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ACCF/ASE/ACEP/AHA/ASNC/SCAI/SCCT/SCMR 2008 Appropriateness Criteria for Stress Echocardiography: A Report of the American College of Cardiology Foundation Appropriateness Criteria Task Force, American Society of Echocardiography, American College of Emergency Physicians, American Heart Association, American Society of Nuclear Cardiology, Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Computed Tomography, and Society for Cardiovascular Magnetic Resonance: Endorsed by the Heart Rhythm Society and the Society of Critical Care Medicine

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ACCF/ASE/ACEP/AHA/ASNC/SCAI/SCCT/SCMR Appropriateness Criteria

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*Developed in accordance with the principles and methodology outlined by ACCF: Patel MR, Spertus JA, Brindis RG, Hendel RC, Douglas PS, Peterson ED, Wolk MJ, Allen JM, Raskin IE. ACCF proposed method for evaluating the appropriateness of cardiovascular imaging. *J Am Coll Cardiol.* 2005;46:1606–13.

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***Abstract*—**The American College of Cardiology Foundation (ACCF) and the American Society of Echocardiography (ASE) together with key specialty and subspecialty societies, conducted an appropriateness review for stress echocardiography. The review assessed the risks and benefits of stress echocardiography for several indications or clinical scenarios and scored them on a scale of 1 to 9 (based upon methodology developed by the ACCF to assess imaging appropriateness). The upper range (7 to 9) implies that the test is generally acceptable and is a reasonable approach, and the lower range (1 to 3) implies that the test is generally not acceptable and is not a reasonable approach. The midrange (4 to 6) indicates a clinical scenario for which the indication for a stress echocardiogram is uncertain. The indications for this review were drawn from common applications or anticipated uses, as well as from current clinical practice guidelines. Use of stress echocardiography for risk assessment in patients with coronary artery disease (CAD) was viewed favorably, while routine repeat testing and general screening in certain clinical scenarios were viewed less favorably. It is anticipated that these results will have a significant impact on physician decision making and performance, reimbursement policy, and will help guide future research.

Key Words: stress echocardiography ■ appropriateness criteria ■ cardiac imaging ■ coronary artery disease ■ diagnostic testing

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Preface

In an effort to respond to the need for the rational use of imaging services in the delivery of high quality care, the American College of Cardiology Foundation (ACCF) has undertaken a process to determine the appropriateness of cardiovascular imaging for selected patient indications.

Appropriateness criteria 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 a current understanding of the technical capabilities of the imaging modalities examined. Although not intended to be entirely comprehensive, the indications are meant to identify common scenarios encompassing the majority of 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.

The ACCF believes that careful blending of a broad range of clinical experiences and available evidence-based informa-

tion will help guide a more efficient and equitable allocation of health care resources in cardiovascular imaging. The ultimate objective of appropriateness criteria is to improve patient care and health outcomes in a cost-effective manner but is not intended to ignore ambiguity and nuance intrinsic to clinical decision making. Local parameters, such as the availability or quality of equipment or personnel, may influence the selection of appropriate imaging procedures. Thus, appropriateness criteria should not be considered substitutes for sound clinical judgment and practice experience.

The ACCF appropriateness criteria process itself is also evolving. In the current iteration, Technical Panel members were asked to rate indications for stress echocardiography in a manner independent and irrespective of prior ACCF ratings for similar diagnostic stress imaging modalities such as single-photon emission computed tomography myocardial perfusion imaging (SPECT MPI),[1] cardiac computed tomography (CT), or cardiac magnetic resonance.[2] Given the iterative nature of the process, readers are counseled not to compare too closely the individual appropriateness ratings among modalities rated at different times over the past 2 years. A "cross-modality" evaluation of the appropriateness of multiple imaging techniques will be undertaken in the near future. This evaluation should more directly answer questions about the strengths of each modality relative to alternatives for various clinical scenarios.

In developing these criteria the Appropriateness Criteria Technical Panel was asked to assess whether the use of the test for each indication is appropriate, uncertain, or inappropriate; they were provided the following definition of appropriateness:

An appropriate imaging study is one in which the expected incremental information, combined with clinical judgment, exceeds the expected negative consequences* 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 scores each indication as follows:

Score 7 to 9

Appropriate test for specific indication (test **is** generally acceptable and **is** a reasonable approach for the indication).

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.)

Score 1 to 3

Inappropriate test for that indication (test is **not** generally acceptable and is **not** a reasonable approach for the indication).

*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).

The contributors acknowledge that the division of these scores into 3 categories of appropriateness is somewhat arbitrary and that the numeric designations should be viewed as a continuum. The contributors also recognize diversity in clinical opinion for particular clinical scenarios. Therefore, scores in the intermediate level of appropriateness should be labeled "uncertain," as critical patient or research data are lacking and should be a prompt to the field to conduct definitive research investigation. It is anticipated that the appropriateness criteria reports will require updates 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 deliberately was not comprised solely of specialists in the particular procedure under evaluation. Specialists, while offering important clinical and technical insights, might have a natural tendency to rate the indications within their specialty as more appropriate than nonspecialists. In addition, care was taken in providing objective, nonbiased information, including guidelines and key references, to the Technical Panel.

We are grateful to the Technical Panel, a professional group with a wide range of skills and insights, for a thoughtful and thorough deliberation of the merits of stress echocardiography for various indications. In addition to our thanks to the Technical Panel for their dedicated work and review, we would like to offer special thanks to William Armstrong, MD, Christopher Kramer, MD, Robert McNamara, MD, and Catherine Otto, MD, for reviewing the draft indications; to Peggy Christiansen, the ACC librarian for her comprehensive literature searches; to Karen Caruth, who continually drove the process forward, and to ACCF Past President Pamela Douglas, MD, MACC, FAHA, FASE, for her insight and leadership.

Eric D. Peterson, MD, MPH, FACC, FAHA
Moderator, Stress Echocardiography Technical Panel

Ralph G. Brindis, MD, MPH, FACC
Chair, ACCF Appropriateness Criteria Task Force

Introduction

This report addresses the appropriateness of stress echocardiography. The improvement in the test characteristics of stress echocardiography in recent years has increased its utility for detection and risk assessment of ischemic heart disease. Similar to other forms of stress imaging testing, stress echocardiography can help more clearly define cardiovascular risk for a patient, but also creates opportunities for overuse and misuse in patients who may not obtain a benefit, or who could have been medically managed effectively without the addition of the test. In particular, inappropriate use may be costly and may prompt potentially harmful and costly downstream testing and treatment such as unwarranted coronary revascularization or unnecessary repeat follow-up. Concerns about inappropriate use exist among those who pay for these services and clinical leaders who evaluate the effectiveness of testing.

Methods

The indications included in this review are purposefully broad, and they comprise a wide array of cardiovascular signs and symptoms as well as clinical judgment as to the likelihood of cardiovascular findings.

A detailed description of the methods used for ranking of the selected clinical indications is outlined in Appendix B and is also found more generally in a previous publication, "ACCF Proposed Method for Evaluating the Appropriateness of Cardiovascular Imaging."[3] Briefly, this process combines evidence-based medicine and practice experience by engaging a technical panel in a modified Delphi exercise. The 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 consensus meeting, panel members were then asked to independently provide their final scores for each indication.

The level of agreement among panelists as defined by RAND[4] was analyzed based on the BIOMED rule for a panel of 14 to 16. 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.

General Assumptions for Stress Echocardiography

To prevent any nuances of interpretation, all indications were considered with the following important assumptions:

1. All indications are assumed to apply to adult patients (18 years of age or older).
2. The test is performed and interpreted by qualified individuals in facilities that are proficient in the imaging technique.[5–8]

The indications were constructed by echocardiography experts and 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 (Online Appendix at http://content.onlinejacc.org).

