Appropriateness Criteria for the Use of MultiFunction Cardiography

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Abstract

The American College of Computational Electrophysiology (ACCEP) and the American Academy of Urgent Care Medicine (AAUCM) together with key specialty and subspecialty experts, conducted an appropriateness criteria review for MultiFunction Cardiography or MCG, a.k.a. 3DMP. The review assessed the risks and benefits of MCG for several indications and/or clinical scenarios and scored them on a scale of 1 to 9 (modeled after methodology developed by the American College of Cardiology Foundation (ACCF) to assess stress-echocardiography appropriateness). The upper range (7 to 9) implies that the test is generally acceptable and represents a reasonable approach to diagnosis, and the lower range (1 to 3) implies that the test is generally not acceptable and does not represent a reasonable approach to diagnosis. The midrange (4 to 6) indicates a clinical scenario for which the indication for use of MCG is uncertain or is under investigation.

The specific indications included in this review were drawn from common clinical applications or anticipated uses the founders have gathered over the past 10 years. Use of MultiFunction CardioGraphy for risk assessment in patients with symptoms or signs of suspected coronary artery disease (CAD) was viewed favorably, while routine testing and/or general screening in certain clinical scenarios were viewed less favorably. It is anticipated that these results will have a signicant impact on physician decision-making and performance, reimbursement policy, and will help guide the future research of MultiFunction Cardiography.

Preface

In an effort to respond to the need for the rational use of diagnostic services in the delivery of high quality care, the American College of Computational Electrophysiology (ACCEP), has undertaken a process to determine the appropriateness of MultiFunction Cardiographic (MCG) evaluation for selected patient indications. Appropriateness criteria publications, such as this, reflect an ongoing effort by the ACCEP to critically and systematically create, review, and categorize clinical situations where MCG is utilized by physicians caring for patients with cardiovascular diseases. The process is based on a current understanding of the technical capabilities of the MultiFunction Cardiogram modality being 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 Tenth Revision of the International Classification of Diseases (ICD-10) system.

The ACCEP believes that careful blending of a broad range of clinical experiences and available evidence-based information will help guide a more efficient and equitable allocation of health care resources in cardiovascular diagnosis. 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 diagnostic procedures. Thus, appropriateness criteria should not be considered substitutes for sound clinical judgment and practice experience. The ACCEP appropriateness criteria process itself is also evolving.

In the current iteration, Working Group members were asked to rate indications for MultiFunction CardioGraphy in a manner independent and irrespective of prior ACC/ASNC/ASE/SCCT/SCMR ratings for similar coronary 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 Working Group was asked to assess whether the use of the MCG test for each indication is appropriate, uncertain, or inappropriate; they were provided the following definition of appropriateness:

An appropriate MCG 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 Working Group scored each indication as follows:

Score 7 to 9 - Appropriate
Appropriate test for specific indication (test is generally acceptable and is a reasonable approach for the indication).

Score 4 to 6 – Uncertain (Under Investigation)
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 or is underway to classify the indication definitively.)

Score 1 to 3 - Inappropriate

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

The contributor(s) 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 Working Group deliberately was not comprised solely of specialists in the MCG procedure. 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 Working Group.

We are grateful to the Working Group, a professional group with a wide range of skills and insights, for a thoughtful and thorough deliberation of the merits of MultiFunction Cardiography for various indications. In addition to our thanks to the Working Group for their dedicated work and review, we would like to offer special thanks to John Strobeck, MD, PhD, Charles Miceli, MD, Robert Silverstein MD, and Howard Sacher, MD, for reviewing the draft indications; to Joseph T. Shen, MD, the ACCEP founding member, for his comprehensive literature searches and technical input; to Michael Graziano, who continually drove the process forward, and to ACCEP's founding members.

Introduction

This report addresses the appropriateness of MultiFunction Cardiography. The improvement in the test characteristics of MultiFunction Cardiography in recent years has increased its utility for detection and risk assessment of ischemic heart disease. Similar to other forms of stress-imaging testing, MultiFunction Cardiography 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 specific clinical benefit, or who could have been medically managed effectively without the collection of the MCG test data. In particular, inappropriate use may be costly and may prompt potentially harmful and costly downstream testing and treatment such as unwarranted stress-imaging, coronary catheterization and/or revascularization or unnecessary repeat follow-up testing or evaluations. 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 A.

