ACCF/SCAI/STS/AATS/AHA/ASNC 2009 Appropriateness Criteria for Coronary Revascularization: A Report by the American College of Cardiology Foundation Appropriateness Criteria Task Force, Society for Cardiovascular Angiography and Interventions, Society of Thoracic Surgeons, American Association for Thoracic Surgery, American Heart Association, and the American Society of Nuclear Cardiology Endorsed by the American Society of Echocardiography, the Heart Failure Society of America, and the Society of Cardiovascular Computed Tomography

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APPROPRIATENESS CRITERIA

ACCF/SCAI/STS/AATS/AHA/ASNC 2009 Appropriateness Criteria for Coronary Revascularization

A Report of the American College of Cardiology Foundation Appropriateness Criteria Task Force, Society for Cardiovascular Angiography and Interventions, Society of Thoracic Surgeons, American Association for Thoracic Surgery, American Heart Association, and the American Society of Nuclear Cardiology

Endorsed by the American Society of Echocardiography, the Heart Failure Society of America, and the Society of Cardiovascular Computed Tomography

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Abstract

The American College of Cardiology Foundation (ACCF), Society for Cardiovascular Angiography and Interventions, Society of Thoracic Surgeons, and the American Association for Thoracic Surgery, along with key specialty and subspecialty societies, conducted an appropriateness review of common clinical scenarios in which coronary revascularization is frequently considered. The clinical scenarios were developed to mimic common situations encountered in everyday practice and included information on symptom status, extent of medical therapy, risk level as assessed by noninvasive testing, and coronary anatomy. Approximately 180 clinical scenarios were developed by a writing committee and scored by a separate technical panel on a scale of 1 to 9. Scores of 7 to 9 indicate that revascularization was considered appropriate and likely to improve health outcomes or survival. Scores of 1 to 3 indicate revascularization was considered inappropriate and unlikely to improve health outcomes or survival. The mid range (4 to 6) indicates a clinical scenario for which the likelihood that coronary revascularization would improve health outcomes or survival was considered uncertain. For the majority of the clinical scenarios, the panel only considered the appropriateness of revascularization irrespective of whether this was accomplished by percutaneous coronary intervention (PCI) or coronary artery bypass graft surgery (CABG). In a select subgroup of clinical scenarios in which revascularization is generally considered appropriate, the appropriateness of PCI and CABG individually as the primary mode of revascularization was considered.

In general, the use of coronary revascularization for patients with acute coronary syndromes and combinations of significant symptoms and/or ischemia was viewed favorably. In contrast, revascularization of asymptomatic patients or patients with

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low-risk findings on noninvasive testing and minimal medical therapy were viewed less favorably. It is anticipated that these results will have an impact on physician decision making and patient education regarding expected benefits from revascularization and will help guide future research.

Preface

The publication of appropriateness criteria reflects one of several ongoing efforts by the ACCF and its partners to assist clinicians caring for patients with cardiovascular diseases to deliver high-quality cardiovascular care. The American College of Cardiology (ACC)/American Heart Association (AHA) practice guidelines provide a foundation for summarizing evidence-based cardiovascular care and, when evidence is lacking, provide expert consensus opinion that is approved in review by the ACCF and AHA. However, in many areas, marked variability remains in the use of cardiovascular procedures, raising questions of over- or under-use. One reason for this variability is a paucity of large randomized clinical trials conducted assessing the value of technology for specific patients, including cardiac imaging, catheterization, and coronary revascularization. As such, there are many instances in practice where the guidelines provide no recommendation, or alternatively, a Level C recommendation (expert opinion). For other areas, evidence is available but variability in clinical practice remains. In either case, appropriateness criteria provide practical tools to measure this variability to examine utilization patterns.

Appropriateness criteria are developed to serve as a supplement to ACC/AHA guideline documents. Appropriateness criteria are designed to examine the use of diagnostic and therapeutic procedures to support efficient use of medical resources during the pursuit of quality medical care. The process of appropriateness criteria development has been defined previously (1). Briefly, the appropriateness criteria writing group combines specific clinical characteristics to create prototypical patient scenarios. These scenarios are then provided to a separate technical panel for appropriateness rating. The technical panel is created from nominations given by multiple relevant professional societies and provider-led organizations as well as from health policy and payer communities. To preserve objectivity, the technical panels are created so as to not include a majority of individuals whose livelihood is tied to the technology under study.

In making its appropriateness determinations, the technical panel is provided with summaries of the relevant evidence from the medical literature and practice guidelines. They are then asked first individually and then collectively to assess the benefits and risks of a test or procedure in the context of the potential benefits to patients' outcomes and an implicit understanding of the associated resource use and costs. After the ranking process, the final appropriateness ratings are summarized using an established rigorous methodology (2).

Appropriateness criteria are based on current understanding of the technical capabilities and potential patient benefits of the procedures examined. Future evidence development may require these ratings to be updated. The appropriateness criteria are also developed to identify common clinical scenarios—but they cannot possibly include every conceivable clinical situation. Thus, some patients seen in clinical practice are not represented in these appropriateness criteria or have additional extenuating features compared with the clinical scenarios presented. Additionally, although appropriateness criteria indications and ratings are shaped by the practice guidelines, the appropriateness criteria often contain more detailed scenarios than the more generalized situations covered in clinical practice guidelines, and thus, subtle differences between these 2 guidance tools is possible.

Finally, appropriateness criteria are intended to assist patients and clinicians, but are not intended to diminish the acknowledged difficulty or uncertainty of clinical decision making and cannot act as substitutes for sound clinical judgment and practice experience. Rather, the aim of these criteria is to allow assessment of utilization patterns for a test or procedure. Comparing utilization patterns across a large subset of provider's patients can allow for an assessment of a provider's management strategies with those of his/her peers. The ACCF and its collaborators believe that an ongoing review of one's practice using these criteria will help guide a more effective, efficient, and equitable allocation of health care resources, and ultimately, better patient outcomes.

In developing these appropriateness criteria for coronary revascularization, the technical panel was asked to assess whether coronary revascularization for each indication was appropriate, uncertain, or inappropriate using the following definition of appropriateness:

Coronary revascularization is appropriate when the expected benefits, in terms of survival or health outcomes (symptoms, functional status, and/or quality of life) exceed the expected negative consequences of the procedure.

The technical panel scored each indication on a scale from 1 to 9 as follows:

Appropriate: Score 7 to 9

Appropriate for the indication provided, meaning coronary revascularization **is** generally acceptable and **is** a reasonable approach for the indication and is **likely** to improve the patients' health outcomes or survival.

Uncertain: Score 4 to 6

Uncertain for the indication provided, meaning coronary revascularization **may** be acceptable and **may** be a reasonable approach for the indication but with uncertainty implying that more research and/or patient information is needed to further classify the indication.

Inappropriate: Score 1 to 3

Inappropriate for the indication provided, meaning coronary revascularization is **not** generally acceptable and is **not** a reasonable approach for the indication and is **unlikely** to improve the patients' health outcomes or survival.

It is acknowledged that grouping these scores into 3 categories is somewhat arbitrary and that the numeric designations should be viewed as a continuum. Since some diversity in clinical opinions for particular clinical scenarios will exist or available research is limited or conflicting, scores in the intermediate level of appropriateness are labeled "uncertain." This identifies the need for targeted investigations to clarify the best therapy in these circumstances. It is anticipated that these appropriateness criteria will require updates as further data are generated and information from the implementation of these criteria accumulates.

To prevent bias in the scoring process, the technical panel was deliberately comprised of physicians with varying perspectives on coronary revascularization and not comprised solely of experts (e.g., interventional cardiologists or cardiovascular surgeons) in the particular procedure under evaluation. Such experts, 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 national practice guidelines and a broad range of 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 their thoughtful and thorough deliberation of the merits of coronary revascularization 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 the many individuals who provided a careful review of the draft indications: to Peggy Christiansen, the ACCF librarian, for her comprehensive literature searches; to Karen Caruth, who continually drove the process forward; to Lindsey Law and Kennedy Elliott, who helped map these criteria with existing ACC/AHA practice guidelines; and to Manesh Patel, MD, the chair of the writing committee, for his dedication, insight and leadership.