The Technical Panel was comprised of clinician experts, some with backgrounds in cardiac imaging and others with experience in general cardiovascular medicine, cardiac surgery, critical care medicine, emergency medicine, health services research, and health plan administration.† Panelists were instructed to incorporate in their deliberations several assumptions specifically for stress echocardiography, including:

1. All standard echocardiographic techniques for image acquisition, including imaging protocols, are available for each indication, and stress echocardiography has a sensitivity and specificity similar to those found in the published literature.
2. For all stress imaging, the mode of stress testing is assumed to be exercise for patients able to exercise. For patients unable to exercise, it is assumed that dobutamine is used for echocardiographic stress testing. Further background on the rationale for the assumption of exercise stress is available in the ACC/AHA 2002 Guideline Update for Exercise Stress Testing.[9] Any indications including a specific mode of stress are labeled as such.
3. Preoperative evaluation includes procedures such as organ transplantation.

†Full detail about the backgrounds of the members of the Technical Panel can be found in Appendix C.

Abbreviations

ACS = acute coronary syndrome
AI = aortic insufficiency
CABG = coronary artery bypass grafting surgery
CAD = coronary artery disease
CHD = coronary heart disease
CT = computed tomography
ECG = electrocardiogram
HF = heart failure
LV = left ventricular
MET = estimated metabolic equivalents of exercise
MI = myocardial infarction
MR = mitral regurgitation
PCI = percutaneous coronary intervention
SPECT MPI = single-photon emission computed tomography myocardial perfusion imaging
UA/NSTEMI = unstable angina (UA) and non-ST-elevation myocardial infarction (NSTEMI)

Results of Ratings

The final ratings for stress echocardiography (Tables 1 to 10) are listed by indication sequentially as obtained from second round rating sheets submitted by each panelist. Additionally, the indications are presented by Appropriateness Category (Tables 11 to 13).

Definitions used by the Technical Panel can be found in Appendix A. Supplemental tables, including documentation of the mean absolute deviation from the median and level of agreement of rankings for each indication, can be found in the Online Appendix at http://content.onlinejacc.org.

For the 51 indications for the use of stress echocardiography, 22 were found to be appropriate, 10 were uncertain, and 19 were considered inappropriate.

Typically, there was greater variability in scores of indications defined as uncertain, suggesting wide variation in opinion. A number of indications failed to meet the above definition of agreement. Still, there were no uncertain indications where the panel held such opposing viewpoints that the indication was labeled as one for which the panel disagreed. There was generally less variation for the indications labeled as either appropriate or inappropriate, with 68.8% and 79.0%, respectively, showing agreement as pre-

viously defined. Disagreement did not occur for any of the indications ultimately defined as appropriate or inappropriate. Finally, as prior research has found that, in general, the test operating characteristics of stress echocardiography and SPECT MPI imaging are similar, we also provide the readers with an asterisk where there were discordances between similar indications rated inappropriate for stress echocardiography and those previously rated uncertain for SPECT MPI.

Stress Echocardiography Appropriateness Criteria (by Indication)

Table 1. Detection of CAD/Risk Assessment: Symptomatic

Indication		Appropriateness Score (1–9)
Evaluation of Chest Pain Syndrome or Anginal Equivalent		
1.	• Low pre-test probability of CAD • ECG interpretable AND able to exercise	I (3)
2.	• Low pre-test probability of CAD • ECG uninterpretable OR unable to exercise	A (7)
3.	• Intermediate pre-test probability of CAD • ECG interpretable AND able to exercise	A (7)
4.	• Intermediate pre-test probability of CAD • ECG uninterpretable OR unable to exercise	A (9)
5.	• High pre-test probability of CAD • Regardless of ECG interpretability and ability to exercise	A (7)
6.	• Prior stress ECG test is uninterpretable or equivocal	A (8)
Acute Chest Pain		
7.	• Intermediate pre-test probability of CAD • ECG–no dynamic ST changes AND serial cardiac enzymes negative	A (8)
8.	• High pre-test probability of CAD • ECG–ST elevation	I (1)
New-Onset/Diagnosed Heart Failure With Chest Pain Syndrome or Anginal Equivalent		
9.	• Intermediate pre-test probability • Normal LV systolic function	A (8)
10.	• LV systolic function	U (5)

Table 2. Detection of CAD and Risk Assessment: Asymptomatic (Without Chest Pain Syndrome or Anginal Equivalent)

Indication		Appropriateness Score (1–9)
General Patient Populations		
11.	• Low CHD risk (Framingham risk criteria)	I (1)
12.	• Moderate CHD risk (Framingham) • ECG Interpretable	I (3)*
13.	• High CHD risk (Framingham)	U (6)

*The ranking of this indication as inappropriate is different from that given to similar but not identical indications in previously published appropriateness criteria. The ratings were done in accordance with established ACCF methodology. Furthermore, the Technical Panel for each modality operated independently without allowance and with discouragement for intermodality comparisons. Discrepant scores may be related to rating variability, differing Technical Panel composition, maturation of the appropriatness criteria process, or perceived differences in appropriateness.

Table 3. Detection of CAD/Risk Assessment: Without Chest Pain Syndrome or Anginal Equivalent in Patient Populations With Defined Comorbidities

	Indication	Appropriateness Score (1–9)
	New-Onset or Diagnosed Heart Failure or LV Systolic Dysfunction	
14.	• Moderate CHD risk (Framingham) • No prior CAD evaluation • Normal LV systolic function	A (7)
15.	• Moderate CHD risk (Framingham) • No prior CAD evaluation • Abnormal LV systolic dysfunction	U (5)
	Valvular Heart Disease Requiring Valve Surgery	
16.	• Moderate CHD risk (Framingham)	I (3)
	New-Onset Atrial Fibrillation	
17.	• Low CHD risk (Framingham) • Part of the evaluation	I (2)*
18.	• Moderate to high CHD risk (Framingham) • Part of the evaluation	A (7)
	Nonsustained Ventricular Tachycardia	
19.	• Moderate to high CHD risk (Framingham) • Stress echo using exercise stress only	A (7)

*The ranking of this indication as inappropriate is different from that given to similar but not identical indications in previously published appropriateness criteria. The ratings were done in accordance with established ACCF methodology. Furthermore, the Technical Panel for each modality operated independently without allowance and with discouragement for intermodality comparisons. Discrepant scores may be related to rating variability, differing Technical Panel composition, maturation of the appropriatness criteria process, or perceived differences in appropriateness.

Table 4. Risk Assessment With Prior Test Results

	Indication	Appropriateness Score (1–9)
	Asymptomatic OR Stable Symptoms, Normal Prior Stress Imaging Study	
20.	• High CHD risk • Repeat stress echo study annually	I (2)
21.	• High CHD risk • Repeat stress echo study after 2 years or greater	U (5)
	Known CAD: Asymptomatic OR Stable Symptoms, Abnormal Catheterization OR Abnormal Prior Stress Imaging Study	
22.	• Assessment of severity of ischemia (CAD) • Less than 1 year to evaluate medically managed patients	I (2)
23.	• Assessment of severity of ischemia (CAD) • Greater than or equal to 2 years to evaluate medically managed patients	U (5)
	Worsening Symptoms: Abnormal Catheterization OR Abnormal Prior Stress Imaging Study	
24.	• Re-evaluation of medically managed patients	A (8)
	Asymptomatic Prior Coronary Calcium Agatston Score	
25.	• Agatston score greater than or equal to 400	A (7)
26.	• Agatston score less than 100	I (1)
	Chest Pain Syndrome or Anginal Equivalent	
27.	• Coronary artery stenosis of unclear significance (cardiac catheterization or CT angiography)	A (8)