General Assumptions for MultiFunction Cardiography

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

1. All indications are assumed to apply to early teen and adult patients (14 years of age or older).
2. The test is performed and interpreted by qualified individuals in facilities that are proficient in the testing technique (5– 8).

The indications were constructed by MultiFunction CardioGraphy experts and modified on the basis of discussions among the Working Group. Wherever possible, indications were mapped to relevant clinical guidelines and key publications/references (Online Appendix at http://content.onlinejacc.org). The Working Group was comprised of clinician experts, some with backgrounds in cardiac imaging and others with experience in general cardiovascular medicine, critical care medicine, emergency medicine, and health services research. Panelists were instructed to incorporate in their deliberations several assumptions specifically for MultiFunction cardiography, including:

1. All standard MultiFunction Cardiographic techniques for data acquisition, including patient preparation protocols, internet connectivity, are available for each indication, and MultiFunction cardiography has a sensitivity and specificity similar to those found in the published literature.
2. Preoperative evaluation includes procedures such as organ transplantation.

Abbreviations used in Text and Tables

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 MultiFunction Cardiography (Tables 1 to 10) are listed by indication sequentially as obtained from second round rating sheets submitted by each member of the Working Group. Additionally, the indications are presented by Appropriateness Category (Tables 11 to 13). For the 61 indications for the use of MultiFunction cardiography, 33 were found to be

appropriate, 17 were uncertain (under investigation), and 11 were considered inappropriate. Typically, there was greater variability in scores of indications defined as uncertain, suggesting wide variation in opinion and/or inadequate available research demonstrating value of the methodology for the specific indication being evaluated. 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. Disagreement did not occur for any of the indications ultimately defined as appropriate or inappropriate.

General Discussion

The appropriateness criteria in this report provide an estimate of the reasonableness of the use of MultiFunction Cardiography for the particular clinical scenarios presented in each of the 61 indications considered. They are expected to be useful for clinicians, health care facilities, and third-party payers engaged in the delivery of cardiovascular diagnostic services. 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 diagnostic tests.

Appropriateness criteria represent the first component of the chain of quality recommended for cardiovascular diagnostics (11). After ensuring proper test selection, the achievement of quality in diagnostics includes adherence to best practices with regard to data acquisition, data 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 Working Group assumes that all quality standards are adequately met. It also is assumed that when considering the appropriateness of ordering a repeat or annual test that the prior data and report can be obtained and are of sufficient quality as outlined above.

Although the appropriateness ratings reflect a general expert consensus of when MultiFunction Cardiography 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 a MultiFunction Cardiogram procedure 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 (under investigation) (score 4 to 6) should not be viewed as limiting the use of MultiFunction Cardiography for such patients. Finally, there may be clinical situations in which the use of MultiFunction Cardiography for an indication considered appropriate does not always represent reasonable practice, such as a patient in whom another diagnostic 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 MultiFunction Cardiography information. However, as with the appropriateness criteria for other diagnostic modalities, they are not exhaustive because of the complexity and number of the potential clinical situations. For example, neither the use of MultiFunction Cardiography prior to organ transplantation nor all instances of peri-operative MultiFunction Cardiography were included as separate indications but are assumed to be covered by the more general preoperative guidelines (10).

MultiFunction Cardiography, like many diagnostic tests, may provide additional useful information beyond the primary purpose outlined by the indication. The appropriateness criteria for MultiFunction Cardiography were not developed to quantify the incremental information obtained by performing the test for reasons beyond those stated in an individual indication. Thus, members of the Working Group 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 MultiFunction Cardiography (12) should be reviewed to assess a broader range of potential reasons for ordering an MCG for an individual patient.

In addition, panelists were asked specifically not to consider comparisons to other diagnostic procedures or other appropriateness criteria documents while completing their rankings. Readers should note that the categorical summaries tend to accentuate differences that sometimes are slight. For example, small fluctuations in a median rating (e.g., 4 vs. 3) will cause an indication to switch appropriateness categories (e.g., 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 Working Group 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, Working Group members have greater familiarity with the indications and implementation requirements than the panels of prior appropriateness modules. Inconsistency in wording of indications for the MultiFunction Cardiography may have also contributed to differences in some scenarios. For example, MultiFunction Cardiography indications combined CAD detection and risk assessment into single indications, whereas the criteria for other diagnostic tests such as stress SPECT separated these indications.

