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DATA STANDARDS

ACC/AHA/ACR/ASE/ASNC/HRS/NASCI/RSNA/SAIP/SCAI/SCCT/SCMR/SIR 2008 Key Data Elements and Definitions for Cardiac Imaging

A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Data Standards (Writing Committee to Develop Clinical Data Standards for Cardiac Imaging)

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Preamble

The American College of Cardiology (ACC) and the American Heart Association (AHA) support their members' goal to improve the prevention and care of cardiovascular diseases through professional education, research, development of guidelines and standards, and by fostering policy that supports optimal patient outcomes. The ACC and AHA recognize the importance of the use of clinical data standards for patient management, to assess outcomes, and conduct research, and the importance of defining the processes and outcomes of clinical care, whether in randomized trials, observational studies, registries, or quality improvement initiatives.

Hence, clinical data standards strive to define and standardize data relevant to clinical topics in cardiology, with the primary goal of assisting data collection by providing a platform of data elements and definitions applicable to various conditions. Broad agreement on a common vocabulary with reliable definitions used by all is vital to pool and/or compare data across studies and assess the applicability of research to clinical practice. The growing adoption of electronic medical records renders an even more imperative and urgent need for such definitions and standards. Therefore, the ACC and AHA have undertaken the task of defining and disseminating clinical data standards—sets of standardized data elements and corresponding definitions to collect data relevant to cardiovascular conditions. The ultimate purpose of clinical data standards is to contribute to the infrastructure necessary for accomplishing the ACC/AHA's mission of fostering optimal cardiovascular care and disease prevention.

The specific goals of clinical data standards are:

1. to facilitate the establishment of registries and quality improvement programs by providing a list of major variables, outcomes, and definitions;
2. to optimize the comparison of results and outcomes across registries and studies; and
3. to become the basis for a standardized medical documentation process, essential for the electronic medical record environment.

The key elements and definitions are a compilation of variables to measure patient management and outcomes for clinical and research purposes as well as for quality improvement in order to standardize the language used to describe cardiovascular diseases and procedures, enhance consistency in cardiology, and increase opportunities for sharing data across data sources. The ACC/AHA Task Force on Clinical Data Standards selects cardiovascular conditions and procedures that will benefit from creating a data standard

set. Experts in the subject are selected to examine/consider existing standards and develop a comprehensive, yet not exhaustive, data standard set. When undertaking a data collection effort, only a subset of the elements contained in a clinical data standards listing may be needed or, conversely, users may want to consider whether it may be necessary to collect some elements not listed. For example, in the setting of a randomized clinical trial of a new drug, additional information would likely be required regarding study procedures and drug therapies.

The Health Insurance Portability and Accountability Act (HIPAA) privacy regulations, which went into effect in April 2003, have heightened all practitioners' awareness of our professional commitment to safeguard our patients' privacy. The HIPAA privacy regulations (http://www.hhs.gov/ocr/combinedregtext.pdf, page 31) specify which information elements are considered "protected health information." These elements may not be disclosed to third parties (including registries and research studies) without the patient's written permission. Protected health information may be included in databases used for health care operations under a data use agreement. Research studies using protected health information must be reviewed by an institutional review board or a privacy board.

We have included identifying information in all clinical data standards to facilitate uniform collection of these elements when appropriate. For example, a longitudinal clinic database may contain these elements, since access is restricted to the patient's caregivers. On the other hand, registries may not contain protected health information unless specific permission is granted by each patient. These fields are indicated as protected health information in the data standards.

The ACC/AHA Task Force on Clinical Data Standards makes every effort to avoid any actual or potential conflicts of interest that may arise as a result of an outside relationship or a personal, professional, or business interest of a member of the writing panel. Specifically, all members of the writing group were required to submit a disclosure form showing all such relationships that might be perceived as real or potential conflicts of interest. These statements are reviewed by the ACC/AHA Task Force on Clinical Data Standards, reported orally to all members of the writing panel at the first meeting, and updated as changes occur. Writing Committee members' relationships with industry are listed in Appendix A. Relationships with industry for official peer reviewers are listed in Appendix B.

In clinical care, caregivers communicate with each other through a common vocabulary. In an analogous fashion, the integrity of clinical research depends on firm adherence to pre-specified procedures for patient enrollment and follow-up; these procedures are guaranteed through careful attention to definitions enumerated in the study design and case-report forms. When data elements and definitions are standardized across studies, comparison, pooled analysis, and meta-analysis are enabled, thus deepening our understanding of individual studies.

The recent development of quality performance measurement initiatives, particularly those for which comparison of providers is an implicit or explicit aim, has further raised awareness about the importance of data standards. Indeed, a wide audience, including nonmedical professionals such as payers, regulators, and consumers, may draw conclusions about care and outcomes. To understand and compare care patterns and outcomes, the data elements that characterize them must be clearly defined, consistently used, and properly interpreted, now more than ever before.

Véronique L. Roger, MD, MPH, FAHA, FACC
Chair, ACC/AHA Task Force on Clinical Data Standards

Modality and Technique Abbreviations Used in This Document

CACS =	Coronary Artery Calcium Score
Cardiac cath =	Cardiac Catheterization
CCT =	Cardiac Computed Tomography
CCTA =	Cardiac Computed Tomographic Angiography
CMR =	Cardiac Magnetic Resonance
Echo =	Echocardiography
ICA =	Invasive Coronary Angiography
LVG =	Left Ventriculography
MPI =	Myocardial Perfusion Imaging
PET =	Positron Emission Tomography
RNA =	Radionuclide Angiography
SPECT =	Single-Photon Emission Computed Tomography
TEE =	Transesophageal Echocardiography
TTE =	Transthoracic Echocardiography

I. Introduction

Cardiac imaging is an integral part of the evaluation and management of patients with known or suspected heart disease. These techniques offer insight into morphologic features and physiologic functioning of the myocardium, valves, pericardium, coronary arteries, and great vessels. Substantial advances in technology have occurred within the past decade, advancing clinical applications and enhancing diagnostic accuracy.

Many options for imaging the heart and adjacent structures are available such as, echocardiography, single-photon emission computed tomography (SPECT) myocardial perfusion imaging (MPI), positron emission tomography (PET), cardiac magnetic resonance (CMR), cardiac computed tomography (CCT), invasive coronary angiography (ICA), and left ventriculography (LVG). Major specialty societies, such as the ACC, the AHA, the Radiological Society of North American (RSNA), and the American College of Radiology (ACR) have demonstrated leadership

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in promoting research and written guidelines and practice standards for the performance of cardiac imaging. In many cases, each modality has developed rather independently and has strong advocacy by dedicated clinicians/researchers and their own subspecialty societies, including the American Society of Nuclear Cardiology (ASNC), the American Society of Echocardiography (ASE), the Society for Atherosclerosis Imaging and Prevention (SAIP), the Society for Cardiovascular Computed Tomography (SCCT), the Society for Cardiovascular Magnetic Resonance (SCMR), the Society for Cardiovascular Angiography and Interventions (SCAI), the Society of Interventional Radiology (SIR), the North American Society for Cardiovascular Imaging (NASCI), and the Heart Rhythm Society (HRS).

Cardiac imaging is included in patient decision-making and is often referenced in guidelines and other data standards. However, differing definitions abound, leading to misunderstanding and confusion. Furthermore, structured reporting is becoming commonplace and imaging data fields are increasingly being used within registries and clinical databases. The ACC has led a multisocietal effort that culminated in the development of a document that recommends the use of structured reporting for cardiovascular imaging as an essential component of improved cardiovascular health care (1); that article is being published simultaneously with these data standards. These two writing efforts were coordinated with each other and underscore the importance for capturing and reporting clear, consistent and complete information for patients undergoing cardiovascular imaging.