Table 5. Risk Assessment: Preoperative Evaluation for Noncardiac Surgery†

	Indication	Appropriateness Score (1–9)
	Low-Risk Surgery	
28.	• Preoperative evaluation for noncardiac surgery risk assessment • Minor or intermediate clinical risk predictors	I (1)
	Intermediate-Risk Surgery	
29.	• Poor exercise tolerance (less than or equal to 4 METs) • Minor or no clinical risk predictors	I (2)
30.	• Poor exercise tolerance (less than or equal to 4 METs) • Intermediate clinical risk predictors	A (7)
	High-Risk Nonemergent Surgery	
31.	• Poor exercise tolerance (less than 4 METs)	A (8)
32.	• Asymptomatic up to 1 year after normal catheterization, noninvasive test, or previous revascularization	I (1)

†See discussion and appendix for changes in the revised 2007 ACC/AHA Perioperative Guidelines relevant to these indications.[10]

Table 6. Risk Assessment: Following Acute Coronary Syndrome

Indication		Appropriateness Score (1–9)
UA/NSTEMI—No Recurrent Symptoms or Signs of Heart Failure		
33.	• Not planning to undergo early catheterization	A (8)
Acute Coronary Syndrome—Asymptomatic Post-Revascularization (PCI or CABG)		
34.	• Routine evaluation prior to hospital discharge	I (1)

Table 7. Risk Assessment: Post-Revascularization (PCI or CABG)

Indication		Appropriateness Score (1–9)
Symptomatic		
35.	• Evaluation of chest pain syndrome • Not in the early post-procedure period	A (8)
Asymptomatic		
36.	• Less than 5 years after CABG	I (2)*
37.	• Asymptomatic (e.g., silent ischemia) prior to previous revascularization • Greater than or equal to 5 years after CABG	U (6)
38.	• Symptomatic prior to previous revascularization • Greater than or equal to 5 years after CABG	U (5)
39.	• Asymptomatic (e.g., silent ischemia) prior to previous revascularization • Less than 2 years after PCI	I (3)*
40.	• Symptomatic prior to previous revascularization • Less than 2 years after PCI	I (2)
41.	• Asymptomatic (e.g., silent ischemia) prior to previous revascularization • Greater than or equal to 2 years after PCI	U (5)

*The ranking of this indication as inappropriate is different from that given to similar but not identical indications in previously published appropriateness criteria. The ratings were done in accordance with established ACCF methodology. Furthermore, the Technical Panel for each modality operated independently without allowance and with discouragement for intermodality comparisons. Discrepant scores may be related to rating variability, differing Technical Panel composition, maturation of the appropriateness criteria process, or perceived differences in appropriateness.

Table 8. Assessment of Viability/Ischemia

Indication		Appropriateness Score (1–9)
Ischemic Cardiomyopathy, Assessment of Viability/Ischemia		
42.	• Known CAD on catheterization • Patient eligible for revascularization	A (8)

Table 9. Stress Study for Hemodynamics (Includes Doppler During Stress)

Indication		Appropriateness Score (1–9)
Valvular Stenosis		
43.	• Evaluation of equivocal aortic stenosis • Evidence of low cardiac output • Use of dobutamine	A (8)
44.	• Asymptomatic individuals • Mild to moderate mitral stenosis	U (5)
45.	• Symptomatic individuals • Mild mitral stenosis	A (7)
46.	• Severe aortic or mitral stenosis	I (2)
47.	• Asymptomatic severe AI or MR • LV size and function not meeting surgical criteria	A (7)
48.	• Severe AI or MR • Symptomatic or with severe LV enlargement or LV systolic dysfunction	I (2)
Pulmonary Hypertension		
49.	• Suspected pulmonary hypertension • Normal or indeterminate resting echo study	U (5)

Table 10. Contrast Use

Indication		Appropriateness Score (1–9)
Use of Contrast With Stress Echo		
50.	• Routine use of contrast • All segments visualized on noncontrast images	I (1)
51.	• Selective use of contrast • 2 or more contiguous segments are NOT seen on noncontrast images	A (8)

Stress Echocardiography Appropriateness Criteria (by Appropriateness Category)

Table 11. Appropriate Indications (Median Score 7 to 9)

Indication		Appropriateness Score (1–9)
Detection of CAD: Symptomatic—Evaluation of Chest Pain Syndrome or Anginal Equivalent		
2.	• Low pre-test probability of CAD • ECG uninterpretable OR unable to exercise	A (7)
3.	• Intermediate pre-test probability of CAD • ECG interpretable AND able to exercise	A (7)
4.	• Intermediate pre-test probability of CAD • ECG uninterpretable OR unable to exercise	A (9)
5.	• High pre-test probability of CAD • Regardless of ECG interpretability and ability to exercise	A (7)
6.	• Prior stress ECG test is uninterpretable or equivocal	A (8)
Detection of CAD: Symptomatic—Acute Chest Pain		
7.	• Intermediate pre-test probability of CAD • ECG—no dynamic ST changes AND serial cardiac enzymes negative	A (8)
Detection of CAD: Symptomatic—New-Onset/Diagnosed Heart Failure With Chest Pain Syndrome or Anginal Equivalent		
9.	• Intermediate pre-test probability • Normal LV systolic function	A (8)
Detection of CAD/Risk Assessment: Without Chest Pain Syndrome or Anginal Equivalent in Patient Populations With Defined Comorbidities—New-Onset or Diagnosed Heart Failure or LV Systolic Dysfunction		
14.	• Moderate CHD risk (Framingham) • No prior CAD evaluation • Normal LV systolic function	A (7)
Detection of CAD/Risk Assessment: Without Chest Pain Syndrome or Anginal Equivalent in Patient Populations With Defined Comorbidities—New-Onset Atrial Fibrillation		
18.	• Moderate to high CHD risk (Framingham) • Part of the evaluation	A (7)
Detection of CAD/Risk Assessment: Without Chest Pain Syndrome or Anginal Equivalent in Patient Populations With Defined Comorbidities—Nonsustained Ventricular Tachycardia		
19.	• Moderate to high CHD risk (Framingham) • Stress echo using exercise stress only	A (7)
Risk Assessment with Prior Test Results—Worsening Symptoms: Abnormal Catheterization OR Abnormal Prior Stress Imaging Study		
24.	• Re-evaluation of medically managed patients	A (8)
Risk Assessment With Prior Test Results—Asymptomatic, Prior Coronary Calcium Agatston Score		
25.	• Agatston score greater than or equal to 400	A (7)
Risk Assessment With Prior Test Results—Chest Pain Syndrome or Anginal Equivalent		
27.	• Coronary artery stenosis of unclear significance (cardiac catheterization or CT angiography)	A (8)
Risk Assessment: Preoperative Evaluation for Noncardiac Surgery—Intermediate-Risk Surgery		
30.	• Poor exercise tolerance (less than or equal to 4 METs) • Intermediate clinical risk predictors	A (7)
Risk Assessment: Preoperative Evaluation for Noncardiac Surgery—High-Risk Nonemergent Surgery		
31.	• Poor exercise tolerance (less than 4 METs)	A (8)
Risk Assessment: Following Acute Coronary Syndrome–UA/NSTEMI—No Recurrent Symptoms or Signs of Heart Failure		
33.	• Not planning to undergo early catheterization	A (8)
Risk Assessment: Post-Revascularization (PCI or CABG)—Symptomatic		
35.	• Evaluation of chest pain syndrome • Not in the early post-procedure period	A (8)