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 diagnostic care.

As outlined in the original methodology by the ACCEP, 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 Working Group 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 and needed. 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 preauthorization 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 Working Group, 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 MultiFunction Cardiography for diverse clinical scenarios. Consensus among the raters was desirable, but any attempt to achieve complete agreement within the diverse panel would have been very difficult due to the fact that this is the first if its kind every compiled. Two rounds of ratings with lively discussion between the ratings did lead to some consensus among some of the panelists. However, further attempts to drive consensus would have diluted true differences in opinion among panelists and, therefore, was not undertaken. In addition, not all the members of the working group participated in 100% of the activities described above. The ones who did participate contributed to the discussions and ratings.

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 diagnostic test utilization. Further investigation of the indications rated as "uncertain" will help generate the data required to further define the appropriateness of MultiFunction Cardiography. Finally, it will be necessary to periodically assess and update the indications and criteria as the technology evolves and new data and field experience become available.

APPENDIX A: Methodological Details

Panel Selection

An initial list of Working Group members was generated in July 2009. Panel members were selected by the Chair of the Appropriateness Criteria Working Group in a manner that ensured an appropriate balance with respect to clinical expertise, academic versus private practice, research, and specialty training.

Development of Indications

The process for creating a first-round set of indications involved outside review and careful reference to relevant existing ACC/AHA clinical practice guidelines. The indications capture the major scenarios faced by cardiologists or referring physicians, but they are not meant to be inclusive of all potential indications for which an MCG study might be performed. Review was done by the ACCEP Appropriateness Criteria Working Group. As a result of the meeting of the Working Group before the second-round of rating, the indications were clarified and modified. A final set of 52 indications comprised the list of possible clinical scenarios that were rated for appropriateness by the panelists and compiled for this report.

Assumptions

All indications were considered with the following important assumption: Panel members were to assume that *all techniques, supplies, and expertise,* for MCG testing were available for each indication, and that each was performed in a manner similar to that found in the published literature.

Rating Process

The Working Group was instructed to follow the RAND/UCLA appropriateness method, including a modified Delphi process involving two rounds of ratings, which included online meetings (5). The appropriateness method combines expert clinical judgment with the scientific literature in evaluating the benefits and risks of medical procedures. Ratings of the net benefits and risks of performing medical procedures for a comprehensive array of potential patient indications or scenarios are obtained from a multidisciplinary panel of expert clinicians. Each panel member has equal weight in producing the final result, and the method does not force consensus. The RAND Web site (http://www.rand.org/publications/MR/MR1269/index.html) provides details of the RAND/UCLA method (5).e

The first round of ratings was completed individually with no interaction among panel members. The panel was then convened for meetings that were facilitated by a moderator. The goal of the meeting was to focus discussion on indications for which the first-round scores of the panel were widely divergent and to allow all views to be heard. The second-round ratings were conducted individually subsequent to the meetings. The second round ratings were used to determine the final appropriateness score based on the median score for each indication. Again, not all members participated in all the meetings, however the written versions have been fully accessible to all participants.

A measure of the level of disagreement was applied to each score. This project employed the BIOMED Concerted Action on Appropriateness definition for a panel size of 11 to 13 members. As defined in the RAND/UCLA manual (5), the BIOMED rule for agreement (+) is that no more than three panelists rate the indication outside the 3-point region containing the median; for disagreement (-), at least four panelists rate in each extreme rating region (i.e., 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 might differ, or where various specialty groups or individual panelists may have differences of clinical opinion. The measures are not meant to force consensus, but to achieve better understanding of the results.

At the meetings, each panelist received a personalized rating form that indicated his or her rating for each indication and the distribution of ratings of other members of the panel, but without personal identification. 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. This additional information helped to identify panelists who rated very differently from the rest of the panel. These additional measures or statistics were not shared with panelists.