The ACC/AHA Clinical Data Standards Task Force was approached about assembling a committee to harmonize cardiac imaging definitions that have been developed by many organizations and committees, in a fashion similar to the existing clinical data standards for electrophysiology, ischemic heart disease, and heart failure. The need for data standardization in cardiac imaging was highlighted at a "Think Tank" meeting sponsored by Duke University and the ACC (2). The development of common data elements was felt to be a priority that would lead to the development of important quality metrics in imaging. A follow-up ad hoc group was formed as part of a subcommittee of the ACC Cardiovascular Imaging Collaborative Committee with a focus on quality in imaging and developed a working draft of data standards, which was used as a starting point for the Writing Committee.

II. Methodology

A. Writing Committee Composition

The ACC/AHA Task Force on Clinical Data Standards selected members for the Writing Committee to Develop Clinical Data Standards for Cardiac Imaging (Writing Committee). The Writing Committee consisted of 15 members who are well versed in structured reporting initiatives, as well as active in the various disciplines of cardiac imaging, including invasive contrast angiography, CCT, CMT, nuclear cardiology, and echocardiography. All organizations listed on the masthead nominated individuals to comprise the makeup of the Writing Committee.

B. Relationships With Industry

The ACC/AHA Task Force on Clinical Data Standards makes every effort to avoid any actual or potential conflicts of interest that may arise as a result of an outside relationship or a personal, professional, or business interest of a member of the writing panel. Specifically, all members of the writing group were required to complete and submit a disclosure form showing all such relationships that might be perceived as real or potential conflicts of interest. These statements are reviewed by the ACC/AHA Task Force on Clinical Data Standards and are updated when changes occur. Please see Appendix A for the Writing Committee relationships with industry.

C. Review of Literature and Existing Data Definitions

These imaging standards are intended to provide data elements that parallel and complement existing data fields as previously reported in ACC and AHA documents, along with those used as fields within existing registries, such as those developed by the ACC National Cardiovascular Data Registry (NCDR) (3). We also reviewed the ACC/AHA Key Data Elements and Definitions for Measuring the Clinical Management and Outcomes of Patients with Chronic Heart Failure (4), the ACC/AHA Key Data Elements and Definitions for Measuring the Clinical Management and Outcomes of Patients with Atrial Fibrillation (5), the ACC/AHA/HRS 2006 Key Data Elements and Definitions for Electrophysiological Studies and Procedures (6), and the American College of Cardiology Key Data Elements and Definitions for Measuring the Clinical Management and Outcomes of Patients with Acute Coronary Syndromes (7).

D. Defining Data Elements

The core elements and definitions were originally drafted by a group of imaging specialists formed after the first Duke/ACC Think Tank meeting, whose proceedings were published 1 year later (2). The Writing Committee then gathered many other candidate data elements gleaned from other sources. As the Writing Committee developed definitions, they were encouraged to write definitions broad enough to be applicable in a variety of data collection settings, but specific enough that the data elements can be uniformly interpreted. Some elements will require an additional level of specificity by the end-user for implementation which is beyond the scope of the Writing Committee. Data definitions were linked whenever possible to the evidence-based national guidelines. To ensure consistency across ACC/AHA clinical data standards, writers used an existing ACC/AHA definition verbatim unless there was a reason related to cardiac imaging to change that definition. The Writing Committee chose not to develop an all-inclusive list of every possible data element that may be used for all

cardiac imaging techniques. Rather, the Writing Committee focused its attention on common elements that cross modality boundaries. It is anticipated that modality-specific data definitions and elements will need further delineation, likely by subspecialty society organizations and groups. The purpose of this document is to attempt to harmonize as many common data fields as possible. These data elements were constructed primarily for use with the adult cardiac patient. Therefore, these elements are not designed for pediatric cardiology or those adults with congenital heart disease.

E. Prioritizing Data Elements

Once the Writing Committee reviewed the draft submitted as a working manuscript by the Think Tank Group, a focused group of data elements and definitions was developed. The group was most interested in common data elements which transcended an individual imaging modality. Of the data elements included within this paper, items were identified as:

1. *Recommended* for all imaging studies;
2. *Recommended* for a specific modality or modalities;
3. *Optional*, meaning a worthwhile data element but not necessarily required in all instances;
4. *Derived*, meaning that this field would be calculated based on previously entered information, negating the need to specifically obtain this information.

These descriptors were felt to help identify the most important data elements for database and registry construction.

F. Relation to Other Standards

The Writing Committee reviewed other standards including those developed for heart failure, atrial fibrillation, electrophysiology, and acute coronary syndromes, as previously noted. Although other groups have used imaging within their disciplines and have definitions based on imaging parameters, the Writing Committee felt that it was the responsibility of this multimodality group to provide a uniform standard that may be adopted by other data standards groups for their imaging parameters. It was felt that this Writing Committee possessed key levels of expertise needed to address this issue in a consistent fashion. It is hoped that these definitions will be used in subsequent revisions of the data standards for heart failure, atrial fibrillation, electrophysiology, and acute coronary syndromes, in order to maintain consistency.

G. Consensus Development

These ACC/AHA data standards, like others, are team-developed written documents and are based on the judgments of experts within cardiovascular imaging. The Writing Committee met more than 10 times, by telephone and in person, over the course of 5 months to define and refine the data elements. Throughout the process, consensus was developed through extensive in-person discussion, teleconferences, and e-mails. Minority opinions are expressed in the discussion of the elements when differences existed.

H. Peer Review, Public Review, and Board Approval

The set of imaging standards and definitions was independently reviewed by official appointees from the ACC, AHA, ACR, ASE, ASNC, HRS, NASCI, RSNA, SAIP, SCAI, SCCT, SCMR, and SIR, as well as the ACC/AHA Data Standards Task Force. To increase its applicability, this document was posted on the ACC and ACR Website for a 30-day public comment period from April 14, 2008, through May 14, 2008. The document was then approved by all sponsoring organizations.

The Writing Committee anticipates these data standards will require review and updating, just as with guidelines, performance measures, and appropriateness criteria. At the anniversary of the data standards publication, the Writing Committee will review the data standards to ascertain whether or not modifications should be considered.

I. Considerations for Cardiac Imaging Clinical Data Standards

The Writing Committee anticipates that the cardiac imaging data standards will prove useful in several settings:

1. *Clinical Programs*, where providers and health plans work in concert to achieve optimal utilization of cardiac imaging procedures. Data standards will assist in the development of structured reporting systems, organizing and designing of electronic medical information systems including clinical databasing, and decision support tools.
2. *Clinical Research*, including prospective registries and randomized controlled trials. Meta-analyses will be particularly strengthened by the use of standardized data for key variables.
3. *Quality Assessment/Performance Measurement*: data standards will especially facilitate interpretation for nonmedical users, including payers, regulators, and consumers.

There is a clear need for a uniform digital standard for all imaging and clinical data (e.g., electronic health records and lab results). These data elements for cardiac imaging are an important step towards this goal.