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Introduction

This report addresses the appropriateness of coronary revascularization. The increasing prevalence of coronary artery disease (CAD), advances in surgical and percutaneous techniques for revascularization as well as concomitant medical therapy for CAD, and the costs of revascularization have resulted in heightened interest regarding the appropriateness of coronary revascularization. Clinicians, payers, and patients are interested in the specific benefits of revascularization. Importantly, inappropriate use of revascularization may be potentially harmful to patients and generate unwarranted costs to the health care system, whereas appropriate procedures should likely improve patients' clinical outcomes.

All prior appropriateness criteria publications from the ACCF and collaborating organizations have reflected an ongoing effort to critically and systematically create, review, and categorize the appropriateness of certain cardiovascular diagnostic tests. This document presents the first attempt to develop appropriateness criteria for therapeutic procedures: in this case, 2 distinct approaches to coronary artery revascularization. This is an important shift to the explicit consideration of the potential benefits and risks of a therapeutic procedure. This document presents the results of this effort, but it is critical to understand the background and scope of this document before interpreting the rating tables.

Methods

Briefly, this process combines evidence-based medicine, guidelines, and practice experience by engaging a technical panel in a modified Delphi exercise as previously described by RAND (2).

Indication Development

The writing group for the coronary revascularization indications was comprised of members from the relevant professional societies including both practicing interventional cardiologists and a cardiothoracic surgeon. Recognizing variability in many patient factors, local practice patterns, and a lack of data comparing PCI with CABG in all possible clinical scenarios, the technical panel was asked to rate the majority of clinical indications only for the appropriateness of revascularization and not to distinguish between the specific modes of revascularization (i.e., PCI versus CABG). In addition, the writing group identified indications for patients with advanced coronary disease and symptoms, where revascularization is generally considered to be appropriate. In this section, PCI and CABG were independently evaluated for appropriateness.

Once the indications were drafted, reviewers from all participating collaborators and stakeholders, including cardiovascular and surgical societies, provided feedback regarding the clinical indications for coronary revascularization. These comments led to substantial improvements and changes in the clinical scenarios.

Scope of Indications

The indications contained in this report are purposefully broad and intended to represent the most common patient scenarios for which coronary revascularization is considered. The development of these clinical scenarios re-emphasized to the writing group the complexity of the decision-making process for revascularization and the number of variables that inform this decision. The writing group estimated that over 4,000 separate clinical scenarios would be required to incorporate all permutations of these variables. However, providing that level of granularity to this framework would be cumbersome and likely degrade the purpose of these

criteria. As this was not a viable option, the indications were developed considering the following common variables:

a. The clinical presentation (e.g., acute coronary syndrome, stable angina, and so on);
b. Severity of angina (asymptomatic, Canadian Cardiovascular Society [CCS] Class I, II, III, or IV);
c. Extent of ischemia on noninvasive testing and the presence or absence of other prognostic factors, such as congestive heart failure (CHF), depressed left ventricular function, or diabetes;
d. Extent of medical therapy; and
e. Extent of anatomic disease (1-, 2-, 3-vessel disease, with or without proximal left anterior descending artery [LAD] or left main coronary disease).

The clinical indications developed include coronary anatomy, as this is the focus of much of the previous literature on coronary revascularization. However, the writing group recognizes that for everyday patient care, symptom status, ischemic burden, and level of medical therapy often play a critical role in decision making even before the coronary anatomy has been defined by angiography.

Please note that the indications focus on revascularization, percutaneous or surgical, and therefore do not address diagnostic catheterization or coronary angiography. Additionally, the clinical scenarios presented are not inclusive of every possible clinical situation. For example, the use of coronary revascularization for patients with multivessel disease including 1 or more occluded vessels and clinical symptoms or ischemia was not included as a separate indication since other variations of multivessel disease are present.

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 announced in the summer of 2006. From this list of nominees, the task force and writing group selected technical panel members to ensure an appropriate balance with respect to expertise. The 17-member technical panel was composed of 4 interventional cardiologists, 4 cardiovascular surgeons, 8 members representing cardiologists, other physicians who treat patients with cardiovascular disease, health outcome researchers, and 1 medical officer from a health plan.

Rating Process and Scoring

The panel members first rated indications independently. Then the panel met for a discussion of each indication. After the face-to-face discussion, panel members then independently provided their final scores for each indication. Each panel member had equal weight in producing the final result for the indications and was not forced into consensus. For each indication, the median numerical score was determined.

At the face-to-face meeting, each panelist received a personalized rating form that indicated his/her rating for each indication and the distribution of deidentified 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 reflecting the level of agreement among panel members. The level of agreement among panelists, as defined by RAND, was analyzed for each indication based on the BIOMED rule for a panel of 14 to 16 (a simplified RAND method for determining disagreement) (2). Per the BIOMED definition, 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 a situation where at least 5 panelists' ratings fell in both the appropriate and the inappropriate categories. Because the panel had 17 representatives, which exceeded the 16 addressed in this rule, an additional level of agreement analysis as described by RAND was performed that examines the interpercentile range compared to interpercentile range adjusted for symmetry (2). This information was used by the moderator to guide the panel's discussion by highlighting areas of differences among the panelists.

General Assumptions

Specific assumptions are provided that were considered by the technical panel in rating the relevant clinical indications for the appropriateness of revascularization:

1. Each clinical indication includes the patient's clinical status/symptom complex, ischemic burden by noninvasive functional testing when presented, burden of coronary atherosclerosis as determined by angiography, and intensity of medical therapy in the determination of the appropriateness of coronary revascularization.
2. Assume coronary angiography has been performed when these findings are presented in the clinical indications. The panel should rate the appropriateness of revascularization based upon the clinical features and coronary findings, and not the appropriateness of diagnostic coronary angiography.
3. Assume left main coronary artery stenosis (greater than or equal to 50% luminal diameter narrowing) or proximal LAD stenosis (greater than or equal to 70% luminal diameter narrowing) is not present unless specifically noted. Assume no other significant coronary artery stenoses are present except those noted in the clinical scenario.
4. The clinical scenarios should be rated based on the published literature regarding the risks and benefits of percutaneous and surgical coronary revascularization. Note that specific patient groups not well represented in the literature are not presented in the current clinical scenarios. However, the writing group recognizes that decisions about coronary artery revascularization in such patients are frequently required. Examples of such

Table A. CAD Prognostic Index

Extent of CAD	Prognostic Weight (0–100)	5-Year Survival Rate (%)*
1-vessel disease, 75%	23	93
>1-vessel disease, 50% to 74%	23	93
1-vessel disease, ≥95%	32	91
2-vessel disease	37	88
2-vessel disease, both ≥95%	42	86
1-vessel disease, ≥95% proximal LAD	48	83
2-vessel disease, ≥95% LAD	48	83
2-vessel disease, ≥95% proximal LAD	56	79
3-vessel disease	56	79
3-vessel disease, ≥95% in at least 1	63	73
3-vessel disease, 75% proximal LAD	67	67
3-vessel disease, ≥95% proximal LAD	74	59

*Assuming medical treatment only. CAD indicates coronary artery disease; LAD, left anterior descending coronary artery. From Califf RM, Armstrong PW, Carver JR, et al. Task Force 5. Stratification of patients into high-, medium-, and low-risk subgroups for purposes of risk factor management. J Am Coll Cardiol. 1996;27:964–1047 (4).

patients include those with end-stage renal disease or advanced age.

