lower extremity discomfort	**I (3)**
66.	• Fever of unknown origin	**I (3)**
67.	• Lower extremity swelling	**I (2)**
71.	• Hypertension	**I (3)**
	Screening for Abdominal Aortic Aneurysm—Asymptomatic	
81.	• Age <65 years • No history of smoking	**I (3)**
	Surveillance of Known Abdominal Aortic Aneurysm	
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency During First Year	
83.	• Men, aneurysm 3.0 to 3.9 cm in diameter • Surveillance at 3 to 5 months	**I (1)**
84.	• Women, aneurysm 3.0 to 3.9 cm in diameter • Surveillance at 3 to 5 months	**I (1)**
	Asymptomatic or Stable Symptoms, No or Slow Progression During First Year, Surveillance Frequency After First Year	
87.	• Men, aneurysm 3.0 to 3.9 cm in diameter • Surveillance every 6 months	**I (2)**
88.	• Women, aneurysm 3.0 to 3.9 cm in diameter • Surveillance every 6 months	**I (2)**
	Asymptomatic or Stable Symptoms, Rapid Progression During First Year, Surveillance Frequency After First Year	
94.	• Aneurysm ≥5.5 cm in diameter • Surveillance every 24 months or greater	**I (3)**

	Indication	Appropriate Use Score (1–9)
	Surveillance After Aortic Endograft or Aortoiliac Stenting	
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency During First Year	
99.	• Aortic endograft without endoleak stable and/or decreasing residual aneurysm sac size • Surveillance at 3 to 5 months	**I (3)**
101.	• Aortic or iliac artery stents • Surveillance at 3 to 5 months	**I (2)**
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency After First Year	
102.	• Aortic endograft without endoleak stable and/or decreasing residual aneurysm sac size • Surveillance every 6 months	**I (3)**
104.	• Aortic or iliac artery stents • Surveillance every 6 months	**I (2)**
	Lower Extremity Artery Testing Using Multi-Level Physiological Testing Alone or Duplex Ultrasound With Single Level ABI and PVR	
	Evaluation for Lower Extremity Atherosclerotic Disease—Potential Signs and/or Symptoms	
110.	• Nocturnal leg cramps • Normal pulses	**I (2)**
111.	• Lack of hair growth on dorsum of foot or toes • Normal pulses	**I (2)**
113.	• Lower extremity swelling • Normal pulses	**I (2)**
114.	• Diabetes with peripheral neuropathy • Normal pulses	**I (3)**
	Surveillance of Known Lower Extremity PAD	
	No Change in Symptom Status (No Revascularization)	
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency During First Year	
117.	• Normal baseline ABI (no stenosis) • Surveillance at 3 to 5 months	**I (1)**
117.	• Normal baseline ABI (no stenosis) • Surveillance at 6 to 8 months	**I (1)**
117.	• Normal baseline ABI (no stenosis) • Surveillance at 9 to 12 months	**I (1)**
118.	• Mild or moderate disease (eg, ABI >0.4) • Surveillance at 3 to 5 months	**I (2)**
118.	• Mild or moderate disease (eg, ABI >0.4) • Surveillance at 6 to 8 months	**I (2)**
119.	• Severe (eg, ABI <0.4) • Surveillance at 3 to 5 months	**I (3)**
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency After First Year	
120.	• Normal baseline ABI (no stenosis) • Surveillance every 6 months	**I (1)**
120.	• Normal baseline ABI (no stenosis) • Surveillance every 12 months	**I (1)**
120.	• Normal baseline ABI (no stenosis) • Surveillance every 24 months or greater	**I (2)**
121.	• Mild or moderate disease (eg, ABI >0.4) • Surveillance every 6 months	**I (2)**
121.	• Mild or moderate disease (eg, ABI >0.4) • Surveillance every 12 months	**I (2)**
122.	• Severe (eg, ABI <0.4) • Surveillance every 24 months or greater	**I (3)**