Although this set of imaging data standards is not specifically designed to be a precursor to an imaging registry, it is clear that the data definitions may be used as fields for such a registry or incorporated as data elements within registries focused on specific diseases, such as for heart failure or ischemic heart disease. Additionally, it is hoped that these standards will be used for definition within the information technology community to standardize textual cardiac imaging data and to be incorporated within structured reporting programs. An ongoing dialogue with key groups, including Digital Imaging and Communications in Medicine (DICOM) and Integrating the Healthcare Enterprise (IHE), will ensure data harmonization and uniformity.

The Writing Committee discussed the overall philosophy of these standards at great length, including whether or not to develop comprehensive or focused data elements. As multiple

modalities were included within this standard, it was decided to include key elements only and those in which there was overlap among modalities.

It is anticipated that these standards will not be comprehensive enough for all needs, and additional elements may need to be created for modality-specific findings. This multimodality data standards document, however, aims to define elements which cross modality barriers. The emphasis for this effort was on harmonization among the imaging modalities whenever possible, such as when defining ischemia or ventricular function.

A modular approach to the use of these imaging data standards should be considered. Certain data definitions are applicable only to an indication, such as detection of ischemia. As such, only the imaging methods of stress echocardiography, stress SPECT MPI, and stress CMR would need to define the presence, absence, and extent of ischemia. Likewise if no intracardiac shunting were detected, then completion of fields defining the presence of a patent foramen ovale or ventricular septal defect would not be required.

Whenever feasible, the Writing Committee attempted to incorporate existing definitions into this document. For example, data elements involving identification of the patient or physician have already been published and replicated within this document. Likewise, defining hypertension or heart failure have been previously described and are beyond the scope of this paper. However, other publications have already included definitions of image-related data which the Writing Committee felt were either inaccurate or not optimally described, and it is the hope of this group that the standards defined in the current document will be used in future, revised versions of other guidelines and data standards.

Two categories of data elements deserve special mention. The Writing Committee firmly supports standardization of nomenclature for left ventricular (LV) segmentation, which was initially supported by all imaging modalities (8) but not universally adopted. Rather than describe imaging abnormalities with use of regions or territories that are defined within a specific modality, the 17-segment model was felt to reflect a reasonable, previously published standard, which should be supported. The size of the abnormality can then be defined by the number of segments affected. A second area of intense discussion involved defining LV function and ejection fraction determination. Once again the Writing Committee emphasized the unique opportunity to help clarify LV function, which has many definitions depending on the imaging modality and method of analysis. The composition of this group representing all key organizations associated with cardiac imaging permitted a unique opportunity for resolving this "tower of Babel."

III. Cardiac Imaging Clinical Data Standard Elements and Definitions

A. Administrative

There are a total of 6 administrative elements: site ID, site of service, cardiac imaging service, accreditation status, accreditation entity, and insurance payer. Ideally, the information from these elements could be provided to the registry once, at the time of site registration, and associated with the site ID, thus decreasing the number of elements requiring data entry at the time of recruitment. Recruitment sites would include a wide variety of facilities: private practice settings, academic centers, both in-patient and outpatient facilities, and emergency departments. As such, a specific institution might have several site IDs, one for each provided service, as patients may be entered into the registry from different departments providing the different services described.

The insurance payer element was included to be certain that patients of all payer status were included in studies equitably, especially those funded federally. The inclusion of this data was not to in any way suggest that cardiac imaging patients should be screened on the basis of ability to pay.

Table 1. Administrative

Element Name	Definition
Site ID (Recommended)	Site ID is a unique number assigned to each database site. A database site is defined as 1 entity that signs a site agreement, submits 1 data submission file to the harvest, and gets back 1 report on their data. Each site's data if submitted to be analyzed must be in 1 data submission file. If 1 site keeps their data in more than 1 file (e.g., at 2 sites), then the data must be combined into a single data submission file for the harvest. If 2 or more sites share a single purchased software, and enter cases into 1 database, then the data must be exported into different data submission files, 1 for each Site ID.
Site of service (Optional)	Indicate the type of facility submitting the reporting data. Choose 1 of the following: • Hospital—inpatient • Hospital—outpatient • Nonhospital—inpatient • Nonhospital—outpatient • Mobile-based—inpatient • Mobile-based—outpatient

Table 1. Continued

Element Name	Definition
Cardiac imaging services (Recommended)	Indicate the cardiac imaging services provided by the site. Choose any of the following: • Echocardiography • CCT • CMR • SPECT MPI • PET • ICA/LVG
Imaging facility: address (Recommended)	Indicate the physical location of the facility which may be described using street address, city, state or province, postal code, and country.
Imaging facility: telephone (Recommended)	Indicate the number that uniquely identifies a telecommunications connection of the facility.
Source(s) of information (Recommended)	May select more than 1: • Patient • Referring clinician • Laboratory • Medical record • Other
Priority of study (Recommended)	Designate the study as 1 of the following: • Routine • STAT
Accreditation status (Recommended)	For each imaging service provided by the site, indicate the accreditation status of the site performing the study. Choose 1 of the following for each imaging service: • Yes • Application submitted, pending approval • No
Accreditation entity (Recommended)	If the site is accredited, indicate the entity providing the accreditation for each imaging modality. Choose any of the following: • American College of Radiology • ICAEL • ICANL • ICACTL • ICAMRL • Other • N/A
Insurance payer (Recommended)	Indicate the appropriate description of the patient's insurance carrier(s) for this admission. If the patient has more than 1, choose all that apply: • Medicare—A federal health care plan that reimburses hospitals and physicians for medical care provided to qualifying people age 65 years or older, people under age 65 years with certain disabilities, and people of all ages with end-stage renal disease. • Medicaid—Any state and federal health care program that reimburses hospitals and physicians for providing care to qualifying people who cannot finance their own medical expenses. • Commercial—Any health insurance provided by a commercial plan, regardless of the type of restrictions or payment arrangements. This includes managed care plans, such as HMOs, PPOs, POSs, and IPAs. • Military/VAMC—Refers to any military or Veteran's Administration Health Plans, and PHS. • Non-U.S. Insurance—Refers to individuals with no or limited health insurance; thus, the individual is the payer regardless of ability to pay. • Self/None—Refers to situations when the individual is the sole payer regardless of his/her ability to pay. Check this choice only when "self" or "none" is listed as the first insurance in the medical record.

N/A indicates not applicable.

B. Demographics

The HIPAA privacy regulations specify which elements are considered "protected health information (PHI)." These elements may not be disclosed to third parties (including registries and research studies) without the patient's written permission. PHI may be included in databases used for health care operations under a data use agreement. Research studies using PHI must be reviewed by an institutional review board or a privacy board. PHI will then need to be uncoupled from any identifying information. One possible

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method of doing this is to generate a unique numerical identifier (i.e., 1-way hash number) (9,10) computer generated by immutable patient statistics. Cross-linkage of data regarding various imaging procedures is essential for evaluation of possibly redundant and serial testing, but the means to accomplish this task are beyond the scope of this project and the charge of the Writing Committee.