5. Clinical outcome is related to the extent of coronary artery disease (Table A) (3). Based on this observation and clinical guideline recommendations regarding "borderline" angiographic stenoses (50% to 60%) in epicardial (non-left main) locations, a significant coronary stenosis for the purpose of the clinical scenarios is defined as:
   - greater than or equal to 70% luminal diameter narrowing, by visual assessment, of an epicardial stenosis measured in the "worst view" angiographic projection.
   - greater than or equal to 50% luminal diameter narrowing, by visual assessment, of a left main stenosis measured in the "worst view" angiographic projection.
6. All patients are receiving standard care, including guideline-based risk factor modification for primary or secondary prevention in cardiovascular patients unless specifically noted (5–9).
7. Despite the best efforts of the clinician, all patients may not achieve target goals for risk factor modification. However, a plan of care to address risk factors is assumed to be occurring in patients represented in the indications. For patients with chronic stable angina, the writing group recognizes that there is a wide variance in the medical therapy for angina. The specific definition of maximal anti-ischemic medical therapy is presented in the definition section.
8. Operators performing percutaneous or surgical revascularization have appropriate clinical training and experience and have satisfactory outcomes as assessed by quality assurance monitoring (10–12).
9. Revascularization by either percutaneous or surgical methods is performed in a manner consistent with established standards of care (10–12).
10. In the clinical scenarios, no unusual extenuating circumstances exist (such as inability to comply with antiplatelet agents, do not resuscitate status, patient unwilling to consider revascularization, technically not feasible to perform revascularization, or comorbidities likely to markedly increase procedural risk substantially), unless specifically noted.

Definitions

A complete set of definitions of terms used throughout the indication set are listed in Appendix A. These definitions were provided and discussed with the technical panel prior to ratings of indications.

Maximal Anti-Ischemic Medical Therapy

As previously stated, the indications assume that patients are receiving risk factor modification according to guideline-based recommendations. For the purposes of the clinical scenarios presented, **maximal antianginal medical therapy is defined as the use of at least 2 classes of therapies to reduce anginal symptoms.**

Stress Testing and Risk of Findings on Noninvasive Testing

Stress testing is commonly used for both diagnosis and risk stratification of patients with coronary artery disease. Using criteria defined for traditional exercise stress tests (13):

Low-risk stress test findings: associated with a cardiac mortality of less than 1% per year;

Intermediate-risk stress test findings: associated with a 1% to 3% per year cardiac mortality;

High-risk stress test findings: associated with a greater than 3% per year cardiac mortality.

Examples of findings from noninvasive studies and their associated level of risk for cardiac mortality are presented in Table A2 (12). As noted in the footnote to this table, for certain low-risk findings, there may be additional findings that alter the assessment of risk, but these relationships have not been well studied. Implicit in these risk definitions is a measure of the amount of myocardium at risk, or ischemic myocardium. For the purpose of the clinical indications for coronary revascularization, stress test findings are presented by these risk criteria. For patients without stress test findings, please refer to the note below on invasive methods of determining hemodynamic significance. Assume that when prior testing (including an imaging procedure) is referenced in an indication, the testing was performed correctly and with sufficient quality so as to produce a meaningful and accurate result within the limits of the test performance.

Table B. Grading of Angina Pectoris by the Canadian Cardiovascular Society Classification System

Class I

Ordinary physical activity does not cause angina, such as walking, climbing stairs. Angina (occurs) with strenuous, rapid, or prolonged exertion at work or recreation.

Class II

Slight limitation of ordinary activity. Angina occurs on walking or climbing stairs rapidly, walking uphill, walking or stair climbing after meals or in cold, or in wind, or under emotional stress, or only during the few hours after awakening. Angina occurs on walking more than 2 blocks on the level and climbing more than one flight of ordinary stairs at a normal pace and in normal condition.

Class III

Marked limitations of ordinary physical activity. Angina occurs on walking one to two blocks on the level and climbing one flight of stairs in normal conditions and at a normal pace.

Class IV

Inability to carry on any physical activity without discomfort—anginal symptoms may be present at rest.

From Campeau L. Grading of angina pectoris [letter]. Circulation. 1976;54:522–3 (14). Copyright 1976 American Heart Association, Inc. Reprinted with permission.

For the purposes of the clinical indications in this document, patients with both typical and atypical angina are classified by the feature of the CCS grading system presented in Table B. Patients with noncardiac chest pain should be considered to be asymptomatic.

High-Risk Features for Short-Term Risk of Death or Nonfatal MI for UA/NSTEMI (15)

At least 1 of the following:

- History—Accelerating tempo of ischemic symptoms in preceding 48 hours
- Character of pain—Prolonged ongoing (greater than 20 minutes) rest pain
- Clinical findings
  - Pulmonary edema, most likely due to ischemia
  - New or worsening mitral regurgitation murmur
  - S_3 or new/worsening rales
  - Hypotension, bradycardia, tachycardia
  - Age greater than 75 years
- Electrocardiogram
  - Angina at rest with transient ST-segment changes greater than 0.5 mm
  - Bundle-branch block, new or presumed new
  - Sustained ventricular tachycardia
- Cardiac marker
  - Elevated cardiac Troponin T, Troponin I, or creatine kinase-MB (e.g., Troponin T or I greater than 0.1 ng per ml)

Abbreviations

CABG = coronary artery bypass grafting
CAD = coronary artery disease
CCS = Canadian Cardiovascular Society
CCT = cardiac computed tomography
CHF = congestive heart failure
ECG = electrocardiogram
FFR = fractional flow reserve
HF = heart failure
IVUS = intravascular ultrasound
LAD = left anterior descending artery
LIMA = left internal mammary artery
LV = left ventricular
LVEF = left ventricular ejection fraction
MI = myocardial infarction
NTG = nitroglycerin
PCI = percutaneous coronary intervention
PDA = patent ductus arteriosus
STEMI = ST-segment elevation myocardial infarction
UA/NSTEMI = unstable angina/non–ST-segment elevation myocardial infarction

Results of Ratings

The final ratings for coronary revascularization (Tables 1 to 4) are listed by indication sequentially as obtained from second round rating sheets submitted by each panelist. Figures demonstrating trends in appropriateness rating by symptom status, ischemic risk, and method of revascularization are also presented.

There was generally less variation in ratings for the indications labeled as either appropriate or inappropriate, with 76% and 70%, respectively showing agreement as defined previously in the Methods section. There was, however, greater variability in the rating scores for indications defined as uncertain, suggesting wide variation in opinion. Several indications failed to meet the definition of agreement noted above. There were no ratings where the panel held such opposing viewpoints that the panel's votes were determined to be in "disagreement" as defined by the strict RAND definitions described previously in the Methods section.

Coronary Revascularization Appropriateness Criteria (By Indication)