Table 11. Continued

Indication		Appropriateness Score (1–9)
Ischemic Cardiomyopathy Assessment of Viability/Ischemia—Ischemic Cardiomyopathy, Assessment of Viability/Ischemia		
42.	• Known CAD on catheterization • Patient eligible for revascularization	A (8)
Stress Study for Hemodynamics (Includes Doppler During Stress)—Valvular Stenosis		
43.	• Evaluation of equivocal aortic stenosis • Evidence of low cardiac output • Use of dobutamine	A (8)
45.	• Symptomatic individuals • Mild mitral stenosis	A (7)
47.	• Asymptomatic severe AI or MR • LV size and function not meeting surgical criteria	A (7)
Contrast Use—Use of Contrast With Stress Echo		
51.	• Selective use of contrast • 2 or more contiguous segments are NOT seen on noncontrast images	A (8)

Table 12. Uncertain Indications (Median Score 4 to 6)

Indication		Appropriateness Score (1–9)
Detection of CAD: Symptomatic—New-Onset/Diagnosed Heart Failure With Chest Pain Syndrome or Anginal Equivalent		
10.	• Intermediate pre-test probability • Abnormal LV systolic function	U (5)
Detection of CAD and Risk Assessment: Asymptomatic (Without Chest Pain Syndrome or Anginal Equivalent) General Patient Populations		
13.	• High CHD risk (Framingham)	U (6)
Detection of CAD/Risk Assessment: Without Chest Pain Syndrome or Anginal Equivalent in Patient Populations With Defined Comorbidities—New-Onset or Diagnosed Heart Failure or LV Systolic Dysfunction		
15.	• Moderate CHD risk (Framingham) • No prior CAD evaluation • Abnormal LV systolic dysfunction	U (5)
Risk Assessment With Prior Test Results—Asymptomatic OR Stable Symptoms, Normal Prior Stress Imaging Study		
21.	• High CHD risk • Repeat stress echo study after 2 years or greater	U (5)
Risk Assessment With Prior Test Results—Known CAD: Asymptomatic OR Stable Symptoms, Abnormal Catheterization OR Abnormal Prior Stress Imaging Study		
23.	• Assessment of severity of ischemia (CAD) • Greater than or equal to 2 years to evaluate medically managed patients	U (5)
Risk Assessment: Post-Revascularization (PCI or CABG)—Asymptomatic		
37.	• Asymptomatic (e.g., silent ischemia) prior to previous revascularization • Greater than or equal to 5 years after CABG	U (6)
38.	• Symptomatic prior to previous revascularization • Greater than or equal to 5 years after CABG	U (5)
41.	• Asymptomatic (e.g., silent ischemia) prior to previous revascularization • Greater than or equal to 2 years after PCI	U (5)
Stress Study for Hemodynamics (Includes Doppler During Stress)—Valvular Stenosis		
44.	• Asymptomatic individuals • Mild to moderate mitral stenosis	U (5)
Stress Study for Hemodynamics (Includes Doppler During Stress)—Pulmonary Hypertension		
49.	• Suspected pulmonary hypertension • Normal or indeterminate resting echo study	U (5)

Table 13. Inappropriate Indications (Median Score 1 to 3)

	Indication	Appropriateness Score (1–9)
	Detection of CAD: Symptomatic—Evaluation of Chest Pain Syndrome or Anginal Equivalent	
1.	• Low pre-test probability of CAD • ECG interpretable AND able to exercise	I (3)
	Detection of CAD: Symptomatic—Acute Chest Pain	
8.	• High pre-test probability of CAD • ECG ST-elevation	I (1)
	Detection of CAD and Risk Assessment: Asymptomatic (Without Chest Pain Syndrome or Anginal Equivalent)—General Patient Populations	
11.	• Low CHD risk (Framingham risk criteria)	I (1)
12.	• Moderate CHD risk (Framingham) • ECG interpretable	I (3)*
	Detection of CAD/Risk Assessment: Without Chest Pain Syndrome or Anginal Equivalent in Patient Populations With Defined Comorbidities—Valvular Heart Disease Requiring Valve Surgery	
16.	• Moderate CHD risk (Framingham)	I (3)
	Detection of CAD/Risk Assessment: Without Chest Pain Syndrome or Anginal Equivalent in Patient Populations With Defined Comorbidities—New-Onset Atrial Fibrillation	
17.	• Low CHD risk (Framingham) • Part of the evaluation	I (2)*
	Risk Assessment With Prior Test Results—Asymptomatic OR Stable Symptoms, Normal Prior Stress Imaging Study	
20.	• High CHD risk • Repeat stress echo study annually	I (2)
	Risk Assessment With Prior Test Results—Known CAD: Asymptomatic OR Stable Symptoms, Abnormal Catheterization OR Abnormal Prior Stress Imaging Study	
22.	• Assessment of severity of ischemia (CAD) • Less than 1 year to evaluate medically managed patients	I (2)
	Risk Assessment With Prior Test Results—Asymptomatic, Prior Coronary Calcium Agatston Score	
26.	• Agatston score less than 100	I (1)
	Risk Assessment: Preoperative Evaluation for Noncardiac Surgery—Low-Risk Surgery	
28.	• Preoperative evaluation for noncardiac surgery risk assessment • Minor or intermediate clinical risk predictors	I (1)
	Risk Assessment: Preoperative Evaluation for Noncardiac Surgery—Intermediate-Risk Surgery	
29.	• Poor exercise tolerance (less than or equal to 4 METs) • Minor or no clinical risk predictors	I (2)
	Risk Assessment: Preoperative Evaluation for Noncardiac Surgery—High-Risk Nonemergent Surgery	
32.	• Asymptomatic up to 1 year after normal catheterization, noninvasive test, or previous revascularization	I (1)
	Risk Assessment: Following Acute Coronary Syndrome—Asymptomatic Post-Revascularization (PCI or CABG)	
34.	• Routine evaluation prior to hospital discharge	I (1)
	Risk Assessment: Post-Revascularization (PCI or CABG)—Asymptomatic	
36.	• Less than 5 years after CABG	I (2)*
39.	• Asymptomatic (eg, silent ischemia) prior to previous revascularization • Less than 2 years after PCI	I (3)*
40.	• Symptomatic prior to previous revascularization • Less than 2 years after PCI	I (2)
	Stress Study for Hemodynamics (Includes Doppler During Stress)—Valvular Stenosis	
46.	• Severe aortic or mitral stenosis	I (2)
48.	• Severe AI or MR • Symptomatic or with severe LV enlargement or LV systolic dysfunction	I (2)
	Contrast Use–Use of Contrast With Stress Echo	
50.	• Routine use of contrast • All segments visualized on noncontrast images	I (1)

*The ranking of this indication as inappropriate is different from that given to similar but not identical indications in previously published appropriateness criteria. The ratings were done in accordance with established ACCF methodology. Furthermore, the Technical Panel for each modality operated independently without allowance and with discouragement for intermodality comparisons. Discrepant scores may be related to rating variability, differing Technical Panel composition, maturation of the appropriateness criteria process, or perceived differences in appropriateness.

General Discussion

The appropriateness criteria in this report provide an estimate of the reasonableness of the use of stress echocardiography for the particular clinical scenarios presented in each of the 51 indications considered. They are expected to be useful for clinicians, health care facilities, and third-party payers engaged in the delivery of cardiovascular imaging. Experience with already published appropriateness criteria[1,2] has shown their value across a broad range of situations, guiding care of individual patients, educating caregivers, and informing policy decisions regarding reimbursement for cardiovascular imaging.

Appropriateness criteria represent the first component of the chain of quality recommended for cardiovascular imaging.[11] After ensuring proper test selection, the achievement of quality in imaging includes adherence to best practices in image acquisition, image interpretation, and results communication, as well as incorporation of findings into clinical care. All components are important for optimal patient care, although not all are addressed in this report. The development of appropriateness criteria and their ranking by the Technical Panel assumes that other quality standards are adequately met. It also is assumed that when considering the appropriateness of ordering a repeat or annual test that the prior image and report can be obtained and are of sufficient quality as outlined above.