	Indication	Appropriate Use Score (1–9)
	Surveillance of Lower Extremity PAD After Revascularization (Duplex/ABI)	
	Asymptomatic or Stable Symptoms	
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency During First Year	
125.	• After angioplasty ± stent placement • Surveillance at 3 to 5 months	**I (2)**
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency After First Year	
128.	• After angioplasty ± stent placement • Surveillance every 6 months	**I (3)**
130.	• After prosthetic bypass graft • Surveillance every 6 months	**I (3)**
	Upper Extremity Arterial Testing-Physiological Testing or Duplex Ultrasound Study	
	Surveillance of Upper Extremity PAD After Revascularization	
	Asymptomatic or Stable Symptoms After Baseline Study, Surveillance Frequency During First Year	
157.	• After prosthetic bypass graft • Surveillance at 3 to 5 months	**I (3)**

ABI = ankle-brachial index; CABG = coronary artery bypass graft; CPK = creatine phosphokinase; GI = gastrointestinal; I = inappropriate; ICA = internal carotid artery; IMT = intima-media thickness; ICA = internal carotid artery; PAD = peripheral artery disease; PVR = pulse volume recording.

* A screening carotid duplex examination includes assessment for the presence of atherosclerotic plaque within the common and internal carotid arteries using grey-scale imaging and assessment for stenosis of the proximal internal carotid artery using spectral Doppler. The screening carotid duplex examination is performed using a limited but clearly defined screening protocol (see ICAVL 2010 standards 5.1.5).[3] A screening study for carotid artery plaque does not include formal measurement of carotid IMT.

8. DISCUSSION

The noninvasive vascular laboratory plays a central role in the evaluation and surveillance of peripheral vascular disorders. The scope of this document includes common clinical indications encountered in patients with suspected or known non-coronary arterial disorders, including atherosclerotic occlusive disease (ie, carotid artery stenosis, lower and upper extremity peripheral arterial disease, renal and mesenteric artery occlusive disease), abdominal aortic aneurysms, and also less common disorders such as fibromuscular dysplasia, vasospasm, arterial dissection, and arterial trauma. Evaluation of the thoracic aorta is not generally undertaken in the noninvasive vascular laboratory and is beyond the scope of this document. The appropriate use of transthoracic echocardiography for evaluation of aortic disease is addressed in the 2011 Appropriate Use Criteria for Echocardiography.[16]

Due to the diversity of peripheral vascular disorders, it is likely that many potential clinical indications are not included in this document. Rather than an exhaustive compendium of clinical indications, it is intended that this document address the most common and important clinical scenarios encountered in the care patients with peripheral vascular disease. This document includes ratings for both duplex ultrasound examinations and physiological testing studies (when appropriate). This document includes indications related to arterial disorders only; separate appropriateness criteria for venous ultrasound and physiological testing, which will also include indications related to dialysis access, are under development and anticipated in the near future. It is intended that this document will provide

guidance for clinicians in maximizing the appropriate use of the noninvasive vascular laboratory for the care of patients with suspected or known peripheral vascular disorders. In addition, it is intended that this document identify critical evidence gaps in the field and serve as a reference for policy makers with regard to noninvasive vascular testing.

Appropriate Use Criteria were developed using medical evidence and supplemented by expert opinion to assess whether the net benefit or risks of a noninvasive, vascular laboratory–based, diagnostic test for arterial disease make it reasonable to perform. The intent of the criteria is to avoid over- or underutilization, thereby promoting optimal healthcare delivery along with justifying healthcare expenditures and promoting the best outcome for patients with minimal risk.

The AUC for vascular laboratory testing were developed as complimentary and are aligned with the ACC/AHA Guidelines for the Management of Patients with Peripheral Arterial Disease and the ASA/ACC/AHA multisocietal Guidelines for the Management of Patients with Extracranial Carotid and Vertebral Artery disease.[7,14] Specifically, the ACC/AHA PAD and carotid/vertebral guidelines include, for each vascular territory, a section on diagnostic methods. The current AUC document includes some of the diagnostic methods for disease investigation such as ultrasound and physiological testing. Other modalities such as computed tomography and magnetic resonance are not covered in the current AUC document.