Table 1. Patients With Acute Coronary Syndromes

Indication		Appropriateness Score (1–9)
1.	• STEMI • Less than or equal to 12 hours from onset of symptoms • Revascularization of the culprit artery	A $_{(9)}$*
2.	• STEMI • Onset of symptoms within the prior 12 to 24 hours • Severe HF, persistent ischemic symptoms, or hemodynamic or electrical instability present	A $_{(9)}$
3.	• STEMI • Greater than 12 hours from symptom onset • Asymptomatic; no hemodynamic instability and no electrical instability	I $_{(3)}$
4.	• STEMI with presumed successful treatment with fibrinolysis • Evidence of HF, recurrent ischemia, or unstable ventricular arrhythmias present • One-vessel CAD, presumed to be the culprit artery	A $_{(9)}$
5.	• STEMI with presumed successful treatment with fibrinolysis • Asymptomatic; no HF or no recurrent ischemic symptoms, or no unstable ventricular arrhythmias • Normal LVEF • One-vessel CAD presumed to be the culprit artery	U $_{(5)}$
6.	• STEMI with presumed successful treatment with fibrinolysis • Asymptomatic; no HF, no recurrent ischemic symptoms, or no unstable ventricular arrhythmias at time of presentation • Depressed LVEF • Three-vessel CAD • Elective/semi-elective revascularization	A $_{(8)}$
7.	• STEMI with successful treatment of the culprit artery by primary PCI or fibrinolysis • Asymptomatic; no HF, no evidence of recurrent or provokable ischemia or no unstable ventricular arrhythmias during index hospitalization • Normal LVEF • Revascularization of a non-infarct related artery during index hospitalization	I $_{(2)}$
8.	• STEMI or NSTEMI and successful PCI of culprit artery during index hospitalization • Symptoms of recurrent myocardial ischemia and/or high-risk findings on noninvasive stress testing performed after index hospitalization • Revascularization of 1 or more additional coronary arteries	A $_{(8)}$
9.	• UA/NSTEMI and high-risk features for short-term risk of death or nonfatal MI • Revascularization of the presumed culprit artery	A $_{(9)}$
10.	• UA/NSTEMI and high-risk features for short-term risk of death or nonfatal MI • Revascularization of multiple coronary arteries when the culprit artery cannot be clearly determined	A $_{(9)}$
11.	• Patients with acute myocardial infarction (STEMI or NSTEMI) • Evidence of cardiogenic shock • Revascularization of 1 or more coronary arteries	A $_{(8)}$

*Subscripted numbers are a reflection of the continuum as per the appropriateness criteria methodology and should not be interpreted as "degrees of appropriateness or inappropriateness."

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Table 2. Patients Without Prior Bypass Surgery

		Appropriateness Score (1–9)		
		CCS Angina Class		
Indication		Asymptomatic	I or II	III or IV
12.	• One- or 2-vessel CAD without involvement of proximal LAD • Low-risk findings on noninvasive testing • Receiving no or minimal anti-ischemic medical therapy	I (1)*	I (2)	U (5)
13.	• One- or 2-vessel CAD without involvement of proximal LAD • Low-risk findings on noninvasive testing • Receiving a course of maximal anti-ischemic medical therapy	I (2)	U (5)	A (7)
14.	• One- or 2-vessel CAD without involvement of proximal LAD • Intermediate-risk findings on noninvasive testing • Receiving no or minimal anti-ischemic medical therapy	I (3)	U (5)	U (6)
15.	• One- or 2-vessel CAD without involvement of proximal LAD • Intermediate-risk findings on noninvasive testing • Receiving a course of maximal anti-ischemic medical therapy	U (4)	A (7)	A (8)
16.	• One- or 2-vessel CAD without involvement of proximal LAD • High-risk findings on noninvasive testing • Receiving no or minimal anti-ischemic medical therapy	U (6)	A (7)	A (8)
17.	• One- or 2-vessel CAD without involvement of proximal LAD • High-risk findings on noninvasive testing • Receiving a course of maximal anti-ischemic medical therapy	A (7)	A (8)	A (9)
18.	• One- or 2-vessel CAD without involvement of proximal LAD • No noninvasive testing performed	†	U (5)	A (7)
19.	• One- or 2-vessel CAD with borderline stenosis “50% to 60%” • No noninvasive testing performed • No further invasive evaluation performed (i.e., FFR, IVUS)	†	I (2)	I (3)
20.	• One- or 2-vessel CAD with borderline stenosis “50% to 60%” • No noninvasive testing performed or equivocal test results present • FFR less than 0.75 and/or IVUS with significant reduction in cross-sectional area	I (3)	U (6)	A (7)
21.	• One- or 2-vessel CAD with borderline stenosis “50% to 60%” • No noninvasive testing performed or equivocal test results present • FFR or IVUS findings do not meet criteria for significant stenosis	I (1)	I (2)	I (2)
22.	• Chronic total occlusion of 1 major epicardial coronary artery, without other coronary stenoses • Low-risk findings on noninvasive testing • Receiving no or minimal anti-ischemic medical therapy	I (1)	I (2)	I (3)
23.	• Chronic total occlusion of 1 major epicardial coronary artery, without other coronary stenoses • Low-risk findings on noninvasive testing • Receiving a course of maximal anti-ischemic medical therapy	I (1)	U (4)	U (6)
24.	• Chronic total occlusion of 1 major epicardial coronary artery, without other coronary stenoses • Intermediate-risk findings on noninvasive testing • Receiving no or minimal anti-ischemic medical therapy	I (3)	U (4)	U (6)
25.	• Chronic total occlusion of 1 major epicardial coronary artery, without other coronary stenoses • Intermediate-risk criteria on noninvasive testing • Receiving a course of maximal anti-ischemic medical therapy	U (4)	U (5)	A (7)
26.	• Chronic total occlusion of 1 major epicardial coronary artery, without other coronary stenoses • High-risk findings on noninvasive testing • Receiving no or minimal anti-ischemic medical therapy	U (4)	U (5)	A (7)
27.	• Chronic total occlusion of 1 major epicardial coronary artery, without other coronary stenoses • High-risk criteria on noninvasive testing • Receiving a course of maximal anti-ischemic medical therapy	U (5)	A (7)	A (8)
28.	• One-vessel CAD involving the proximal LAD • Low-risk findings on noninvasive testing • Receiving no or minimal anti-ischemic medical therapy	U (4)	U (5)	A (7)
29.	• One-vessel CAD involving the proximal LAD • Low-risk findings on noninvasive testing • Receiving maximal anti-ischemic medical therapy	U (4)	A (7)	A (8)

Table 2. Continued

Indication		Appropriateness Score (1–9)		
		CCS Angina Class		
		Asymptomatic	I or II	III or IV
30.	• One-vessel CAD involving the proximal LAD • Intermediate-risk findings on noninvasive testing • Receiving no or minimal anti-ischemic medical therapy	U (4)	U (6)	A (7)
31.	• One-vessel CAD involving the proximal LAD • Intermediate-risk findings on noninvasive testing • Receiving maximal anti-ischemic medical therapy	U (5)	A (8)	A (9)
32.	• One-vessel CAD involving the proximal LAD • High-risk findings on noninvasive testing • Receiving no or minimal anti-ischemic medical therapy	A (7)	A (8)	A (9)
33.	• One-vessel CAD involving the proximal LAD • High-risk findings on noninvasive testing • Receiving maximal anti-ischemic medical therapy	A (7)	A (9)	A (9)
34.	• Two-vessel CAD involving the proximal LAD • Low-risk findings on noninvasive testing • Receiving no or minimal anti-ischemic medical therapy	U (4)	U (6)	A (7)
35.	• Two-vessel CAD involving the proximal LAD • Low-risk findings on noninvasive testing • Receiving a course of maximal anti-ischemic medical therapy	U (5)	A (7)	A (8)
36.	• Two-vessel CAD involving the proximal LAD • Intermediate-risk findings on noninvasive testing • Receiving no or minimal anti-ischemic medical therapy	U (5)	A (7)	A (8)
37.	• Two-vessel CAD involving the proximal LAD • Intermediate-risk findings on noninvasive testing • Receiving a course of maximal anti-ischemic medical therapy	U (6)	A (7)	A (9)
38.	• Two-vessel CAD involving the proximal LAD • High-risk findings on noninvasive testing • Receiving no or minimal anti-ischemic medical therapy	A (7)	A (8)	A (9)
39.	• Two-vessel CAD involving the proximal LAD • High-risk findings on noninvasive testing • Receiving a course of maximal anti-ischemic medical therapy	A (8)	A (9)	A (9)
40.	• Three-vessel CAD (no left main) • Low-risk findings on noninvasive testing including normal LV systolic function • Receiving no or minimal anti-ischemic medical therapy	U (5)	U (6)	A (7)
41.	• Three-vessel CAD (no left main) • Low-risk findings on noninvasive testing including normal LV systolic function • Receiving a course of maximal anti-ischemic medical therapy	U (5)	A (7)	A (8)
42.	• Three-vessel CAD (no left main) • Intermediate-risk findings on noninvasive testing • Receiving no or minimal anti-ischemic medical therapy	A (7)	A (7)	A (8)
43.	• Three-vessel CAD (no left main) • Intermediate risk findings on noninvasive testing • Receiving a course of maximal anti-ischemic medical therapy	A (7)	A (8)	A (9)
44.	• Three-vessel CAD (no left main) • High-risk findings on noninvasive testing • Receiving no or minimal anti-ischemic medical therapy	A (7)	A (8)	A (9)
45.	• Three-vessel CAD (no left main) • High-risk findings on noninvasive testing • Receiving a course of maximal anti-ischemic medical therapy	A (8)	A (9)	A (9)
46.	• Three-vessel CAD (no left main) • Abnormal LV systolic function	A (8)	A (9)Q	A (9)
47.	• Left main stenosis	A (9)	A (9)	A (9)

*Subscripted numbers are a reflection of the continuum as per the appropriateness criteria methodology and should not be interpreted as "degrees of appropriateness or inappropriateness." †Indicates that the writing group felt the likelihood of the clinical scenario was so low that rating should not be performed.