Table 2. Demographics

Element Name	Definition
Unique patient ID (Recommended)	Participant ID is a unique number that permanently identifies each patient. Once assigned to a patient, this can never be changed or reassigned to a different patient. If a patient returns to the site, they MUST receive this same unique patient identifier.
Patient DOB (Recommended)	Indicate the patient's date of birth
Gender (Recommended)	Indicate the patient's gender at birth as either male or female. Choose 1 of the following: • Male • Female
Race (Recommended)	Indicate the patient's race as determined by the patient/family. Choose 1 of the following: • Caucasian • Black • Asian • Native American or Alaska Native • Native Hawaiian or other Pacific Islander • Other race not listed
Ethnicity (Recommended)	Indicate if the patient is of Hispanic ethnicity as determined by the patient/family. Hispanic ethnicity includes patient reports of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin, regardless of race. Choose 1 of the following: • Yes • No

C. Study Referral Data

It is important to capture the referral source data for purposes of studying trends in referral patterns over time and to determine the utilization of cardiac imaging. The use of the National Physician Identifier (NPI) was chosen to uniquely and longitudinally track referral physician, particularly in longstanding studies and in the case of physicians that change geographic or institutional venues. The Referral Physician Specialty element was designed to capture the most likely specialty groups to be referring patients for cardiac imaging studies; the level of granularity for this element was discussed at length, and the final decision was to include a representative list, rather than a comprehensive all-inclusive list of likely physician referrers.

Table 3. Study Referral Data

Element Name	Definition
Physician NPI—Referral physician (Recommended)	Indicate the participant's National Provider Identifier (NPI). This number, assigned by the Centers for Medicare & Medicaid Services (CMS), is used to uniquely identify physicians for Medicare billing purposes.
Referral physician specialty (Recommended)	Indicate the primary specialty of the physician referring the patient. • Cardiologist • Family practice • Internal medicine • OB/GYN • Hospitalist • Surgeon • Physician extender • Anesthesiologist • Radiologist • Emergency department physician • Other

D. History and Risk Factors

Information about a patient's medical history and risk factors obtained prior to an imaging test is important for quality performance measurement, clinical research, and clinical care. Presence of cardiac risk factors or symptoms may impact interpretation of findings and are necessary to track the appropriate use of imaging tests. Medical history may impact the imaging test chosen or alter the technical approach of an imaging test in an effort to maximize diagnostic yield. Medical history is also critical to ensure the safety of an imaging test, as it may reveal absolute or relative contraindications to an imaging modality or agents used in performance of an imaging test.

The medical history and risk factors data elements chosen for inclusion in this document are intended to reproduce standard elements in other data standard documents and to adhere to current consensus guidelines on the classification of disease states whenever possible. In addition, elements were constructed with the specific purpose of tracking applications of relevant Appropriateness Criteria and Consensus Practice Guidelines in which imaging tests are prominent (e.g., Perioperative Guidelines for Noncardiac Surgery [11]). Some of the elements in this area may be derived from others using standard risk-factor calculation tools. The Writing Group recognizes that all historical information included may not be routinely available for all imaging tests and that more detailed information may be necessary/routine prior to specific imaging tests or for specific indications.

Table 4. History and Risk Factors

Element Name	Definition
Height (cm) (Recommended)	Indicate the patient's first recorded height in centimeters at the time of the study. If not in cm, list units. To be converted from English units if needed.
Weight (kg) (Recommended)	Indicate the patient's first recorded weight in kilograms at the time of the study. If not in kg, list units. To be converted from English units if needed.
Estimated ability to exercise (prior to test), described in METS (Recommended—stress SPECT, stress TTE, stress CMR, stress PET)	Indicate the ability of the patient to meet estimated energy requirements for various activities expressed as a number of metabolic equivalents. Choose 1 of the following: • Less than 4 METS—defined as ability to do 1 or more of the following activities (can take care of oneself, eat, dress, or use the toilet, walk indoors around the house, or walk a block or 2 on level ground at 2 to 3 mph or 3.2 to 4.8 km/h) • 4 METS or greater—defined as the ability to do 1 or more of the following activities (climb a flight of stairs or walk uphill, walk on level ground at 4 mph or 6.4 km/h, run a short distance, do heavy work around the house such as scrubbing floors or lifting or moving heavy furniture, participate in moderate recreational activities like golf, bowling, dancing, doubles tennis, or throwing a baseball or football, or participate in strenuous sports like swimming, singles tennis, football, basketball or skiing)
Hypertension (Recommended)	Indicate if the patient has a current diagnosis of hypertension defined by any 1 of the following: • History of hypertension diagnosed and treated with medication, diet, and/or exercise • Prior documentation of blood pressure greater than 140 mm Hg systolic and/or 90 mm Hg diastolic for patients without diabetes or chronic kidney disease, or prior documentation of blood pressure greater than 130 mm Hg systolic or 80 mm Hg diastolic on at least 2 occasions for patients with diabetes or chronic kidney disease • Currently on pharmacological therapy for the treatment of hypertension. Choose 1 of the following: • Yes • No • Unknown
Systolic blood pressure (Recommended)	Indicate most recent systolic blood pressure (mm Hg) reading during visit for the imaging study.
Diastolic blood pressure (Recommended)	Indicate most recent diastolic blood pressure (mm Hg) reading during visit for the imaging study.
Dyslipidemia (Recommended)	Indicate if the patient has a history of dyslipidemia diagnosed and/or treated by a physician. National Cholesterol Education Program (12) criteria include documentation of the following: • Total cholesterol greater than 200 mg/dl (5.18 mmol/l) • Low-density lipoprotein (LDL) greater than or equal to 130 mg/dl (3.37 mmol/l) • High-density lipoprotein (HDL) less than 40 mg/dl (1.04 mmol/l) in men and less than 50 mg/dl (1.30 mmol/l) in women • Currently on antilipidemic treatment Choose 1 of the following: • Yes • No • Unknown
LDL (Optional)	Indicate most recent LDL measurement (mg/dl) in medical record prior to imaging study.
HDL (Optional)	Indicate most recent HDL measurement (mg/dl) in medical record prior to imaging study.
Family history of coronary artery disease (Recommended)	Any first-degree relatives (parents, siblings, children) who have had any of the following at age less than 55 years: 1. Angina, 2. Myocardial infarction (MI), 3. Coronary artery bypass graft (CABG), 4. Percutaneous coronary intervention (PCI), or 5. Sudden cardiac death without obvious cause. Choose 1 of the following: • Yes • No • Unknown
History of tobacco use (Recommended)	Indicate if the patient has a history confirming any form of tobacco use in the past. This includes cigarettes, cigar, tobacco chew, etc. Choose 1 of the following: • Yes, Current: Use of tobacco within 1 month of this study. • Yes, Former: Use of tobacco greater than 3 months prior to this study. • Never • Unknown