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. The RAND/UCLA method requires that *any* score with disagreement be denoted as "uncertain" (5). Panel members were asked to incorporate scientific evidence in their ratings, including relevant clinical practice guideline recommendations. All indications were evaluated based on the available medical literature and the prevailing practice for the *average* physician in the *average* clinical setting. Where available, both the guideline class of recommendation and level of evidence for a specific clinical indication were presented in the rating tables. As set out in the RAND/UCLA Appropriateness Method User's Manual (5), costs were not explicitly considered in the ratings. Panelists, however, *implicitly* assessed a wide constellation of factors in their ratings, including patient expectations, cost reimbursement options, and the nature and level of clinical capacity. In the future, costs may be considered explicitly in *subsequent* stages of review and analysis, after the initial appropriateness review is completed. A review of the ratings that are in the uncertain range can help to guide the development of new empirical research required to expand the evidence base for future ratings. Finally, publication of the criteria merits discussion about how to evaluate the impact of the appropriateness criteria on health care practice and reimbursement policy.

Relationships with Industry

The ACCEP foundation rigorously avoided 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 Working Group. Specifically, all members 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 ACCEP board, discussed with all members at each meeting, and updated and reviewed as changes occur. Dr. Shen, the founder of Premier Heart and developer of MCG technology took part in these activities with a purpose to facilitate the birth of the first of its kind guideline for future debates and research. He contributed his knowledge and expertise in the process due to his two decades of research work in developing this technology. His opinions have been challenged, verified and validated by the panelists who have been applying the technique to their patients on a daily basis. All contributing members performed their duties without pay for benefiting the mankind at large and to improve the practice of medicine.

Literature Review

The Working Group 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. Lastly, they were provided Web links to the previously published materials pertaining to the appropriateness criteria work (1–3).

APPENDIX B: Definitions and Processes for Determining Likelihood of Disease and Risk

Determining Pre-Test Probability of Coronary Artery Disease

Chest pain syndrome. This is any constellation of symptoms that the physician believes 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, and jaw pain.

Pre-test probability of coronary artery disease (CAD). Once the physician determines the presence of symptoms that may represent obstructive CAD (chest pain syndrome present), then the pre-test probability of CAD should be determined. Although several methods exist for determining pre-test probability of CAD (6,16), the method assumed for this report is a modification of a literature review (17) recommended by the ACC/AHA 2002 Guideline Update for Exercise Testing (8) and ACC/AHA 2002 Guideline Update for Management of Patients With Chronic Stable Angina (13). The reader should refer to the definitions of angina and Table B1.

Angina. As defined by the ACC/AHA 2002 Guideline Update on Exercise Testing (8):

- ***Typical*** **angina (definite):** 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.
- ***Non-anginal*** **chest pain:** Chest pain or discomfort that *meets one or none* of the typical angina characteristics.

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 MCG 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 (18). Numerous discussions of the Framingham risk score calculation can be found online, including at the NHLBI Web site (http://www.nhlbi.nih.gov/about/framingham/riskabs.htm).

Coronary heart disease (CHD) risk.*

- **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 the presence of diabetes mellitus or the 10-year absolute CHD risk of greater than 20%.

Evaluating Perioperative Risk for Non-Cardiac Surgery

Method for determining perioperative risk.
Perioperative risk was determined for this report using a "Stepwise Approach to Preoperative Cardiac Assessment," found in ACC/AHA 2002 Guideline Update for Perioperative Cardiovascular Evaluation for Non-cardiac Surgery (11). Based on that algorithm, once it is determined that the patient does not require urgent surgery, and that there has not been revascularization within the last five years, the clinician should determine the patient's perioperative risk predictors (see the definitions in the following text). If major risk predictors are present, coronary angiography and the postponement or cancellation of non-cardiac surgery should be considered. 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.

Perioperative risk predictors.†

• **Major risk predictors.** Unstable coronary syndromes, decompensated heart failure (HF), significant arrhythmias,
and severe valve disease.
• **Intermediate risk predictors.** Mild angina, prior myocardial infarction (MI), compensated or prior HF, diabetes, or renal insufficiency.
• **Minor risk predictors.** Advanced age, abnormal electrocardiogram (ECG), rhythm other than sinus, low functional capacity, history of cardiovascular accident (CVA), 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 _ 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
This refers to ECGs with resting ST-segment depression (greater than or equal to 0.10 mV), complete left bundle branch block, pre-excitation (Wolf-Parkinson-White Syndrome), or paced rhythm.