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Table 3. Patients With Prior Bypass Surgery (Without Acute Coronary Syndromes)

		Appropriateness Score (1–9)		
		CCS Angina Class		
Indication		Asymptomatic	I or II	III or IV
48.	• One or more stenoses in saphenous vein graft(s) • Low-risk findings on noninvasive testing including normal LV systolic function • Receiving no or minimal anti-ischemic medical therapy	I (3)	U (4)	U (6)
49.	• One or more stenoses in saphenous vein graft(s) • Low-risk findings on noninvasive testing including normal LV systolic function • Receiving a course of maximal anti-ischemic medical therapy	U (4)	U (6)	A (7)
50.	• One or more stenoses in saphenous vein graft(s) • Intermediate-risk findings on noninvasive testing • Receiving no or minimal anti-ischemic medical therapy	U (4)	U (6)	A (7)
51.	• One or more stenoses in saphenous vein graft(s) • Intermediate-risk findings on noninvasive testing • Receiving a course of maximal anti-ischemic medical therapy	U (4)	A (7)	A (8)
52.	• One or more stenoses in saphenous vein graft(s) • High-risk findings on noninvasive testing • Receiving no or minimal anti-ischemic medical therapy	U (6)	A (7)	A (7)
53.	• One or more stenoses in saphenous vein graft(s) • High-risk findings on noninvasive testing • Receiving a course of maximal anti-ischemic medical therapy	A (7)	A (8)	A (9)
54.	• One or more lesions in native coronary arteries without bypass grafts • All bypass grafts patent and without significant disease • Low-risk findings on noninvasive testing including normal LV systolic function • Receiving no or minimal anti-ischemic medical therapy	†	I (3)	U (6)
55.	• One or more lesions in native coronary arteries without bypass grafts • All bypass grafts patent and without significant disease • Low-risk findings on noninvasive testing including normal LV systolic function • Receiving a course of maximal anti-ischemic medical therapy	I (3)	U (5)	A (7)
56.	• One or more lesions in native coronary arteries without bypass grafts • All bypass grafts patent and without significant disease • Intermediate-risk findings on noninvasive testing • Receiving no or minimal anti-ischemic medical therapy	I (3)	U (5)	A (7)
57.	• One or more lesions in native coronary arteries without bypass grafts • All bypass grafts patent and without significant disease • Intermediate-risk findings on noninvasive testing • Receiving a course of maximal anti-ischemic medical therapy	U (4)	U (6)	A (8)
58.	• One or more lesions in native coronary arteries without bypass grafts • All bypass grafts patent and without significant disease • High-risk findings on noninvasive testing • Receiving no or minimal anti-ischemic medical therapy	U (6)	A (7)	A (8)
59.	• One or more lesions in native coronary arteries without bypass grafts • All bypass grafts patent and without significant disease • High-risk finding on noninvasive testing • Receiving a course of maximal anti-ischemic medical therapy	U (5)	A (8)	A (9)

*Subscripted numbers are a reflection of the continuum as per the appropriateness criteria methodology and should not be interpreted as "degrees of appropriateness or inappropriateness." †Indicates that the writing group felt the likelihood of the clinical scenario was so low that rating should not be performed.

Rating Revascularization Methods

Mode of Revascularization for High Severity of CAD (Indications 60 to 73)

Recognizing a large range of variability in revascularization methods often based upon patient factors and local practice patterns, the majority of clinical indications were not intended to distinguish between the specific modes of revascularization (i.e., PCI versus CABG). However, the committee recognized that among patients with extensive or complex atherosclerosis the mode of revascularization is also of interest when revascularization is deemed appropriate. Therefore, Table 4 presents complex scenarios where the features of revascularization are considered. In these cases, the raters were asked to consider the

appropriateness of PCI and CABG as the revascularization method independently of each other (such that each modality would receive separate scores based on each specific clinical indication).

Mortality Risk

Many of the known clinical factors that increase the risk of revascularization are shared between CABG and percutaneous methods. For the indications presented below, the guideline-based features of diabetes and depressed left ventricular systolic function were used to stratify patients.

Advanced CAD

The clinical scenarios below specifically apply to patients with advanced CAD. It was assumed for these clinical scenarios that all patients have unacceptable levels of symptoms despite appropriate medical therapy and evidence of intermediate- to high-risk findings on noninvasive testing. In other words, the technical panel assumed that revascularization is appropriate and focused on rating the merit of the different modes with the intent of complete coronary revascularization for each indication.

Table 4. Method of Revascularization: Advanced Coronary Disease,* CCS Angina Greater Than or Equal to Class III, and/or Evidence of Intermediate- to High-Risk Findings on Noninvasive Testing

Indication		Appropriateness Score (1–9)	
		PCI Appropriateness Rating	CABG Appropriateness Rating
60.	• Two-vessel CAD with proximal LAD stenosis • No diabetes and normal LVEF	A $_{(8)}$*	A $_{(8)}$
61.	• Two-vessel CAD with proximal LAD stenosis • Diabetes	A $_{(7)}$	A $_{(8)}$
62.	• Two-vessel CAD with proximal LAD stenosis • Depressed LVEF	A $_{(7)}$	A $_{(8)}$
63.	• Three-vessel CAD • No diabetes and normal LVEF	U $_{(6)}$	A $_{(8)}$
64.	• Three-vessel CAD • Diabetes	U $_{(5)}$	A $_{(9)}$
65.	• Three-vessel CAD • Depressed LVEF	U $_{(4)}$	A $_{(9)}$
66.	• Isolated left main stenosis • No diabetes and normal LVEF	I $_{(3)}$	A $_{(9)}$
67.	• Isolated left main stenosis • Diabetes	I $_{(3)}$	A $_{(9)}$
68.	• Isolated left main stenosis • Depressed LVEF	I $_{(3)}$	A $_{(9)}$
69.	• Left main stenosis and additional CAD • No diabetes and normal LVEF	I $_{(3)}$	A $_{(9)}$
70.	• Left main stenosis and additional CAD • Diabetes	I $_{(2)}$	A $_{(9)}$
71.	• Left main stenosis and additional CAD • Depressed LVEF	I $_{(2)}$	A $_{(9)}$
72.	• Prior bypass surgery with native 3-vessel disease and failure of multiple bypass grafts • LIMA remains patent to a native coronary artery • Depressed LVEF	A $_{(7)}$	U $_{(6)}$
73.	• Prior bypass surgery with native 3-vessel disease and failure of multiple bypass grafts • LIMA was used as a graft but is no longer functional • Depressed LVEF	U $_{(6)}$	A $_{(8)}$

*Subscripted numbers are a reflection of the continuum as per the appropriateness criteria methodology and should not be interpreted as "degrees of appropriateness or inappropriateness."