It should be noted that the optimal clinical management of many common peripheral vascular disorders requires periodic imaging surveillance, both to follow for disease progression and to determine the time at which a threshold for intervention has been reached. In contrast to many cardiac conditions, peripheral arterial interventions are often indicated to prevent untoward vascular events in the patient with severe but asymptomatic vascular disease. Examples of such indications include repair of a large but asymptomatic abdominal aortic aneurysm to prevent fatal rupture or revascularization of severe asymptomatic internal carotid artery stenosis to prevent ipsilateral stroke. As such, there are many more surveillance indications included in the current AUC document than in the AUC for other cardiovascular imaging modalities, such as echocardiography or nuclear imaging. In addition, it must be noted that periodic noninvasive vascular testing is a standard component of care following vascular intervention, such as follow-up of a lower extremity bypass graft or arterial stent for significant stenosis or for assessment after endovascular aortic aneurysm repair to assure aneurysm exclusion and the absence of endoleak. In some clinical settings, repeat intervention may be required based solely upon surveillance ultrasound findings in the absence of worsening clinical symptoms, such as to optimize primary assisted patency of a severely stenotic lower extremity bypass graft.

Summary of Evidence and Call for Additional Research

A consensus of “appropriate” was found for most vascular studies where clinical signs and symptoms were the indication for testing and to establish a “baseline” after a revascularization procedure. In general, a follow-up study for a patient with a normal baseline study was deemed inappropriate. For cerebrovascular disease, a duplex ultrasound study was appropriate for hemispheric neurological symptoms such as transient ischemic

attack or stroke. There was uncertainty regarding the use of cerebrovascular ultrasound for assessment of asymptomatic patients with risk factors or comorbidities for carotid artery stenosis, but this was deemed appropriate for assessment of occult cerebrovascular disease in patients with established atherosclerotic disease in other vascular territories. Another area considered uncertain for cerebrovascular ultrasound was preoperative assessment prior to cardiac surgery.

For duplex ultrasound to assess for renal artery stenosis, appropriate testing indications were hypertension, increased creatinine, and heart failure and for mesenteric artery stenosis were patients with postprandial pain and weight loss who have previously undergone GI evaluation. The appropriate indications for evaluation of the abdominal aorta and iliac arteries included intermittent claudication, an aneurysmal femoral or popliteal pulse, a pulsatile abdominal mass, a decreased or absent femoral pulse, and an abdominal or femoral bruit, as well as clinical evidence of atheroemboli in the lower extremities, abnormal physiological testing suggestive of aortoiliac occlusive disease, and the presence of a thoracic aortic aneurysm. Erectile dysfunction was considered an uncertain indication of duplex ultrasound of the aorta and iliac arteries. Inappropriate indications for aorta and iliac duplex ultrasound were non-specific discomfort and swelling in lower extremities, fever of unknown origin, and hypertension. Surveillance of known aortic or iliac aneurysms was appropriate but did depend on size of the vessel and rapidity of enlargement.

Lower or upper extremity physiological testing alone or duplex ultrasound with single-level ABI and PVR was appropriate for signs and symptoms of ischemia. Screening tests for the various vascular territories were appropriate for abdominal aortic aneurysms and the ratings were generally consistent with USPSTF recommendations. The screening of selected populations with the ABI was uncertain and reflects the paucity of data regarding effect on prevention of claudication and limb loss. However, it did not address whether ABI screening would impact the high rate of heart attack and stroke in patients with PAD. With regard to carotid artery ultrasound screening, a low Framingham risk score was an inappropriate indication, whereas an intermediate or high Framingham risk score was an uncertain indication. The uncertain indications noted in all the vascular territories exposes the need for outcome and clinical effectiveness data to allow for appropriateness certainly.

The current evidence base and clinical practice guidelines were used to develop and rate the clinical indications whenever available, although for certain indications, the available scientific literature was limited and clinical expertise played a larger role. The writing panel recognizes a need for more clinical and cost-effectiveness studies focused specifically on noninvasive vascular testing, and the significant number of indications rated by the technical panel as “uncertain” are reflective of these evidence gaps. The writing panel identifies the following areas as among those in greatest need of focused research:

1. Clinical and cost effectiveness of carotid artery duplex examinations prior to open heart surgery;
2. Cost–benefit analysis and utility of carotid duplex ultrasound examination for asymptomatic patients with atherosclerotic vascular disease in other vascular beds

(eg, coronary or peripheral artery disease) and for patients with multiple atherosclerotic risk factors;

3. Optimal frequency of ultrasound examinations for surveillance of untreated internal carotid artery stenosis, accounting for severity of disease on the baseline examination.
4. Optimal frequency of ultrasound examinations for surveillance of abdominal aortic aneurysms, accounting for size of the aneurysm on the baseline examination and select patient characteristics (eg, gender).
5. Optimal frequency of ultrasound and physiological testing for surveillance following lower extremity arterial bypass grafts and endovascular revascularization procedures, accounting for type of procedure (stenting or bypass), nature of conduit (for bypass grafting), and anatomic location of the procedure.
6. Comparative effectiveness of duplex ultrasound versus other imaging modalities for surveillance after aortic endografting.