APPENDIX C: ACCEP Appropriateness Criteria Working Group Participants

ACCEP Appropriateness Criteria Working Group
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Appropriateness - Table 1
Appropriateness - Table 2
Appropriateness - Table 3
Appropriateness - Table 4
Appropriateness - Table 5
Appropriateness - Table 6
Appropriateness - Table 7
Appropriateness - Table 8
Appropriateness - Table 9
Appropriateness - Table 10
Appropriateness - Table 11
Appropriateness - Table 12
Appropriateness- Table 13

« Back

Indications		Appropriateness Scores (1-9)
Evaluation of Chest Pain Syndrome or Anginal Equivalent		
1.	• Low pre-test probability of CAD • ECG interpretable • No History of MI • History of normal repeat ECG tests on record	Appropriate (8)
2.	• Low pre-test probability of CAD • ECG deemed as normal or uninterpretable OR unable to exercise	Appropriate (9)
3.	• Intermediate pre-test probability of CAD • ECG deemed as normal or interpretable AND able to exercise	Appropriate (8)
4.	• Intermediate pre-test probability of CAD • ECG deemed as normal uninterpretable OR unable to exercise	Appropriate (9)
5.	• High pre-test probability of CAD • Regardless of ECG interpretability and ability to exercise	Appropriate (9)
6.	• Prior stress ECG test is uninterpretable or equivocal	Appropriate (9)
Acute Chest Pain		
7.	• Intermediate pre-test probability of CAD • ECG–no dynamic ST changes or deemed as normal AND serial cardiac enzymes negative	Appropriate (9)
8.	• High pre-test probability of CAD • ECG–ST elevation	Inappropriate (1)
New-Onset/Diagnosed Heart Failure With Chest Pain Syndrome or Anginal Equivalent		
9.	• Intermediate pre-test probability • Normal LV systolic function	Appropriate (8)
10.	• LV systolic dysfunction	Appropriate (8)

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

Indications		Appropriateness Scores (1-9)
General Patient Populations for Screening		
11.	• Low CHD risk (Framingham risk criteria)	Inappropriate (1)
12.	• Moderate CHD risk (Framingham) • ECG Interpretable	Uncertain (4)
13.	• High CHD risk (Framingham) •	Uncertain (6-7)

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

Indications		Appropriateness Scores (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	Appropriate (8)
15.	• Moderate CHD risk (Framingham) • No prior CAD evaluation • Abnormal LV systolic dysfunction	Appropriate (9)
Valvular Heart Disease Requiring Valve Surgery		
16.	• Moderate CHD risk (Framingham)	Uncertain (5)
New-Onset Atrial Fibrillation		
17.	• Low CHD risk (Framingham) • Part of the evaluation	Uncertain (4)
18.	• Moderate to high CHD risk (Framingham) • Part of the evaluation	Appropriate (8)
Nonsustained Ventricular Tachycardia		
19.	• Moderate to high CHD risk (Framingham) • Stress echo using exercise stress only	Appropriate (8)

Table 4. Risk Assessment with Prior Test Results

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

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

Indications		Appropriateness Scores (1-9)
Low-Risk Non-Cardiac Surgery		
29.	• Preoperative evaluation for non-cardiac surgery risk assessment • Minor or intermediate clinical risk predictors	Inappropriate (1)
Intermediate-Risk Non-Cardiac Surgery		
30.	• Poor exercise tolerance (less than or equal to 4 METs) • Minor or no clinical risk predictors	Inappropriate (2)
31.	• Poor exercise tolerance (less than or equal to 4 METs) • Intermediate clinical risk predictors	Appropriate (7)
High-Risk, Non-Emergent, Cardiac Surgery		
32.	• Poor exercise tolerance (less than 4 METs)	Appropriate (8)
33.	• Asymptomatic up to 1 year after normal catheterization, non-invasive tests, or previous revascularization with normal or low MCG severity scores	Inappropriate (2)

Table 6. Risk Assessment: Following Acute Coronary Syndrome

Indications		Appropriateness Scores (1-9)
UA/NSTEMI—No Recurrent Symptoms or Signs of Heart Failure		
34.	● Not planning to undergo early catheterization	Appropriate (9)
Asymptomatic Post-Revascularization (PCI or CABG)		
35.	● Routine evaluation prior to hospital discharge	Inappropriate (2)