Discussion

The ratings developed in this report provide an assessment of the appropriateness of the use of coronary revascularization for the clinical scenarios presented in each of the indications. These criteria should be useful to clinicians, health care facilities, third-party payers engaged in the delivery of cardiovascular services, and most importantly, patients. Experience with previous appropriateness criteria has shown their value across a broad range of situations, guiding care of individual patients, educating caregivers, and affecting policy decisions regarding reimbursement.

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Clinical Judgment

These indications are intended to provide guidance for patients and clinicians. This approach is not intended to diminish the acknowledged difficulty or uncertainty of clinical decision making. Appropriateness criteria are not substitutes for sound clinical judgment and practice experience. The writing group recognizes that many patients seen in clinical practice may not be represented in these appropriateness criteria or have extenuating features when compared with the clinical scenarios presented. However, these criteria provide a framework for discussions regarding revascularization between patients and physicians.

Although these ratings provide a general assessment of when revascularization may or may not be likely to improve health outcomes or survival, physicians and other stakeholders should continue to acknowledge the pivotal role of clinical judgment in determining whether revascularization is indicated for an individual patient. For example, the rating of a revascularization indication as "uncertain" should not preclude a provider from performing a revascularization procedure when there are patient- and condition-specific data to support that decision. Uncertain indications require individual physician judgment and understanding of the patient to better determine the usefulness of the procedure for a particular scenario. Indeed revascularization may be the correct treatment, if supported by mitigating characteristics of the patient. Therefore, these criteria provide a framework for discussion regarding revascularization upon which the specific clinical characteristics of an individual patient must be superimposed. Ranking of an indication as uncertain (4 to 6) **should not be viewed as excluding the use of revascularization for such patients.** Although it is considered unlikely, an indication rated as "inappropriate" may in rare circumstances be the best therapy for an individual patient. In contrast, a clinical situation rated as "appropriate" may not always represent reasonable practice in a specific patient with extenuating circumstances. Appropriateness also does not equate to medical necessity. Shared physician/patient decision making for many scenarios would be expected and may result in the patient deferring coronary revascularization while maintaining medical therapy.

These ratings are intended to evaluate the appropriateness of specific patient scenarios to determine overall **patterns of care** regarding revascularization. In situations where there is substantial variation between the appropriateness rating and what the clinician believes is the best recommendation for the patient, further considerations or actions, such as a second opinion, may be appropriate. Moreover, it is not anticipated that all physicians or facilities will have 100% of their revascularization procedures deemed appropriate. However related to the overall patterns of care, if the national average of appropriate procedure ratings is 80%, for example, and a physician or facility has only a 40% rate of appropriate procedures, further examination of the patterns of care may be warranted and helpful.

General Themes in Appropriateness Criteria for Revascularization

The purpose of coronary revascularization should be to improve health outcomes for the patients undergoing the procedure. As such, the technical panel was asked to rate each specific clinical indication with emphasis on the benefit imparted to health outcomes (symptoms, functional status, and/or quality of life) or survival. It should be noted that the Appropriateness Criteria for Coronary Revascularization contain no scenarios rated as "appropriate" that correlate with Class III recommendations in guideline documents. Likewise, no "inappropriate" appropriateness criteria indications correlate with Class I guideline recommendations. Although multiple clinical and anatomic factors could have been included in the clinical scenarios, the writing group focused on symptom status, degree of medical therapy, extent of ischemia by noninvasive testing, and finally, the presence and location of significant coronary stenoses. Several themes were identified in reviewing the results for the Appropriateness Criteria for Coronary Revascularization.

Acute Coronary Syndromes

The technical panel rated the majority of clinical scenarios in these patients as appropriate for revascularization (Figure 1). However, there were 2 notable exceptions that received inappropriate ratings. First, in patients with STEMI presenting greater than 12 hours from symptom onset without ongoing symptoms of ischemia or clinical instability, immediate revascularization was deemed inappropriate. By extension, this also implies that the need for immediate angiography on presentation in such patients is unnecessary. Second, after successful treatment of the culprit artery by PCI or fibrinolysis, revascularization of nonculprit arteries before hospital discharge in patients without clinical instability, with no evidence of recurrent or provokable ischemia, and with a normal LVEF was rated as inappropriate.

Stable Ischemic Heart Disease *Without* Prior CABG

In general, the presence of high-risk findings on noninvasive testing, higher severity of symptoms, or an increasing burden of CAD tended to elevate the rating to appropriate. Inappropriate ratings tended to cluster among groups receiving no or minimal anti-ischemic treatment with low-risk findings on noninvasive testing. Figures 2 to 4 illustrate the interplay of these elements in determining appropriateness. Four clinical scenarios (18 to 21) were included in which no functional testing was performed. Although the ability to couple the anatomic findings from coronary angiography with the physiologic evaluation available from the various diagnostic testing modalities is ideal, the writing group recognized that there are patients who undergo angiography without such testing. Revascularization was rated appropriate in such patients if they had 1- or 2-vessel disease with or without involvement of the proximal LAD and class III or IV angina. The level of medical therapy patients were receiving in this particular scenario was not

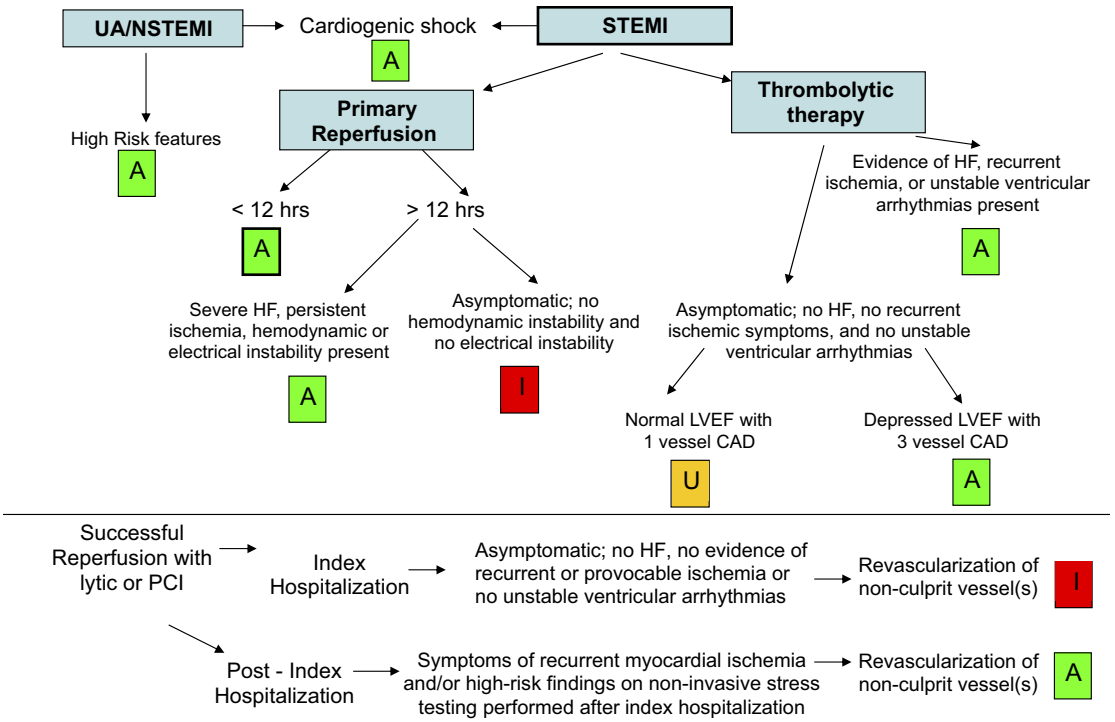

Figure 1. Acute Coronary Syndromes*

*The fact that the use of coronary revascularization for a particular condition is listed in this figure (appropriate, uncertain, inappropriate) does not preclude the use of other therapeutic modalities that may be equally effective. See the most current ACC/AHA UA/NSTEMI and STEMI guidelines (15,16). A indicates appropriate; CAD, coronary artery disease; HF, heart failure; I, inappropriate; LVEF, left ventricular ejection fraction; PCI, percutaneous coronary intervention; STEMI, ST-elevation myocardial infarction; U, uncertain; and UA/NSTEMI, unstable angina/non–ST-elevation myocardial infarction.