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Table 4. Continued

Element Name	Definition
Diabetes (Recommended)	Indicate if the patient has a history of diabetes mellitus, regardless of duration of disease or need for antidiabetic agents; or a fasting blood sugar greater than 7 mmol/l or 126 mg/dl. This includes diagnosis at any time prior to the study. It does not include gestational diabetes. Choose 1 of the following: • Yes—insulin requiring • Yes—noninsulin requiring • No • Unknown
History of acute renal failure (Recommended)	Indicate if the patient has a history of acute renal failure, which is defined as history of reduced renal function (GFR greater than 30) for less than 3 months. Year of occurrence and precipitant for acute renal insufficiency may be specified.
History of chronic kidney disease (Recommended)	Indicate if the patient has a history of chronic kidney disease, which is defined as either kidney damage or GFR less than 60 ml/min/1.73 m^2 for greater than or equal to 3 months. Kidney damage is defined as pathologic abnormalities or markers of damage, including abnormalities in blood or urine tests or imaging studies. Indicate the patient's stage of disease (13): • Stage 0—No known kidney disease • Stage 1—Kidney damage with normal or high—GFR greater than or equal to 90 ml/min/1.73 m^2 • Stage 2—Kidney damage with mildly decreased—GFR 60 to 89 ml/min/1.73 m^2 • Stage 3—Moderately decreased—GFR 30 to 59 ml/min/1.73 m^2 • Stage 4—Severely decreased—GFR 15 to 29 ml/min/1.73 m^2 • Stage 5—Kidney failure—GFR less than 15 ml/min/1.73 m^2 or on dialysis • Unknown
Peripheral arterial disease (Recommended)	Indicate if the patient has a history of peripheral arterial disease (includes upper and lower extremity, renal, mesenteric, and abdominal aortic systems). This can include: • Claudication, either with exertion or at rest • Amputation for arterial vascular insufficiency • Vascular reconstruction, bypass surgery, or percutaneous intervention to the extremities (excluding dialysis fistulas and vein stripping) • Documented aortic aneurysm with or without repair • Positive invasive angiogram • Positive noninvasive test (e.g., ankle brachial index less than or equal to 0.9, ultrasound, magnetic resonance or computed tomography imaging of greater than 50% diameter stenosis in any peripheral artery, i.e., renal, subclavian, femoral, iliac). Choose 1 of the following: • Yes • No • Unknown
Cerebrovascular disease (Recommended)	Indicate if the patient has a history of cerebrovascular disease, including any 1 of the following: • Cerebrovascular accident (CVA): Patient has a history of stroke, i.e., loss of neurological function with residual symptoms at least 24 h after onset, presumed to be from vascular etiology. • Transient ischemic attack (TIA): Patient has a history of loss of neurological function that was abrupt in onset but with complete return of function within 24 h, presumed to be due to vascular etiology. • Noninvasive/invasive carotid test with greater than greater than or equal to 80% occlusion. • Previous carotid artery surgery/intervention for carotid artery stenosis. This does not include neurological disease processes such as metabolic and/or anoxic ischemic encephalopathy. Choose 1 of the following: • Yes • No • Unknown
Erectile dysfunction (Optional)	Indicate if the patient has a history of erectile dysfunction. Choose 1 of the following: • Yes • No • Unknown

Table 4. Continued

Element Name	Definition
Estimated cardiac event risk (Recommended—stress SPECT, stress PET, stress TTE, CCTA, CACS, stress CMR)	Indicate the coronary (Framingham) risk (calculated based on published criteria at the NHLBI Web site [14]) of myocardial infarction or cardiac death based on clinical history of the patient as estimated at the study site. Choose 1 of the following: • Low (less than 10% 10-year risk) • Intermediate (10% to 20% 10-year risk) • High (greater than 20% 10-year risk or a coronary risk equivalent as defined by ATPII/NCEP (diabetes, PAD, etc.) • N/A
Calculated cardiac event risk (Derived)	Indicate the patient's calculated cardiac (Framingham) risk (calculated based on published criteria at the NHLBI Web site [14]): • Low (less than 10% 10-year risk) • Intermediate (10% to 20% 10-year risk) • High (greater than 20% 10-year risk or a coronary risk equivalent as defined by ATPII/NCEP (diabetes, PAD, etc.) • N/A
History of arrhythmias (Recommended)	Indicate whether the patient has a history of the following arrhythmias. Choose any of the following: • Frequent PVCs • Sinus tachycardia • Ventricular tachycardia • Atrial fibrillation • Atrial flutter • Other • None
History of asthma or bronchospasm (Recommended—stress TTE, stress SPECT, stress PET, CCTA, stress CMR)	Indicate if the patient has a history of asthma or bronchospasm: • Yes • No • Unknown
Previous pacemaker or implantable cardioverter-defibrillator (ICD) insertion (Recommended)	Pacemaker or ICD implantation prior to the current encounter. Device type (pacemaker, ICD, combination), cardiac chamber(s) involved, and year of implantation may be helpful. Choose 1 of the following: • Yes • No
History of heart failure (Recommended)	History of heart failure, per medical record, physician, or patient history • Yes • No
New York Heart Association (NYHA) functional class (Optional)	If heart failure, indicate NYHA functional class (15) Choose 1 of the following: • Class I: patients with cardiac disease but without resulting limitations of physical activity. Ordinary physical activity does not cause undue fatigue, palpitation, or dyspnea. • Class II: patients with cardiac disease resulting in slight limitation of physical activity. They are comfortable at rest. Ordinary physical activity results in fatigue, palpitation, or dyspnea. • Class III: patients with cardiac disease resulting in marked limitation of physical activity. They are comfortable at rest. Less than ordinary activity causes fatigue, palpitation, or dyspnea. • Class IV: patients with cardiac disease resulting in inability to carry on any physical activity without discomfort. Symptoms are present even at rest or minimal exertion).
Canadian Cardiovascular Angina Class (Optional)	If angina, indicate the Canadian Cardiovascular Angina class. Choose 1 of the following: • 0. Asymptomatic. No angina. • 1. Ordinary physical activity (e.g., walking or climbing stairs) does not cause angina; angina occurs with strenuous or rapid or prolonged exertion at work or recreation • 2. Slight limitation of ordinary activity (e.g., angina occurs walking or stair climbing after meals, in cold, in wind, under emotional stress, or only during the few hours after awakening; walking more than 2 blocks on the level or climbing more than 1 flight of ordinary stairs at a normal pace; and in normal conditions) • 3. Marked limitation of ordinary activity (e.g., angina occurs with walking 1 or 2 blocks on the level or climbing 1 flight of stairs in normal conditions and at a normal pace) • 4. Inability to perform any physical activity without discomfort; angina syndrome may be present at rest • 5. N/A

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Table 4. Continued

Element Name	Definition
Chest pain symptoms or suspected angina equivalent (Recommended—stress TTE, stress SPECT, stress PET, CCTA, stress CMR)	Indicate whether chest pain or discomfort, dyspnea/shortness of breath suspected to be anginal equivalent, or other suspected anginal equivalent has been documented within the past month. Choose 1 of the following: • Yes • No • Unknown
Stability of chest pain symptoms (Recommended—stress TTE, stress SPECT, stress PET, CCTA, stress CMR)	Indicate the patient's angina type: • Atypical chest pain • Stable angina • Unstable angina • Myocardial infarction
Characteristics of chest pain/discomfort or suspected angina equivalent (Recommended—stress TTE, stress SPECT, stress PET, CCTA, stress CMR)	If chest pain or discomfort has been documented, indicate all characteristics of the chest pain or discomfort. Choose 1 or more of the following: • Substernal chest pain or discomfort • Provoked by exertion or emotional distress • Relieved by rest and/or nitroglycerin
Angina type (Derived from previous element)	Indicate the angina type based on the characteristics of chest pain/discomfort or suspected angina equivalent. • Typical angina (definite)—the chest pain or discomfort has all three characteristics recorded in the previous element. • Atypical angina (probable)—the chest pain or discomfort recorded in the previous element lacks one of the three characteristics. • Nonanginal chest pain—the chest pain or discomfort recorded in the previous element meets one or none of the typical angina characteristics. • N/A due to absence of chest pain
Pre-test probability of coronary artery disease (Derived)	If chest pain or discomfort has been documented, calculate the pre-test probability of obstructive CAD. Choose 1 of the following: • Low (less than 10%) • Intermediate (10% to 90%) • High (greater than 90%) • Known CAD • N/A, no chest pain or anginal equivalent
ECG interpretable for ischemia (Recommended—stress TTE, stress SPECT, stress PET, CCTA, stress CMR)	Indicate whether the ECG is interpretable for ischemia if used as part of a stress test. Choose 1 of the following: • Yes • No [resting ST-segment depression (greater than or equal to .10 mV), complete left bundle-branch block (LBBB), pre-excitation (Wolf-Parkinson-White Syndrome), left ventricular hypertrophy, digoxin use, or paced rhythm] • Equivocal • N/A
Previous diagnostic test and date (Recommended)	Indicate diagnostic imaging test within the last 24 months. Select all applicable from the following: • Stress SPECT MPI • Stress TTE • TTE • TEE • CACS • CCTA • CMR • Invasive coronary angiography • ECG—only stress test • Unknown • None Include the date of the test. If the month and day are unknown, the year is sufficient.