Although the appropriateness ratings reflect a general expert consensus of when stress echocardiography may or may not be useful for specific patient populations, physicians and other stakeholders should understand the role of clinical judgment in determining whether to order a test for an individual patient. For example, the rating of an indication as inappropriate should not preclude a provider from performing stress echocardiographic procedures when there are patient- and condition-specific data to support that decision. Indeed this may be the correct clinical pathway if supported by mitigating characteristics of the patient. Likewise, uncertain indications often require individual physician judgment and understanding of the patient to better determine the usefulness of a test for a particular scenario. As such, the ranking of an indication as uncertain (score 4 to 6) should not be viewed as limiting the use of stress echocardiography for such patients. Finally, there may be clinical situations in which the use of stress echocardiography for an indication considered to be appropriate does not always represent reasonable practice, such as a patient in whom another diagnostic imaging test might be scheduled or has already been performed.

The indications contained in this report are purposefully broad to capture the range of situations in which clinicians find value in stress echocardiography information. However, as with the appropriateness criteria for other imaging modalities, they are not exhaustive because of the complexity and number of the potential clinical situations. For example, neither the use of stress echocardiography prior to organ transplantation nor all forms of perioperative echocardiography were included as separate indications but are assumed to be covered by the more general perioperative guidelines.[10]

Stress echocardiography tests, like many imaging tests, may provide additional useful information beyond the primary purpose outlined by the indication. The appropriateness criteria for stress echocardiography were not developed to quantify the incremental information obtained by performing the test for reasons beyond those stated in an individual indication. For example, the additional information available with a stress echocardiogram, including the assessment of resting ejection fraction or the identification of concomitant valve disease, was not considered when determining the appropriateness rankings. Thus, members of the Technical Panel were asked specifically not to consider implicit or additional information outside the scope of an individual indication in their rankings. As such, the entire list of indications from this document and those published separately for transthoracic and transesophageal echocardiography[12] should be reviewed to assess a broader range of potential reasons for ordering a stress echocardiogram for an individual patient.

In addition, panelists were asked specifically not to consider comparisons to other imaging procedures or other appropriateness criteria documents while completing their rankings. While stress CT and MR are newer modalities which have not been extensively studied, stress echocardiography and stress SPECT MPI have similar bodies of evidence to support their use. The overwhelming majority of final ratings of stress echocardiography and stress SPECT MPI were concordant for similar clinical indications. However, a small number of the final scores and rating categories reported in this document differ from those previously published for stress SPECT MPI. Readers should note, however, that the categorical summaries tend to accentuate differences that sometimes are slight. For example, small fluctuations in a median rating (eg, 4 vs 3) will cause an indication to switch appropriateness categories (eg, from uncertain to inappropriate).

There are several potential reasons for these discordant occurrences. The most likely reason for this is a simple variation in rating by the different panel members, whether due to composition, different levels of clinical experience, or different interpretations of data. The RAND process has documented that the interpretation of the literature by different sets of experts can yield slightly different final ratings.[4] For example, one panel may contain a slightly higher percentage of "modality experts" than another panel. The Appropriateness Criteria Task Force has subsequently examined this influence of specialty and made every effort to provide a balance of expertise. Another source of potential variation is timing. As appropriateness criteria gain more exposure, Technical Panel members have greater familiarity with the indications and implementation requirements than the panels of prior modules. Inconsistency in wording of indications for the stress echocardiography and stress nuclear panels may have also contributed to differences in some scenarios. For example, stress echocardiography indications combined CAD detection and risk assessment into single indications, whereas the criteria for stress SPECT separated these indications.

The indications were developed and rated prior to the release of the ACC/AHA 2007 Perioperative Guidelines.[10] As

such, in addition to the Online Appendix (http://content.onlinejacc.org), the reader should refer to the 2007 version of the guidelines for further discussion of the use of noninvasive testing prior to surgery.

There are many potential applications for appropriateness criteria. Clinicians could use the ratings as a decision support or educational tool when ordering a test or providing a referral to another qualified physician. The criteria also may be used to facilitate discussion with referring clinicians who have patterns of ordering tests for inappropriate indications. Facilities and payers may choose to use the criteria either prospectively in the design of protocols, automated order entry, and pre-authorization procedures, or retrospectively for quality reports. It is hoped that payers will use this document as the basis to inform rational strategies to ensure that their members receive the highest-quality, cost-effective cardiovascular care.

As outlined in the original methodology by the ACCF,[3] it is expected that services performed for appropriate indications will receive reimbursement. In contrast, services performed for inappropriate indications will likely require additional documentation to justify payment because of unique circumstances or the clinical profile of the patient. Payers should note that the Technical Panel and clinical community do not consider uncertain indications as those that should not be performed or reimbursed. Rather, the uncertain indications are those where the opinions of the panel vary and the data may be conflicting. In many of these areas, additional research is clearly desirable. Indications with high clinical volume that are rated as uncertain identify areas for increased focus and research.

When used to assess performance, appropriateness criteria should be applied in conjunction with systems that support quality improvement. Ordering forms containing essential information for determining appropriateness along with periodic feedback reports to providers may help educate providers on their ordering patterns. Prospective pre-authorization procedures, if put in place, are most effective once a retrospective review has identified a pattern of potential inappropriate use. Because the criteria are based on current scientific evidence and the deliberations of the Technical Panel, they should be used prospectively to generate future discussions about reimbursement, but should *not* be applied retrospectively to cases completed prior to issuance of this report.

The primary objective of this report is to provide guidance regarding the perceived suitability of stress echocardiography for diverse clinical scenarios. As with previous appropriateness criteria documents, consensus among the raters was desirable, but any attempt to achieve complete agreement within this diverse panel would have been artificial and not necessarily of clinical value. Two rounds of ratings with lively discussion between the ratings did lead to some consensus among panelists. However, further attempts to drive consensus would have diluted true differences in opinion among panelists and, therefore, was not undertaken.

Future research analyzing patient outcomes utilizing indications rated appropriate would help ensure the equitable and efficient allocation of resources for diagnostic studies. Review of medically necessary care may also improve the understanding of regional variations in imaging utilization. Further exploration of the indications rated as "uncertain" will help generate the data required to further define the appropriateness of stress echocardiography. Finally, it will be necessary to periodically assess and update the indications and criteria as technology evolves and new data and field experience become available.

Appendix A: Stress Echocardiography Definitions

Determining Pre-Test Probability of CAD

Angina: as defined by the ACC/AHA Guidelines on Exercise Testing[9]

- ***Typical*** **Angina (Definite)**[13]:

1. Substernal chest pain or discomfort that is
2. provoked by exertion or emotional stress and
3. relieved by rest and/or nitroglycerin.

- ***Atypical*** **Angina (Probable):** Chest pain or discomfort that lacks one of the characteristics of definite or typical angina (13).

Nonanginal **Chest Pain:** Chest pain or discomfort that meets one or none of the typical angina characteristics.[13]

Chest Pain Syndrome or Anginal Equivalent: Any constellation of symptoms that the physician feels may represent a complaint consistent with obstructive CAD. Examples of such symptoms include, but are not exclusive to, chest pain, chest tightness, burning, dyspnea, shoulder pain, palpitations, syncope, breathlessness, and jaw pain.

Pre-Test Probability of CAD: Once the physician determines the presence of symptoms that may represent obstructive CAD (chest pain syndrome or anginal equivalent present), then the pre-test probability of CAD should be determined. There are a number of risk algorithms[14,15] available that can be used to calculate this probability. Clinicians should become familiar with those that pertain to the populations they encounter most often. In scoring the indications, the following probabilities as calculated from any of the various available algorithms should be applied.