specifically considered and was thus left to the judgment of the clinician. However, consistent with the pattern of care developed in these appropriateness criteria, a trial of medical therapy before performing revascularization may be appropriate in some patients. The remaining three scenarios involved patients found to have so-called intermediate severity stenoses. The ratings in these settings reflect the ability of additional evaluations performed in the catheterization laboratory (such as FFR or IVUS) to identify significant stenoses beyond their appearance by angiography

Low Risk Findings on Noninvasive Study							Asymptomatic					
Symptoms / Med. Rx							**Stress Test / Med. Rx**					
Class III or IV Max Rx	U	A	A	A	A		High Risk Max Rx	U	A	A	A	A
Class I or II Max Rx	U	U	A	A	A		High Risk No/min Rx	U	U	A	A	A
Asymptomatic Max Rx	I	I	U	U	U		Int. Risk Max Rx	U	U	U	U	A
Class III or IV No/min Rx	I	U	A	A	A		Int. Risk No/min Rx	I	I	U	U	A
Class I or II No/min Rx	I	I	U	U	U		Low Risk Max Rx	I	I	U	U	U
Asymptomatic No/min Rx	I	I	U	U	U		Low Risk No/min Rx	I	I	U	U	U
Coronary Anatomy	CTO of 1 vz.; no other disease	1-2 vz. disease; no Prox. LAD	1 vz. disease of Prox. LAD	2 vz. disease with Prox. LAD	3 vz. disease; no Left Main		**Coronary Anatomy**	CTO of 1 vz.; no other disease	1-2 vz. disease; no Prox. LAD	1 vz. disease of Prox. LAD	2 vz. disease with Prox. LAD	3 vz. disease; no Left Main

Figure 2. Appropriateness Ratings by Low-Risk Findings on Noninvasive Imaging Study and Asymptomatic (Patients Without Prior Bypass Surgery)

A indicates appropriate; CTO, chronic total occlusion; I, inappropriate; Int., intervention; Med., medical; Prox. LAD, proximal left anterior descending artery; Rx, treatment; U, uncertain; and vz., vessel.

Intermediate Risk Findings on Noninvasive Study							CCS Class I or II Angina					
Symptoms / Med. Rx							Stress Test / Med. Rx					
Class III or IV / Max Rx	A	A	A	A	A		High Risk / Max Rx	A	A	A	A	A
Class I or II / Max Rx	U	A	A	A	A		High Risk / No/min Rx	U	A	A	A	A
Asymptomatic / Max Rx	U	U	U	U	A		Int. Risk / Max Rx	U	A	A	A	A
Class III or IV / No/min Rx	U	U	A	A	A		Int. Risk / No/min Rx	U	U	U	A	A
Class I or II / No/min Rx	U	U	U	A	A		Low Risk / Max Rx	U	U	A	A	A
Asymptomatic / No/min Rx	I	I	U	U	A		Low Risk / No/min Rx	I	I	U	U	U
Coronary Anatomy	CTO of 1 vz.; no other disease	1-2 vz. disease; no Prox. LAD	1 vz. disease of Prox. LAD	2 vz. disease with Prox. LAD	3 vz. disease; no Left Main		**Coronary Anatomy**	CTO of 1 vz.; no other disease	1-2 vz. disease; no Prox. LAD	1 vz. disease of Prox. LAD	2 vz. disease with Prox. LAD	3 vz. disease; no Left Main

Figure 3. Appropriateness Ratings by Intermediate-Risk Findings on Noninvasive Imaging Study and CCS Class I or II Angina (Patients Without Prior Bypass Surgery)

CCS indicates Canadian Cardiovascular Society, other abbreviations as in Figure 2.

alone. In patients without noninvasive testing, revascularization of intermediate stenoses without further documentation of significance by FFR or IVUS was rated as inappropriate. Revascularization of such patients who demonstrate abnormal IVUS or FFR findings and are highly symptomatic was deemed appropriate.

Stable Ischemic Heart Disease *With* Prior CABG

Similar to the pattern seen in patients without prior CABG, the presence of high-risk findings on noninvasive testing, higher severity of symptoms, or an increasing burden of disease in either the bypass grafts or native coronaries tended to increase the likelihood of an appropriate rating. The only inappropriate ratings in patients with prior CABG were noted in patients receiving no or minimal antiischemic therapy or having low-risk findings on noninvasive testing. More uncertain ratings occurred in this group of patients, reflecting their higher complexity, higher risk, and the limited availability of published evidence regarding management outcome.

PCI and CABG in Patients With Advanced CAD

In this group of ratings, it was assumed that revascularization was necessary, and the technical panel rated the

High Risk Findings on Noninvasive Study							CCS Class III or IV Angina					
Symptoms / Med. Rx							Stress Test / Med. Rx					
Class III or IV / Max Rx	A	A	A	A	A		High Risk / Max Rx	A	A	A	A	A
Class I or II / Max Rx	A	A	A	A	A		High Risk / No/min Rx	A	A	A	A	A
Asymptomatic / Max Rx	U	A	A	A	A		Int. Risk / Max Rx	A	A	A	A	A
Class III or IV / No/min Rx	A	A	A	A	A		Int. Risk / No/min Rx	U	U	A	A	A
Class I or II / No/min Rx	U	A	A	A	A		Low Risk / Max Rx	U	A	A	A	A
Asymptomatic / No/min Rx	U	U	A	A	A		Low Risk / No/min Rx	I	U	A	A	A
Coronary Anatomy	CTO of 1 vz.; no other disease	1-2 vz. disease; no Prox. LAD	1 vz. disease of Prox. LAD	2 vz. disease with Prox. LAD	3 vz. disease; no Left Main		**Coronary Anatomy**	CTO of 1 vz.; no other disease	1-2 vz. disease; no Prox. LAD	1 vz. disease of Prox. LAD	2 vz. disease with Prox. LAD	3 vz. disease; no Left Main

Figure 4. Appropriateness Ratings by High-Risk Findings on Noninvasive Imaging Study and CCS Class III or IV Angina (Patients Without Prior Bypass Surgery)

Abbreviations as in Figures 2 and 3.

	CABG			PCI		
	No diabetes and normal LVEF	Diabetes	Depressed LVEF	No diabetes and normal LVEF	Diabetes	Depressed LVEF
Two vessel coronary artery disease with proximal LAD stenosis	A	A	A	A	A	A
Three vessel coronary artery disease	A	A	A	U	U	U
Isolated left main stenosis	A	A	A	I	I	I
Left main stenosis and additional coronary artery disease	A	A	A	I	I	I

Figure 5. Method of Revascularization of Advanced Coronary Artery Disease

CABG indicates coronary artery bypass grafting; LAD, left anterior descending artery; LVEF, left ventricular ejection fraction; and PCI, percutaneous coronary intervention.

appropriateness of the mode of revascularization (Table 4, Figure 5). CABG was rated as appropriate in all of the clinical scenarios developed, whereas PCI was rated appropriate only in patients with 2-vessel CAD with involvement of the proximal LAD and uncertain in patients with 3-vessel disease. For patients with left main stenosis and/or left main stenosis and multivessel CAD, CABG was deemed to be appropriate and likely to improve the patients' health outcomes or survival. PCI for this patient group was deemed not to be a reasonable approach and unlikely to improve the patients' health outcomes or survival.