Table 4. Continued

Element Name	Definition
Previous diagnostic imaging test result (Optional)	Indicate documented and verified findings of previous diagnostic imaging study. Select all that apply: • Coronary artery stenosis greater than or equal to 50% • Coronary artery stenosis less than 50% stenosis • Myocardial ischemia • Scar/MI • Cardiac mass/thrombus/vegetation • Significant LV systolic dysfunction • Pericardial disease • Valvular heart disease • Congenital heart disease • Nondiagnostic • Not applicable
Previous MI (Recommended)	History of MI by patient history, medical records, or physician Choose 1 of the following: • Yes • No
Date of previous MI (Optional)	If the patient had a previous MI, indicate the date of most recent MI. If the month and day are unknown, the year is sufficient.
Previous PCI (Recommended)	Indicate if the patient had a previous percutaneous intervention (PCI) (even if unsuccessful) of any type (balloon angioplasty, stent or other), performed prior to the study. Choose 1 of the following: • Yes • No
Previous PCI—date (Recommended—stress TTE, stress SPECT, stress PET, CCTA, stress CMR)	If the patient had a previous PCI of any type (balloon angioplasty, stent or other), performed prior to the current study, indicate the date of the most recent PCI. If the month and day are unknown, the year is sufficient.
Previous CABG (Recommended)	Indicate if the patient had a previous coronary artery bypass graft surgery (CABG) by any approach. Choose 1 of the following: • Yes • No
Previous CABG—date (Recommended—stress TTE, stress SPECT, stress PET, CCTA, stress CMR)	If the patient had a previous CABG prior to the current admission, indicate the date of the most recent CABG. If the month and day are unknown, the year is sufficient.
Noncardiac surgery—risk of procedure (Recommended if pre-operative)	If the patient is scheduled for surgery, indicate the cardiac risk (incidence of cardiac death and nonfatal myocardial infarction) from the surgery itself. Choose 1 of the following: • Low-risk surgery (less than 1%; e.g., endoscopic procedures, superficial procedures, cataract surgery, breast surgery) • Intermediate-risk surgery (less than 5%; e.g. intraperitoneal and intrathoracic surgery, carotid endarterectomy, head and neck surgery, orthopedic surgery, prostate surgery) • High-risk surgery (greater than or equal to 5%, e.g., emergent major operations, aortic or other major vascular surgery, peripheral vascular surgery, anticipated prolonged surgical procedure associated with large fluid shifts and/or blood loss) • N/A
Noncardiac surgery—patient active conditions (Recommended if pre-operative)	For a patient scheduled to undergo noncardiac surgery, does the patient have any active cardiac conditions; defined as any of the following: • Unstable coronary syndrome • Decompensated heart failure (NYHA functional class IV, worsening or new heart failure) • Significant arrhythmias (e.g., high-grade AV block, ventricular arrhythmias, symptomatic bradycardia, supraventricular arrhythmias with an uncontrolled rate) • Severe valvular heart disease Choose 1 of the following: • Yes • No

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Table 4. Continued

Element Name	Definition
Noncardiac surgery—patient risk factors (Recommended if pre-operative)	For a patient scheduled to undergo noncardiac surgery, how many of the following clinical risk factors are present: • Ischemic heart disease • Compensated or prior heart failure • Diabetes mellitus • Renal insufficiency • Cerebrovascular disease Choose 1 of the following: • 3 or more • 1 to 2 • None
Medication ID—medications (Recommended) (Optional—TEE, TTE)	Indicate which of the following categories of medications are routinely taken by the patient. Choose all applicable of the following: • ACE inhibitor/angiotensin receptor blocker • Aspirin, other antiplatelet agents • Calcium channel blockers • Beta-blockers • Erectile dysfunction medication • Nitrates • Warfarin • Antiarrhythmics • Digitalis • Metformin • Lipid-lowering medication (niacin, statins, fibrates, etc.) • Other antihypertensives • Aminophylline or theophylline • Dipyridamole • Inhaler • Diabetic medications • None
Medications—normally used but held prior to testing (Recommended) (Optional—TEE, TTE)	Indicate if any medications normally used by the patient that were not administered per routine schedule prior to test: • ACE inhibitor/angiotensin receptor blocker • Aspirin, other antiplatelet agents • Calcium-channel blockers • Beta-blockers • Erectile dysfunction medication • Nitrates • Warfarin • Antiarrhythmics • Digitalis • Metformin • Lipid-lowering medication (niacin, statins, fibrates, etc.) • Other antihypertensives • Aminophylline or theophylline • Dipyrdiamole • Inhaler • Diabetic medications • None
History of reaction to contrast agent (Recommended)	If history of reaction to contrast agent, list all applicable: • Iodinated • Gadolinium • Echocardiography agent • Radionuclide • N/A

N/A indicates not applicable.

E. Study Description

The study description includes a categorical designation of the imaging modality employed. The specific physician involved in the interpretation of the study should be noted, along with his/her credentials. Subsequent elements further describe the details of the method used to perform the examination. This generally includes technical elements of image acquisition specific to the modality, use of an imaging agent, i.e., contrast or radionuclide, and, if stress testing was performed, the method of stress testing. The primary and secondary indications for the study are also included in this section.

Table 5. Study Description

Element Name	Definition
Study ID (Recommended)	Unique study identifier.
Study acquisition date (Recommended)	Indicate the date of the image acquisition.
Physician NPI—study interpretation and report (Recommended)	Indicate the National Provider Identifier (NPI) of the physician interpreting the study and producing the report. This number, assigned by the Centers for Medicare & Medicaid Services (CMS), is used to uniquely identify physicians for Medicare billing purposes. If there is more than one physician, enter the billing physician's NPI.
Physician board certification—study interpretation and report (Recommended)	Indicate the Board certification of the physician interpreting the study and producing the report. Choose 1 or more of the following: • Cardiovascular Disease • Internal Medicine • Radiology • Nuclear Medicine • Other • None
Physician subspecialty certification—study interpretation and report (Recommended)	Indicate whether the physician interpreting the study and producing the report holds a subspecialty certification specific to the imaging modality being performed. • Certification Board of Nuclear Cardiology (CBNC) • American Board of Nuclear Medicine (ABNM) • Certification Board of Cardiovascular Computed Tomography (CBCCT) • National Board of Echocardiography, Inc. (NBE) • Certificate of Added Qualification—Nuclear Medicine (ACR) • American Board of Internal Medicine Certification in Interventional Cardiology • American Board of Internal Medicine Certification in Electrophysiology • Certificate of Proficiency in CCTA (ACR)
Imaging study performed (Recommended)	Indicate the type of diagnostic imaging test performed. Choose 1 of the following: • Nuclear: SPECT MPI • Nuclear: PET • Nuclear: RNA • Echocardiography: stress TTE • Echocardiography: TTE • Echocardiography: TEE • CCT: CACS • CCT: CCTA • CCT: CACS and CCTA • CMR: CMR • CMR: stress CMR • Cardiac catheterization: ICA • Cardiac catheterization: ICA and LVG
Acquisition parameters: Contrast/imaging agent use (Recommended)	If echo, CCT, or CMR study was performed, indicate whether contrast or radiopharmaceutical was used during the study. Choose 1 of the following: • Yes • No