5. ABBREVIATIONS

ABI	ankle-brachial index
ACE	angiotensin-converting enzyme inhibitor
ARB	angiotensin II receptor blocker
CABG	coronary artery bypass graft
CT	computed tomography
GI	gastrointestinal
ICA	internal carotid artery
ICAVL	Intersocietal Commission for the Accreditation of Vascular Laboratories
IMT	intima-media thickness
PAD	peripheral artery disease
PVR	pulse volume recording

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APPENDIX A: ADDITIONAL METHODS

See the Methods section of the report for a description of panel selection, indication development, scope of indications, and rating process.

Relationships With Industry and Other Entities

The College and its partnering organizations rigorously avoid any actual, perceived, or potential conflicts of interest that might arise as a result of an outside relationship or personal interest of a member of the technical panel. Specifically, all panelists are asked to provide disclosure statements of all relationships that might be perceived as real or potential conflicts of interest. These statements were reviewed by the Appropriate Use Criteria Task Force, discussed with all members of the technical panel at the face-to-face meeting, and updated and reviewed as necessary. A table of disclosures by the technical panel and oversight working group members can be found in Appendix C.

APPENDIX B: ACCF/ACR/AIUM/ASE/ASN/ICAVL/SCAI/SCCT/SIR/SVM/SVS 2012 APPROPRIATE USE CRITERIA FOR PERIPHERAL VASCULAR ULTRASOUND AND PHYSIOLOGICAL TESTING PART I: ARTERIAL PARTICIPANTS

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APPENDIX C: ACCF/ACR/AIUM/ASE/ASN/ICAVL/SCAI/SCCT/SIR/SVM/SVS 2012 APPROPRIATE USE CRITERIA FOR PERIPHERAL VASCULAR ULTRASOUND AND PHYSIOLOGICAL TESTING PART I: ARTERIAL WRITING GROUP, TECHNICAL PANEL, TASK FORCE, AND INDICATION REVIEWERS—RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES (IN ALPHABETICAL ORDER)

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Phillip J. Bendick	None	• GE Ultrasound • Zonare Ultrasound	None	None	None	None
Raymond Edward Bertino	None	None	None	None	None	None
Robert W. W. Biederman	None	• Merck-Schering-Plough	None	• Merck-Schering-Plough (MRI research) • Osiris Steering committee (no financial support)	None	None
John Blebea	None	None	None	None	None	None
Andressa G. R. Borges	None	None	None	None	None	None
Doug Campos-Outcalt	None	None	None	None	None	None
Kathleen A. Carter	None	None	None	None	None	None
Donald E. Casey Jr	None	None	None	None	None	None
Alan M. Dietzek	None	• International RN Congress	None	None	None	None
Regina S. Druz	None	None	None	None	None	None
Troy Fiesinger	None	None	None	None	None	None
Naomi Hamburg	None	None	None	None	None	None
Sujith Kalathiveetil	None	None	None	None	None	None
Jengyu Lai	None	None	None	None	None	None
Carol Miranda	None	None	None	None	None	None
Steffen E. Petersen	None	None	None	None	None	None
Patricia (Tish) A. Poe	None	None	None	None	None	None
Robert R. Ross	None	None	None	None	None	None
Lawrence Rudski	None	None	None	None	None	None
Russell H. Samson	None	None	None	None	None	None
Aseem Vashist	None	None	None	None	None	None
James Wrobel	None	None	None	None	None	None

This table represents the relevant relationships with industry and other entities that were disclosed by participants at the time of participation. It does not necessarily reflect relationships with industry at the time of publication. A person is deemed to have a significant interest in a business if the interest represents ownership of 5% of the voting stock or share of the business entity, or ownership of $10,000 of the fair market value of the business entity; or if funds received by the person from the business entity exceed 5% of the person's gross income for the previous year. A relationship is considered to be modest if

it is less than significant under the preceding definition. Relationships in this table are modest unless otherwise noted. Names are listed in alphabetical order within each category of review. Participation does not imply endorsement of this document.

* Significant relationship.