Application of Criteria

There are many potential applications for appropriateness criteria. Clinicians could use the ratings for decision support or as an educational tool when considering the need for revascularization. Moreover, these criteria could be used to facilitate discussion with patients and or referring physicians about the need for revascularization. Facilities and payers may choose to use these criteria either prospectively in the design of protocols or pre-authorization procedures, or retrospectively for quality reports. It is hoped that payers would use these criteria as the basis for the development of rational payment management strategies to ensure that their members receive necessary, beneficial, and cost-effective cardiovascular care, rather than for other purposes.

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 the unique circumstances or the clinical profile that must exist in such a patient. It is critical to emphasize that the writing group, technical panel, Appropriateness Task Force, and clinical community do not believe an uncertain rating is grounds to deny reimbursement for revascularization. Rather, uncertain ratings are those in which the available data vary and many other factors exist that may affect the decision to perform or not perform revascularization. The opinions of the technical panel often varied for these indications, reflecting that additional research is needed. Indications with high clinical volume that are rated as uncertain identify important areas for further research.

When evaluating physician or facility performance, appropriateness criteria should be used in conjunction with efforts that lead to quality improvement. Prospective preauthorization procedures, if put in place, are most effective once a retrospective review has identified a pattern of potential inappropriate use. Because these 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 before issuance of this report or documentation of centers/providers performing an unexpectedly high proportion of inappropriate cases as compared with their peers.

The writing group recognizes that these criteria will be evaluated during routine clinical care. To that end, specific data fields such as symptom status, presence or absence of acute coronary syndrome, history of bypass surgery, extent of ischemia on noninvasive imaging, CAD burden, and degree of antianginal therapy are anticipated to provide sufficient detail to determine individual appropriateness ratings. Since a reasonable and tolerated dose of antianginal therapy may vary significantly among different patients, the writing group recommends the presence of 2 classes of antianginal therapies as a minimum standard for medical therapy.

The primary objective of this report is to provide guidance regarding the suitability of coronary revascularization for diverse clinical scenarios. As with previous appropriateness criteria documents, consensus among the raters was desirable, but an attempt to achieve complete agreement within this diverse panel would have been artificial and was not the goal of the process. Two rounds of ratings with substantial discussion among the technical panel members 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 for indications rated as appropriate would help ensure the equitable and efficient allocation of resources for coronary revascularization. Review of appropriateness patterns may also improve understanding of regional variations in the use of revascularization as highlighted in the Dartmouth Atlas Project (17). Further exploration of the indications rated as "uncertain" will help generate the information required to further define the appropriateness of coronary revascularization. Additionally, the criteria will need to be updated with the publication of ongoing trials in coronary revascularization and new clinical practice guidelines.

In conclusion, this document represents the current understanding of the clinical benefit of coronary revascularization with respect to health outcomes and survival. It is intended to provide a practical guide to clinicians and patients when considering revascularization. As with other appropriateness criteria, some of these ratings will require research and further evaluation to provide the greatest information and benefit to clinical decision making. Finally, it will be necessary to periodically assess and update the indications and criteria as technology evolves and new data and field experience becomes available.

Appendix A: Additional Coronary Revascularization Definitions

Angina/Chest Pain Classification

Angina is a syndrome typically noted to include discomfort in the chest, jaw, shoulder, back, or arm that is aggravated by exertion or emotional stress and relieved by nitroglycerin. The quality of the discomfort, provoking factors, and relieving factors are used to define typical, atypical, and noncardiac chest pain. Atypical angina is generally defined by 2 of the above 3 characteristics, and noncardiac chest pain is generally defined as chest pain that meets 1 or none of the above criteria. These definitions are represented in Table A1 presented below.

Table A1. Clinical Classification of Chest Pain

Typical angina (definite)
1) Substernal chest discomfort with a characteristic quality and duration that is 2) provoked by exertion or emotional stress and 3) relieved by rest or NTG.
Atypical angina (probable)
Meets 2 of the above characteristics.
Noncardiac chest pain
Meets one or none of the typical anginal characteristics.

Modified from Diamond GA. A clinically relevant classification of chest discomfort. J Am Coll Cardiol. 1983;1:574–5 (18).

The writing group assumes that noninvasive assessments of coronary anatomy (i.e., cardiac computed tomography, cardiac magnetic resonance angiography) provide anatomic information that is potentially similar to X-ray angiography. However, these modalities do not currently provide information on ischemic burden and are not assumed to be present in the clinical scenarios.

Invasive Methods of Determining Hemodynamic Significance

The writing group recognizes that not all patients referred for coronary angiography and revascularization will have previous noninvasive testing. In fact, there are several situations in which patients may be appropriately referred for coronary angiography based on symptom presentation and a high pre-test probability of CAD. In these settings, there may be situations where angiography shows a coronary narrowing of questionable hemodynamic importance in a patient with symptoms that could be related to myocardial ischemia. In such patients, the use of additional invasive measurements (such as fractional flow reserve or intravascular ultrasound) at the time of diagnostic angiography may be very helpful in further defining the need for revascularization and substituted for stress test findings (Table A2).

Table A2. Noninvasive Risk Stratification

High-Risk (greater than 3% annual mortality rate)
1. Severe resting left ventricular dysfunction (LVEF less than 35%)
2. High-risk treadmill score (score less than or equal to −11)
3. Severe exercise left ventricular dysfunction (exercise LVEF less than 35%)
4. Stress-induced large perfusion defect (particularly if anterior)
5. Stress-induced multiple perfusion defects of moderate size
6. Large, fixed perfusion defect with LV dilation or increased lung uptake (thallium-201)
7. Stress-induced moderate perfusion defect with LV dilation or increased lung uptake (thallium-201)
8. Echocardiographic wall motion abnormality (involving greater than two segments) developing at low dose of dobutamine (less than or equal to 10 mg/kg/min) or at a low heart rate (less than 120 beats/min)
9. Stress echocardiographic evidence of extensive ischemia
Intermediate-Risk (1% to 3% annual mortality rate)
1. Mild/moderate resting left ventricular dysfunction (LVEF equal to 35% to 49%)
2. Intermediate-risk treadmill score (−11 less than score less than 5)
3. Stress-induced moderate perfusion defect without LV dilation or increased lung intake (thallium-201)
4. Limited stress echocardiographic ischemia with a wall motion abnormality only at higher doses of dobutamine involving less than or equal to two segments
Low-Risk (less than 1% annual mortality rate)
1. Low-risk treadmill score (score greater than or equal to 5)
2. Normal or small myocardial perfusion defect at rest or with stress*
3. Normal stress echocardiographic wall motion or no change of limited resting wall motion abnormalities during stress*

*Although the published data are limited, patients with these findings will probably not be at low risk in the presence of either a high-risk treadmill score or severe resting left ventricular dysfunction (LVEF < 35%).

Appendix B: Additional Methods

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

Relationships With Industry

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 Appropriateness Criteria Working Group, 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 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).

Appendix C: ACCF/SCAI/STS/AATS/AHA/ASNC 2009 Appropriateness Criteria for Coronary Revascularization Participants

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APPENDIX D. ACCF/SCAI/STS/AATS/AHA/ASNC 2009 CORONARY REVASCULARIZATION APPROPRIATENESS CRITERIA WRITING GROUP, TECHNICAL PANEL, TASK FORCE, AND INDICATION REVIEWERS—RELATIONSHIPS WITH INDUSTRY (IN ALPHABETICAL ORDER)

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APPENDIX

Supplementary materials cited in this article are available online.

ACCF/SCAI/STS/AATS/AHA/ASNC 2009 Appropriateness Criteria for Coronary Revascularization: A Report by the American College of Cardiology Foundation Appropriateness Criteria Task Force, Society for Cardiovascular Angiography and Interventions, Society of Thoracic Surgeons, American Association for Thoracic Surgery, American Heart Association, and the American Society of Nuclear Cardiology Endorsed by the American Society of Echocardiography, the Heart Failure Society of America, and the Society of Cardiovascular Computed Tomography

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