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

Indications		Appropriateness Scores (1-9)
Symptomatic Post-Revascularization (PCI or CABG)		
36.	• Evaluation of chest pain syndrome	Appropriate (8)
Asymptomatic Post-Revascularization (PCI or CABG)		
37.	• Less than 5 years after CABG	Inappropriate (2)
38.	• Asymptomatic (e.g., silent ischemia) prior to previous revascularization • Greater than or equal to 5 years after CABG	Uncertain (6)
39.	• Symptomatic prior to previous revascularization • Greater than or equal to 5 years after CABG	Appropriate (8)
40.	• Asymptomatic (e.g., silent ischemia) prior to previous revascularization • Less than 2 years after PCI	Inappropriate (2)
41.	• Symptomatic prior to previous revascularization • Less than 2 years after PCI	Appropriate (8)
42.	• Asymptomatic (e.g., silent ischemia) prior to previous revascularization • Greater than or equal to 2 years after PCI	Uncertain (5)

Table 8. Assessment of Viability/Ischemia

Indications		Appropriateness Scores (1-9)
Ischemic Cardiomyopathy, Assessment of Viability/Ischemia		
43.	● Known CAD on catheterization ● Patient eligible for revascularization	Appropriate (8)

Table 9. Pharmacological MCG Stress Study for Hemodynamics

Indications		Appropriateness Scores (1-9)
Valvular Stenosis		
44.	• Evaluation of equivocal aortic stenosis • Evidence of low cardiac output • Use of dobutamine	Uncertain (6)
45.	• Asymptomatic individuals • Mild to moderate mitral stenosis	Uncertain (5)
46.	• Symptomatic individuals • Mild mitral stenosis	Uncertain (6)
47.	• Severe aortic or mitral stenosis	Uncertain (5)
48.	• Asymptomatic severe AI or MR • LV size and function not meeting surgical criteria A (7)	Uncertain (5)
49.	• Symptomatic prior to previous revascularization • Less than 2 years after PCI	Inappropriate (2)
50.	• Severe AI or MR • Symptomatic or with severe LV enlargement or LV systolic dysfunction I (2)	Inappropriate (2)
Pulmonary Hypertension		
51.	• Suspected pulmonary hypertension • Normal or indeterminate resting echo study	Uncertain (5)

Table 10. Detection of CAD and Risk Assessment: Asymptomatic with specific abnormal findings

Indications		Appropriateness Scores (1-9)
Specific Patient Populations for Screening		
52.	• Abnormal ABI	Uncertain (6)
53.	• Abnormal Carotid Doppler	Appropriate (7)
54.	• Cerebral Vascular Accident	Appropriate (8)
55.	• Abdominal Aortic Aneurysm • Any arterial aneurysms	Appropriate (7)
56.	• Peripheral Vascular Disease	Appropriate (8)
57.	• Poorly controlled Diabetes	Uncertain (6)
58.	• Renal vascular Hypertension	Appropriate (7)
59.	• Chronic Hypertension with or without hyperlipidemia	Uncertain (6)
60.	• Micro albumin urea	Uncertain (6)
61.	• Chronic Renal Failure on dialysis	Appropriate (7)

Table 11. Appropriate Indications for MCG Use		Appropriateness Scores (1-9)
Evaluation of Chest Pain Syndrome or Anginal Equivalent		
1.	• Low pre-test probability of CAD • ECG interpretable • No History of MI • History of normal repeat ECG tests on record	Appropriate (8)
2.	• Low pre-test probability of CAD • ECG uninterpretable OR unable to exercise	Appropriate (9)
3.	• Intermediate pre-test probability of CAD • ECG interpretable AND able to exercise	Appropriate (8)
4.	• Intermediate pre-test probability of CAD • ECG uninterpretable OR unable to exercise	Appropriate (9)
5.	• High pre-test probability of CAD • Regardless of ECG interpretability and ability to exercise	Appropriate (9)
6.	• Prior stress ECG test is uninterpretable or equivocal	Appropriate (9)
Acute Chest Pain		
7.	• Intermediate pre-test probability of CAD • ECG–no dynamic ST changes AND serial cardiac enzymes negative	Appropriate (9)
New-Onset/Diagnosed Heart Failure With Chest Pain Syndrome or Anginal Equivalent		
9.	• Intermediate pre-test probability • Normal LV systolic function	Appropriate (8)
New-Onset/Diagnosed Heart Failure With Chest Pain Syndrome or Anginal Equivalent		
10.	• LV Systolic Dysfunction	Appropriate (8)