Table A1. Pre-Test Likelihood of CAD in Symptomatic Patients According to Age and Gender* (Combined Diamond/Forrester and CASS Data)[17,18]

Age (Years)	Nonanginal Chest Pain		Atypical Angina		Typical Angina	
	Men	Women	Men	Women	Men	Women
30–39	4	2	34	12	76	26
40–49	13	3	51	22	87	55
50–59	20	7	65	31	93	73
60–69	27	14	72	51	94	86

*Each value represents the percentage with significant CAD on catheterization.

Table A2. Comparing Pre-Test Likelihoods of CAD in Low-Risk Symptomatic Patients With High-Risk Symptomatic Patients—Duke Database[15]

Age (Years)	Nonanginal Chest Pain		Atypical Angina		Typical Angina	
	Men	Women	Men	Women	Men	Women
35	3–35	1–19	8–59	2–39	30–88	10–78
45	9–47	2–22	21–70	5–43	51–92	20–79
55	23–59	4–25	45–79	10–47	80–95	38–82
65	49–69	9–29	71–86	20–51	93–97	56–84

Each value represents the percent with significant CAD. The first is the percentage for a low-risk, mid-decade patient without diabetes, smoking, or hyperlipidemia. The second is that of the same age patient with diabetes, smoking, and hyperlipidemia. Both high- and low-risk patients have normal resting ECGs. If ST-T-wave changes or Q waves had been present, the likelihood of CAD would be higher in each entry of the table.

- Low pre-test probability: Less than 10% pre-test probability of CAD
- Intermediate pre-test probability: Between 10% and 90% pre-test probability of CAD
- High pre-test probability: Greater than 90% pre-test probability

The method recommended by the ACC/AHA Guidelines for Chronic Stable Angina[16] is provided below as 1 example of a method used to calculate pre-test probability and is a modification of a previously published literature review.[17] Please refer to definitions of angina and Table A1. Please note that the following table only predicts pre-test probability in patients without other complicating history or ECG findings. History and electrocardiographic evidence of prior infarction dramatically affect pre-test probability. Detailed nomograms are available that incorporate the effects of a history of prior infarction, electrocardiographic Q waves, electrocardiographic ST- and T-wave changes, diabetes, smoking, and hypercholesterolemia[9] (Table A2 presents 1 example).

Determining Pre-Test Risk Assessment for Risk Stratification

Risk Assessment

The rating sheets on risk assessment include indications in patients with suspected CAD.

It is assumed that clinicians will use echocardiography studies in addition to standard methods of risk assessment as presented in the AHA/ACC Scientific Statement: Assessment of Cardiovascular Risk by Use of Multiple-Risk-Factor Assessment Equations.[19] See the scientific statement to determine Framingham Risk Score (Tables A3 and A4) to calculate CHD risk percentage. As noted in the scientific statement, these scores should be modified on the basis of additional relevant factors shown to affect risk such as obesity, physical inactivity, psychosocial factors, family history of premature CHD, ethnic characteristics (especially South Asians in the United States), and hypertriglyceridemia.

Table A3. Men: 10-Year CHD Risk According to Framingham Risk Score

Age	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74		
(Low-risk level)*	(2%)	(3%)	(3%)	(4%)	(5%)	(7%)	(8%)	(10%)	(13%)	Absolute Risk	Absolute Risk§
Points†										Total CHD‡	Hard CHD§
0	1.0									2%	2%
1	1.5	1.0	1.0							3%	2%
2	2.0	1.3	1.3	1.0						4%	3%
3	2.5	1.7	1.7	1.3	1.0					5%	4%
4	3.5	2.3	2.3	1.8	1.4	1.0				7%	5%
5	4.0	2.6	2.6	2.0	1.6	1.1	1.0			8%	6%
6	5.0	3.3	3.3	2.5	2.0	1.4	1.3	1.0		10%	7%
7	6.5	4.3	4.3	3.3	2.6	1.9	1.6	1.3	1.0	13%	9%
8	8.0	5.3	5.3	4.0	3.2	2.3	2.0	1.6	1.2	16%	13%
9	10.0	6.7	6.7	5.0	4.0	2.9	2.5	2.0	1.5	20%	16%
10	12.5	8.3	8.3	6.3	5.0	3.6	3.1	2.5	1.9	25%	20%
11	15.5	10.3	10.3	7.8	6.1	4.4	3.9	3.1	2.3	31%	25%
12	18.5	12.3	12.3	9.3	7.4	5.2	4.6	3.7	2.8	37%	30%
13	22.5	15.0	15.0	11.3	9.0	6.4	5.6	4.5	3.5	45%	35%
>14	26.5	>17.7	>17.7	>13.3	>10.6	>7.6	>6.6	>5.3	>4.1	>53%	>45%

Green indicates below average risk; violet, average risk; yellow, moderately above average risk; and red, high risk. *Low-risk level is defined in the Framingham Report[21] as the risk of CHD at any age for a nonsmoker, nondiabetic, with blood pressure less than 120/80 mm Hg, total cholesterol of 160 to 199 mg/dL, LDL-C 100 to 129 mg/dL, and HDL-C greater than or equal to 45 mg/dL in men and greater than or equal to 55 mg/dL in women. †Number of points estimated from Table 4 of Grundy et al.[19] ‡Total Coronary Heart Disease (Total CHD) includes angina pectoris, recognized and unrecognized myocardial infarction, unstable angina, and CHD deaths. §Hard CHD includes all of the total CHD events except for angina pectoris. Adapted from Grundy et al.[19]

Table A4. Women: 10-Year CHD Risk According to Framingham Risk Score

Age	40–44	45–49	50–54	55–59	60–64	65–69	70–74		
(Low-risk level)*	(2%)	(3%)	(5%)	(7%)	(8%)	(8%)	(8%)	Absolute Risk	Absolute Risk
Points†								Total CHD ‡	Hard CHD§
0	1.0							2%	1%
1	1.0							2%	1%
2	1.5	1.0						3%	2%
3	1.5	1.0						3%	2%
4	2.0	1.3						4%	2%
5	2.0	1.3						4%	2%
6	2.5	1.7	1.0					5%	2%
7	3.0	2.0	1.2					6%	3%
8	3.5	2.3	1.4	1.0				7%	3%
9	4.0	2.7	1.6	1.1	1.0	1.0	1.0	8%	3%
10	5.0	3.3	2.0	1.4	1.3	1.3	1.3	10%	4%
11	5.5	3.7	2.2	1.6	1.4	1.4	1.4	11%	7%
12	6.5	4.3	2.6	1.9	1.6	1.6	1.6	13%	8%
13	7.5	5.0	3.0	2.1	1.9	1.9	1.9	15%	11%
14	9.0	6.0	3.6	2.6	2.3	2.3	2.3	18%	13%
15	10.0	6.7	4.0	2.9	2.5	2.5	2.5	20%	15%
16	12.0	8.0	4.8	3.4	3.0	3.0	3.0	24%	18%
≥ 17	>13.5	>9.0	>5.4	>3.9	5.4	5.4	5.4	>27%	>20%

Green indicates below average risk; violet, average risk; yellow, moderately above average risk; and red, high risk. ∗Low-risk level is defined in the Framingham Report[21] as the risk of CHD at any age for a nonsmoker, nondiabetic, with blood pressure less than 120/80 mm Hg, total cholesterol of 160 to 199 mg/dL, LDL-C 100 to 129 mg/dL, and HDL-C greater than or equal to 45 mg/dL in men and greater than or equal to 55 mg/dL in women. †Number of points estimated from Table 4 of Grundy et al.[19] ‡Total Coronary Heart Disease (Total CHD) includes angina pectoris, recognized and unrecognized myocardial infarction, unstable angina, and CHD deaths. §Hard CHD includes all of the total CHD events except for angina pectoris. Adapted from Grundy et al.[19]