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Table 5. Continued

Element Name	Definition
Acquisition parameters: Echocardiography (Recommended—TTE/TEE)	If TTE or TEE was performed, indicate the acquisition parameter used. Choose all applicable from the following: • M-mode and 2-D • 3-D • Spectral Doppler • Doppler—color • Perfusion • Tissue Doppler • Other
Acquisition parameters: Contrast use (Recommended)	List all contrast/imaging agents used: • Radionuclide —F-18 FDG for viability —Rubidium-82 perfusion —Nitrogen-13 ammonia perfusion —Tc-99m tetrofosmin (Myoview) —Tc-99m sestamibi (Cardiolite) —Tl-201 • Echo contrast —Optison (Perflutren) —Definity (Perflutren Lipid Microsphere) —Agitated saline —Iodinated contrast • High osmolar contrast media (ionic) —Diatrizoate meglumine and diatrizoate sodium (Renografin, etc.) —Ioxithalamate (Telebrix) —Iothalamate dimeglumine (Conray) • Low osmolar nonionic contrast media —Iopamidol (Isovue) —Iohexol (Omnipaque) —Ioversol (Optiray) —Ioxaglate (Hexabrix) —Iomeprol (Iomeron) —Iopromide (Ultravist) • Iso-osmolar nonionic contrast media —Iodixanol (VisiPaque) • Paramagnetic agent —Gadopentetate dimeglumine (Magnevist) —Gadodiamide (Omniscan) —Gadoversetamide (Optimark) —Gadobenate dimeglumine (MultiHance) • None
Acquisition parameters for SPECT or PET: Radionuclide dose (Recommended)	If radionuclide was used during the study, indicate the dose of each radiopharmaceutical in mCi.
Acquisition parameters: Gating (Recommended—CCT, CMR, SPECT, PET)	If a nuclear, CCT, or CMR study was performed, indicate whether gating was used. Choose 1 of the following: • Yes —Prospective —Retrospective —Both • No
Acquisition parameters: Attenuation correction (Recommended—SPECT, PET)	If a SPECT/PET study was performed, indicate whether attenuation correction was used for the nuclear imaging study. Choose 1 of the following: • Yes • No

Table 5. Continued

Element Name	Definition
Acquisition parameters for CCT: Number of slices (Recommended)	If CCT was the study performed, indicate if the number of "slices" was greater than or equal to 64. Choose 1 of the following: • Yes • No
Acquisition parameters for CCT: Temporal resolution (Optional)	If CCT was the study performed, indicate the gantry rotation speed in milliseconds.
Acquisition parameters for CCT: Contrast volume (Recommended)	If iodinated or paramagnetic contrast was used during the study, indicate the volume of contrast used, in milliliters (ml) or not used.
Acquisition parameters for CCT: Radiation exposure (Recommended)	If a CCT was performed, indicate the total radiation exposure in mGy cm (the dose-length product).
Acquisition parameters: Medications used (Recommended)	Indicate whether or not a medication was used during the procedure. Choose 1 or more of the following: • Beta-blocker • Nitrates • Calcium-channel blocker • Aminophylline • None
Acquisition parameters: Heart rate (bpm) during acquisition (Recommended—CTA)	Indicate the heart rate (bpm) during acquisition.
Acquisition parameters for CMR: Method (Recommended—CMR)	If CMR was the study performed, indicate the methods used. Choose 1 or more of the following: • Morphology and function • Delayed enhancement • Flow/velocity quantification • MR angiography • Perfusion • Other
Acquisition parameters for catheterization: Fluoroscopy time (Recommended)	Indicate total fluoroscopy time recorded, during the catheterization laboratory visit, to the nearest 0.1 min. The time recorded should include the total time for the procedure.
Primary clinical reason for test (Recommended)	Choose 1 of the following: • Detection of CAD • Risk assessment of CAD • Pre-operative assessment • Post-revascularization assessment • Determination of viability—candidacy for revascularization • Congenital heart disease • Pericardial disease • Pulmonary vein assessment • Cardiac morphology (including cardiac mass) • Assessment of ventricular function • Evaluation for cardiomyopathy • Evaluation for valvular heart disease • Evaluation for great vessels • Symptom/signs evaluation not related to above categories

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Table 5. Continued

Element Name	Definition
Other clinical reasons for test (Optional)	Choose any of the following: • Detection of CAD • Risk assessment of CAD • Pre-operative assessment • Post-revascularization assessment • Determination of viability • Congenital heart disease • Pericardial disease • Pulmonary vein assessment • Cardiac morphology (including cardiac mass) • Assessment of ventricular function • Evaluation of cardiomyopathy • Evaluation of valvular heart disease • Evaluation of great vessels • Assessment of symptoms suspected of cardiac etiology • No other indication
Type of stress (Recommended—stress CMR, stress TTE, stress SPECT, stress PET)	Indicate if both pharmacologic stress testing and exercise stress testing were performed. Choose 1 of the following: • Exercise • Pharmacologic • Combined exercise and pharmacologic
Type of stress: Exercise (Recommended)	If exercise stress testing was performed during the study, indicate the type of protocol used to perform the study. Choose 1 of the following: • Bicycle • Treadmill exercise testing —Naughton —Bruce —Modified Bruce —Low level —Other
Type of stress: Exercise time (Recommended)	If exercise stress testing was performed during the study, indicate exercise duration in minutes.
Type of stress: Pharmacologic (Recommended)	If pharmacologic stress testing was performed during the study, indicate the agent(s) administered: • Adenosine • Atropine • Dipyridamole • Dobutamine • Regadenoson • Other

N/A indicates not applicable.

F. Study Findings—Ischemic Heart Disease

Commonly recognized confounding factors in the baseline electrocardiographic recording, including Q waves, abnormal rhythm, ST-segment depression, and evidence of ventricular pacing or conduction abnormalities, should be noted due to their potential negative impact on the interpretability of the ECG recording during any subsequent stress testing for inducible ischemia.

For any exercise stress testing performed, the number of metabolic equivalent tasks (a.k.a. METS) may be noted to reflect exercise capacity. A recording of the nature of any induced chest pain, along with the maximum amount of ST-segment depression, should be recorded.

Changes in both heart rate (HR) and in blood pressure (BP) components, from baseline to maximum, should be noted to reflect the physiologic response to any stress testing performed. Achievement of at least 85% of maximum predicted HR is to be used to assess adequacy of the stress, and together, achieved HR and achieved BP, permit calculation of the double product. HR recovery from peak exercise may be used to further assess physiologic response to stress.