New-Onset or Diagnosed Heart Failure or LV Systolic Dysfunction		
14.	• Moderate CHD risk (Framingham) • No prior CAD evaluation • Normal LV systolic function	Appropriate (8)
15.	• Moderate CHD risk (Framingham) • No prior CAD evaluation • Abnormal LV systolic dysfunction	Appropriate (9)
New-Onset Atrial Fibrillation		
18.	• Moderate to high CHD risk (Framingham) • Part of the evaluation	Appropriate (8)
Non-sustained Ventricular Tachycardia		
19.	• Moderate to high CHD risk (Framingham) • Stress echo using exercise stress only	Appropriate (8)

Asymptomatic OR Stable Symptoms, Normal Prior Stress Imaging Study		
20.	• High CHD risk • Repeat stress echo study annually	Appropriate (8)
21.	• High CHD risk • Repeat stress echo study after 2 years or greater U (5)	Appropriate (8)
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	Appropriate (8)
23.	• Assessment of severity of ischemia (CAD) • Greater than or equal to 2 years to evaluate medically managed patients	Appropriate (8)
Worsening Symptoms: Abnormal Catheterization OR Abnormal Prior Stress Imaging Study		
24.	• Re-evaluation of medically managed patients	Appropriate (8)

24.	• Re-evaluation of medically managed patients	Appropriate (8)
Asymptomatic Prior Coronary Calcium Agatston Score		
25.	Agatston score greater than or equal to 400	Appropriate (7)
Chest Pain Syndrome or Anginal Equivalent		
28.	• Coronary artery stenosis of unclear significance (cardiac catheterization or CT angiography)	Appropriate (9)
Intermediate-Risk Non-Cardiac Surgery		
31.	• Poor exercise tolerance (less than or equal to 4 METs) • Intermediate clinical risk predictors	Appropriate (7)
High-Risk, Non-Emergent, Cardiac Surgery		
32.	• Poor exercise tolerance (less than 4 METs)	Appropriate (8)
UA/NSTEMI—No Recurrent Symptoms or Signs of Heart Failure		
34.	● Not planning to undergo early catheterization	Appropriate (9)
Symptomatic Post-Revascularization (PCI or CABG)		
36.	• Evaluation of chest pain syndrome	Appropriate (8)
Asymptomatic Post-Revascularization (PCI or CABG)		
39.	• Symptomatic prior to previous revascularization • Greater than or equal to 5 years after CABG	Appropriate (8)
41.	• Symptomatic prior to previous revascularization • Less than 2 years after PCI	Appropriate (8)
Ischemic Cardiomyopathy, Assessment of Viability/Ischemia		
	● Known CAD on catheterization	

Specific Patient Populations for Screening		
53.	• Abnormal Carotid Doppler	Appropriate (7)
54.	• Cerebral Vascular Accident	Appropriate (8)
55.	• Abdominal Aortic Aneurysm • Any arterial aneurysms	Appropriate (7)
56.	• Peripheral Vascular Disease	Appropriate (8)
58.	• Renal vascular Hypertension	Appropriate (7)
61.	• Chronic Renal Failure on dialysis	Appropriate (7)

Table 12. Uncertain Appropriateness: Requires Further Investigation

Uncertain Indications		Appropriateness Scores (1-9)
General Patient Populations for Screening		
12.	• Moderate CHD risk (Framingham) • ECG Interpretable	Uncertain (4)
13.	• High CHD risk (Framingham)	Uncertain (6-7)
Valvular Heart Disease Requiring Valve Surgery		
16.	• Moderate CHD risk (Framingham)	Uncertain (5)
New-Onset Atrial Fibrillation		
17.	• Low CHD risk (Framingham) • Part of the evaluation	Uncertain (4)
Asymptomatic Prior Coronary Calcium Agatston Score		
27.	Agatston Score less than 100 with non-specific ST-T changes.	Uncertain (5)
Post Revascularization patients: Asymptomatic		
38.	• Asymptomatic (e.g., silent ischemia) prior to previous revascularization • Greater than or equal to 5 years after CABG	Uncertain (6)
42.	• Asymptomatic (e.g., silent ischemia) prior to previous revascularization • Greater than or equal to 2 years after PCI	Uncertain (5)
Pharmacological MCG Stress Study for Hemodynamics:		
Valvular Stenosis		
44.	• Evaluation of equivocal aortic stenosis • Evidence of low cardiac output • Use of dobutamine	Uncertain (6)