CHD Risk‡

(Based on the AHA/ACC Scientific Statement on Cardiovascular Risk Assessment[19])

- **CHD Risk–Low**
  Defined by the age-specific risk level that is below average. In general, low risk will correlate with a 10-year absolute CHD risk less than 10%.
- **CHD Risk–Moderate**
  Defined by the age-specific risk level that is average or above average. In general, moderate risk will correlate with a 10-year absolute CHD risk between 10% to 20%.
- **CHD Risk–High**
  Defined as a 10-year absolute CHD risk of greater than 20% or the presence of diabetes mellitus.†

Evaluating Perioperative Risk for Noncardiac Surgery§

Method for Determining Perioperative Risk

(Based on the recommendations from the ACC/AHA Perioperative Cardiovascular Evaluation for Noncardiac Surgery[20])

Review Figure A1, "Stepwise Approach to Preoperative Cardiac Assessment." Based on the algorithm, once it is determined that the patient does not require urgent surgery, and that there has not been revascularization within the last 5 years, the clinician should determine the patient's perioperative risk predictors (see definitions in the following text). If major risk predictors are present, Figure A1 suggests consideration of coronary angiography and postponing or canceling noncardiac surgery. Once perioperative risk predictors are assessed based on the algorithm, then the surgical risk and patient's functional status should be used to establish the need for noninvasive testing.

‡Grundy et al.[19] cite Framingham when assigning patients with diabetes mellitus to a category of high short-term risk because these patients typically have multiple risk factors and have poor prognoses if they develop CHD.

§Definitions and algorithms cited were current at the time of the technical panel and are those reviewed by the technical panel at time of rating. See 2007 ACC/AHA Perioperative Guidelines for updated content.[10]

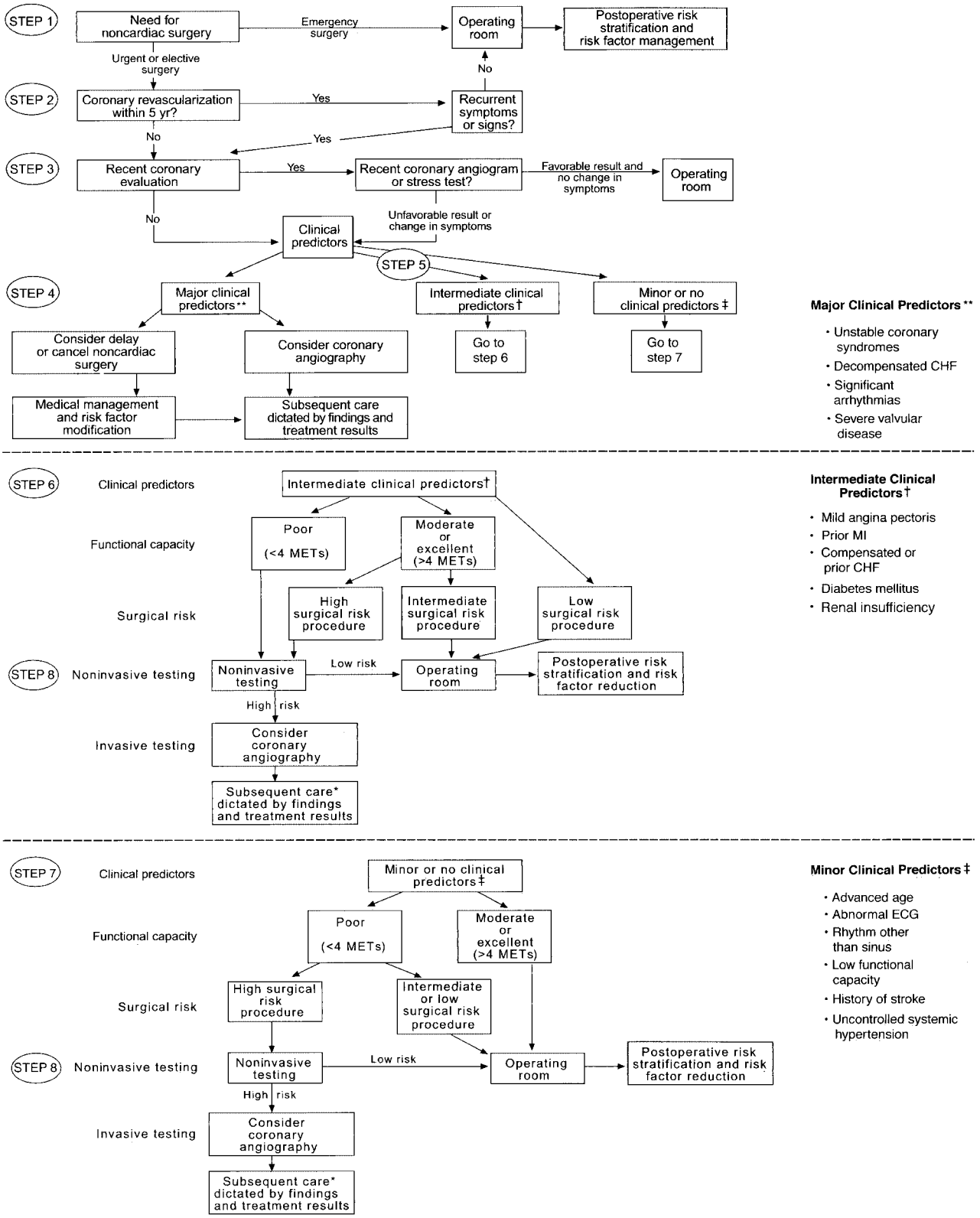

Figure A1. Stepwise Approach to Preoperative Cardiac Assessment. Steps are discussed in the text. Definitions and algorithms cited were current at the time of the technical panel and are those reviewed by the technical panel at time of rating. See 2007 ACC/AHA Perioperative Guidelines for updated content.[10] *Subsequent care may include cancellation or delay of surgery, coronary revascularization followed by noncardiac surgery, or intensified care. CHF = congestive heart failure; ECG = electrocardiogram; MET = metabolic equivalent; MI = myocardial infarction.

Perioperative Risk Predictors‖

- **Major risk predictors**

Unstable coronary syndromes, decompensated HF, significant arrhythmias, and severe valve disease.

- **Intermediate risk predictors**

Mild angina, prior MI, compensated or prior HF, diabetes, or renal insufficiency.

- **Minor risk predictors**

Advanced age, abnormal ECG, rhythm other than sinus, low functional capacity, history of cerebrovascular accident, and uncontrolled hypertension.

Surgical Risk Categories‖

- High-Risk Surgery–cardiac death or MI greater than 5%
  Emergent major operations (particularly in the elderly), aortic and peripheral vascular surgery, prolonged surgical procedures associated with large fluid shifts and/or blood loss.
- Intermediate-Risk Surgery–cardiac death or MI equal to 1% to 5%
  Carotid endarterectomy, head and neck surgery, surgery of the chest or abdomen, orthopedic surgery, prostate surgery.
- Low-Risk Surgery–cardiac death or MI less than 1%
  Endoscopic procedures, superficial procedures, cataract surgery, breast surgery.

ECG–Uninterpretable

Refers to ECGs with resting ST-segment depression (greater than or equal to 0.10 mV), complete left bundle-branch block, pre-excitation (Wolff-Parkinson-White syndrome), or paced rhythm.

Appendix B: Methods

Panel Selection

Stakeholders were given the opportunity to participate in the appropriateness criteria process by submitting nominees from their organizations through a Call for Nominations released in the summer of 2006. From this list of nominees, the Task Force selected panel members to ensure an appropriate balance with respect to expertise in the specific modality, referring physicians, academic versus private practice, health services research, and specialty training.

Development of Indications

The process for creating a robust set of indications involved consulting current literature and previously published guidelines and clinical policy statements. The indications capture the majority of scenarios faced by cardiologists or referring physicians, but are not meant to be inclusive of all potential indications for which a stress echocardiography imaging study may be performed. Review was done by the Task Force, including additional comments from external reviewers. As a result of the meeting of the Technical Panel prior to the second round of rating, a number of the indications were clarified and modified. A final set of indications comprised the list of possible clinical scenarios that were rated for appropriateness by the panelists and compiled for this report.

Rating Process

The Technical Panel was instructed to follow the process outlined in the document, "ACCF Proposed Method for Evaluating the Appropriateness of Cardiovascular Imaging".[3] The appropriateness method combines expert clinical judgment with the scientific literature in evaluating the benefits and risks of medical procedures. Each panel member has equal weight in producing the final result for the set of indications they are asked to rate and the method does not force consensus.

The rating process includes a modified Delphi process involving 2 rounds of ratings and an intervening face-to-face meeting. At the face-to-face meeting, each panelist received a personalized rating form that indicated his or her rating for each indication and the distribution of de-identified ratings of other members of the panel. In addition, the moderator received a summary rating form with similar information (including panelist identification), along with other statistics that measured the level of agreement among panel members. A measure of the level of disagreement was applied to each score after both the first and second round scoring was completed. This project employed the BIOMED Concerted Action on Appropriateness definition for a panel size of 14 to 16. As defined in the RAND/UCLA manual[4] upon which the ACCF ratings method is based, the BIOMED rule for agreement (+) is that no more than 4 panelists rate the indication outside the 3-point region containing the median; for disagreement (−), at least 5 panelists rate in each extreme rating region (ie, 1 to 3 and 7 to 9). Measures of agreement and the dispersion of ratings (mean absolute deviation from the median) may highlight areas where definitions are not clear or ratings are inconsistent, where panelist perceptions of the "average" patient may differ, or where various specialty groups or individual panelists may have differences of clinical opinion. In cases of obvious disagreement or outlier scores, the indication was highlighted in a summary table and identification of the outlier raters brought to the attention of the moderator. This information was used by the moderator to guide the panel's discussion.

Relationships With Industry

The ACCF and its partnering organizations rigorously avoid any actual, perceived, or potential conflicts of interest that may 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 may be perceived as real or potential conflicts of interest. These statements were reviewed by the

‖As defined by the ACC/AHA Guideline Update for Perioperative Cardiovascular Evaluation of Non-Cardiac Surgery.[20]

ACCF Appropriateness 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 of the Technical Panel and Task Force Members can be found in the Appendix D.

Literature Review

The Technical Panel members were asked to refer to the relevant guidelines for a summary of the relevant literature, guideline recommendation tables, and reference lists provided for each indication table when completing their ratings (Online Appendix at http://content.onlinejacc.org). Lastly, they were provided Web links to the previously published materials pertaining to the appropriateness criteria work.[1–3]

Appendix C: ACCF Appropriateness Criteria Task Force and Technical Panels

Stress Echocardiography Writing Group

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Appendix D. ACCF/ASE/ACEP/AHA/ASNC/SCAI/SCCT/SCMR Stress Echocardiography Appropriateness Criteria Writing Group, Technical Panel, and Task Force, and Indication Reviewers—Relationships With Industry (in Alphabetical Order)

Committee Member	Research Grant	Speakers Bureau/ Honoraries/ Expert Witness	Stock Ownership	Board of Directors	Consultant/ Scientific Advisory Board/ Steering Committee
Stress Echocardiography Appropriateness Criteria Writing Group					
Dr. Pamela S. Douglas	None	None	None	None	• GE Healthcare
Dr. Bijoy Khandheria	None	None	None	None	None
Dr. Raymond F. Stainback	None	None	None	None	None
Dr. Neil J. Weissman	• Arena Pharmaceuticals • Bristol-Myers Squibb Imaging • Acusphere • Medtronic • Carbamedics • Edwards • St. Jude Medical	None	None	None	• Pfizer • Wyeth Pharmaceuticals
Stress Echocardiography Appropriateness Criteria Technical Panel					
Dr. Michael Blaivas	None	None	None	None	None
Dr. Roger D. Des Prez	None	None	None	None	None
Dr. Linda D. Gillam	• Acusphere • Bristol-Myers Squibb	• Bristol-Myers Squibb	None	None	None
Dr. Terry Golash	None	None	• Aetna	None	None
Dr. Robert C. Hendel	• Astellas Healthcare • GE Healthcare • Cornatus Genetics	• Bristol-Myers Squibb	None	None	• GE Healthcare
Dr. Loren F. Hiratzka	None	None	None	None	None
Dr. William G. Kussmaul	None	None	None	None	None
Dr. Arthur J. Labovitz	• Boehringer Ingelheim • Encysive	• Baxter Healthcare	None	None	None
Dr. JoAnn Lindenfeld	• Wyeth Pharmaceuticals • NovoCardia • Zealand • SomoLogic	None	None	None	None
Dr. Frederick A. Masoudi	None	• Takeda, North America	None	None	• Takeda, North America • Amgen • United Healthcare
Dr. Paul H. Mayo	None	None	None	None	None

(Continued)

Appendix D. Continued

Committee Member	Research Grant	Speakers Bureau/ Honoraries/ Expert Witness	Stock Ownership	Board of Directors	Consultant/ Scientific Advisory Board/ Steering Committee
Dr. Todd D. Miller	• Bristol-Myers Squibb • Radiant Medical • TherOx • TargeGen • KAI Pharmaceuticals • King Pharmaceuticals	None	None	None	None
Dr. Eric D. Peterson	• Millennium Pharmaceuticals • Schering-Plough • Bristol-Myers Squibb/Sanofi	None	None	None	None
Dr. David Porembka	None	None	None	None	None
Dr. John A. Spertus	• Amgen	None	• Amgen • Outcomes Instruments • Health Outcomes Sciences	None	• Amgen • United Healthcare
Dr. Raymond F. Stainback	None	None	None	None	None
Dr. L. Samuel Wann	None	None	None	None	None
Dr. Susan E. Wiegers	None	None	None	None	None
Stress Echocardiography Appropriateness Criteria Task Force					
Mr. Joseph M. Allen	None	None	None	None	None
Dr. Ralph G. Brindis	None	None	None	None	None
Dr. Pamela S. Douglas	None	None	None	None	• GE Healthcare
Dr. Robert C. Hendel	• Astellas Healthcare • GE Healthcare • Cornatus Genetics	• Bristol-Myers Squibb			• GE Healthcare
Dr. Manesh R. Patel	None	None	None	None	• Genzyme • Amgen
Dr. Eric D. Peterson	• Millennium Pharmaceuticals • Schering-Plough • Bristol-Myers Squibb/Sanofi	None	None	None	None
Dr. Michael J. Wolk	None	None	None	None	None
Stress Echocardiography Appropriateness Criteria Indication Reviewers					
Dr. William Armstrong	None	None	None	None	• Point Biomedical • St. Jude Medical
Dr. Christopher M. Kramer	• Siemens Medical Solutions • Novartis Healthcare • Astellas Healthcare • Merck	• GE Healthcare	None	None	None
Dr. Robert McNamara	None	None	None	None	None
Dr. Catherine M. Otto	None	None	None	None	None

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