44.	• Evaluation of equivocal aortic stenosis • Evidence of low cardiac output • Use of dobutamine	Uncertain (6)
45.	• Asymptomatic individuals • Mild to moderate mitral stenosis	Uncertain (5)

Asymptomatic Prior Coronary Calcium Agatston Score		
27.	• Agatston score less than 100 with non-specific abnormal ECGs	
Post Revascularization patients: Asymptomatic		
38.	• Asymptomatic (e.g., silent ischemia) prior to previous revascularization • Greater than or equal to 5 years after CABG	Uncertain (6)
39.	• Symptomatic prior to previous revascularization • Greater than or equal to 5 years after CABG	Uncertain (5)
42.	• Asymptomatic (e.g., silent ischemia) prior to previous revascularization • Greater than or equal to 2 years after PCI	Uncertain (5)
Pharmacological MCG Stress Study for Hemodynamics:		
Valvular Stenosis		
44.	• Evaluation of equivocal aortic stenosis • Evidence of low cardiac output • Use of dobutamine	Uncertain (6)
45.	• Asymptomatic individuals • Mild to moderate mitral stenosis	Uncertain (5)
46.	• Symptomatic individuals • Mild mitral stenosis	Uncertain (6)
47.	• Severe aortic or mitral stenosis	Uncertain (5)
48.	• Asymptomatic severe AI or MR • LV size and function not meeting surgical criteria A (7)	Uncertain (5)
Pulmonary Hypertension		
51.	• Suspected pulmonary hypertension • Normal or indeterminate resting echo study	Uncertain (5)

Specific Patient Populations for Screening		
52.	• Abnormal ABI	Uncertain (6)
57.	• Poorly controlled Diabetes	Uncertain (6)
59.	• Chronic Hypertension with or without hyperlipidemia	Uncertain (6)
60.	• Microalbuminuria	Uncertain (6)

Table 13. Inappropriate Indications for MCG Use

Inappropriate Indications		Appropriateness Scores (1-9)
Acute Chest Pain		
8.	• High pre-test probability of CAD • ECG–ST elevation	Inappropriate (1)
General Patient Populations for Screening		
11.	• Low CHD risk (Framingham risk criteria)	Inappropriate (1)
Asymptomatic Prior Coronary Calcium Agatston Score		
26.	• Agatston score less than 100 with two or more normal repeated ECGs	Inappropriate (2)
Low-Risk Surgery		
29.	• Preoperative evaluation for non-cardiac surgery risk assessment • Minor or intermediate clinical risk predictors	Inappropriate (1)
Intermediate-Risk Surgery		
30.	• Poor exercise tolerance (less than or equal to 4 METs) • Minor or no clinical risk predictors	Inappropriate (2)
High-Risk Non-Emergent Surgery		
33.	• Asymptomatic up to 1 year after normal catheterization, non-invasive tests, or previous revascularization with normal or low prior MCG severity scores (< 3.0)	Inappropriate (2)
Asymptomatic Post-Revascularization (PCI or CABG)		
35.	• Routine evaluation prior to hospital discharge	Inappropriate (2)
Asymptomatic		
37.	• Less than 5 years after CABG	Inappropriate (2)

40.	• Asymptomatic (e.g., silent ischemia) prior to previous revascularization • Less than 2 years after PCI	Inappropriate (2)
Pharmacological MCG Stress Study for Hemodynamics:		
Valvular Stenosis		
49.	• Symptomatic prior to previous revascularization • Less than 2 years after PCI	Inappropriate (2)
50.	• Severe AI or MR • Symptomatic or with severe LV enlargement or LV systolic dysfunction I (2)	Inappropriate (2)