Regardless of the measure of myocardial ischemia induced by stress testing (evoked hypoperfusion or ventricular dysfunction) and/or the measure of post-infarct myocardial scarring (nonreversible hypoperfusion or ventricular dys-

function versus contrast-delineated necrosis/scar visualization), myocardial abnormalities (normal versus scar versus ischemia versus mixed) and their severity are to be addressed using a standard 17-segment LV description (7). This permits a unified approach to study categorization, irrespective of the stress imaging modality. It is, however, recognized that there can be significant patient-to-patient variability in the relationship between an LV myocardial segment and the supplying coronary artery. It is also understood that not all segments may be visualized for all studies or modalities given that certain techniques, such as single-plane contrast ventriculography, would not allow for it. The severity of the abnormality is to be graded as mild, moderate, or severe; the definition of the severity is modality-dependent and beyond the scope of this multimodality Writing Committee. Subspecialty organizations, however, are encouraged to assign properties to each category in the near future. The delineation of the size of the abnormality is based on the number/location of the involved segments. It is assumed that if a segment has an abnormality, even if the complete segment is not completely involved, it will be categorized as being abnormal. A geographically distinct second abnormality may also be described.

When imaging of the coronary artery lumen is involved, the assessment of diameter percent stenosis by coronary distribution should be described according to a standard 6-element description. For an example of a table for visualization of the coronary territory, which includes the 6-segment scheme, see Appendix C.

Table 6. Study Findings—Ischemic Heart Disease

Element Name	Definition
Baseline ECG: Q-wave pathology (Optional)	Indicate if pathologic Q waves were present on the baseline electrocardiogram (leads). Choose 1 of the following: • Yes • No • N/A
Baseline ECG: Rhythm (Recommended—CCTA, SPECT, CMR)	Indicate the patient's baseline ECG rhythm. Choose 1 of the following: • Normal sinus rhythm • Atrial fibrillation • Premature atrial contractions • Premature ventricular contractions • Paced rhythm • Atrial flutter • Sinus tachycardia • Sinus bradycardia
Baseline ECG: ST-segment depression (Optional)	Indicate if there was negative deflection below the isoelectric line greater than or equal to 0.1 mV on the electrocardiogram (in mm). Choose 1 of the following: • Yes • No • N/A
Baseline ECG readings (Recommended—stress TTE, stress SPECT, stress PET, CCTA, stress CMR)	Indicate whether any additional ECG findings were present. Choose any of the following: • Left bundle branch block • Right bundle branch block • Ventricular paced rhythm • Pre-excitation • Other
Exercise capacity: METS (Optional)	If exercise stress testing was performed during the study, indicate the number of METS achieved (based on time completed for a specific protocol, using standardized tables)
HR response: Baseline heart rate (Recommended—stress TTE, stress SPECT)	If stress testing was performed during the study, indicate the baseline heart rate.
HR response: % Predicted heart rate response achieved (Derived)	If stress testing was performed during the study, indicate the % predicted heart rate response achieved.

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Table 6. Continued

Element Name	Definition
HR response: Max heart rate (Recommended—stress TTE, stress SPECT)	If stress testing was performed during the study, indicate the maximum heart rate.
HR response: Heart rate recovery (Optional)	If exercise stress testing was performed during the study, indicate the heart rate recovery, defined as the reduction in the heart rate from the rate at peak exercise to the rate 1 minute after the cessation of exercise. Choose 1 of the following: • Adequate (greater than 12 bpm) • Inadequate (less than or equal to 12 bpm) • Unknown
BP response: Baseline systolic blood pressure (Recommended—stress echo, stress SPECT)	If stress testing was performed during the study, indicate the first measurement or earliest record of systolic blood pressure (in mm Hg) for this episode of care.
BP response: Baseline diastolic blood pressure (Recommended—stress echo, stress SPECT)	If stress testing was performed during the study, indicate the baseline diastolic blood pressure (in mm Hg).
BP response: Max systolic blood pressure (Recommended—stress TTE, stress SPECT)	If stress testing was performed during the study, indicate the maximum systolic pressure (in mm Hg).
BP response: Max diastolic blood pressure (Optional)	If stress testing was performed during the study, indicate the maximum diastolic pressure (in mm Hg).
BP and HR response: Double product (Derived)	If stress testing was performed during the study, indicate the double product (heart rate × systolic blood pressure).
Stress testing: Chest pain during exercise (Recommended—exercise SPECT, exercise TTE, stress PET)	If exercise stress testing was performed during the study, indicate the type of chest pain. Choose 1 of the following: • Limiting chest pain • Nonlimiting chest pain • Anginal equivalent • None
Sufficient heart rate for exercise testing (Derived)	If exercise stress testing was performed during the study, indicate whether the patient is able to achieve 85% or greater of maximum predicted heart rate [(220 − age in years) × 0.85]. Choose 1 of the following: • Yes • No • N/A
ECG: ST-segment depression (Optional)	Indicate additional ST-segment depression beyond baseline. If baseline ST-segment depression is greater than 1 mm, then uninterpretable. Choose 1 of the following: • None • Less than 1 mm • 1 mm • 1.5 mm • 3 mm
Results: Abnormality location, segments (Recommended—stress SPECT, stress PET, stress TTE, stress CMR)	For each of the 17 myocardial segments, indicate whether it was normal, scarred, ischemic, or mixed. If an abnormality was observed, indicate the severity as mild, moderate, or severe. *An example of how this information could be collected, along with a diagram of the 17 segments, is included in Appendix D.*
Results: Abnormality extent (Derived)	Extent of abnormality based on number of segments within 17-segment model: • None • Small: 1 to 2 segments • Moderate: 3 to 4 segments • Large: greater than 5 segments
Report conclusions: ECG findings (Recommended)	Indicate the conclusion derived from the ECG findings. Choose 1 of the following: • Ischemia • Equivocal • Normal • Nondiagnostic • N/A

Table 6. Continued

Element Name	Definition
Evidence of viability in the infarct zone (Optional)	If perfusion defects or wall motion abnormalities are present, indicate the degree of viability. Choose 1 of the following: • Small • Moderate • Large • None
Coronary calcium score (Recommended—CACS)	If coronary CT calcium score is performed, provide Agatston score.
Coronary angiography (ICA and CCTA): Arterial segments (Recommended—CCTA or ICA)	If coronary angiography was performed, indicate the arterial segments visualized. Choose any of the following: • Left main • Proximal LAD and 1st diagonal branches • Mid/Distal LAD, D2 and D3 branches • LCX, OMs, LPDA and LPL branches • RCA, RPDA, RPL, AM branches • Ramus • Saphaneous vein grafts or free arterial grafts, if relevant • Internal mammary artery (LIMA, RIMA), if relevant For each segment visualized, indicate the percent stenosis: Normal • Less than 50% • 50% to 70% • Greater than 70% • Occluded *An example of how this information could be collected is included in Appendix C.*
Coronary angiography (invasive and CCTA): Dominance (Recommended—CCTA or ICA)	Indicate the anatomic coronary dominance (which coronary provides the posterior descending artery and PL branches). • Left • Right • Codominant
Coronary angiography (ICA and CCTA): Coronary anomalies (Optional)	If coronary angiography was performed, indicate whether coronary anomalies, such as abnormal origin or location, are present. • Yes • No

N/A indicates not applicable.

G. Study Findings—LV Function

The description of LV function was divided into systolic and diastolic components. The definition of diastolic dysfunction was left broad in acknowledgment of differences in capabilities of the various imaging modalities to investigate the diastolic phase. Expansion of this category would be desirable for certain modalities, especially echocardiography.

It was acknowledged that determination of systolic function, although pivotal to patient care, occurs with significant variability between the modalities. It is well appreciated that each imaging modality has a unique range of normal values for quantitative ejection fraction determination. Even within modalities, different quantitative methods may yield disparate results, with differences in ejection fraction units, at times, approaching 10 absolute units.

Although there was great discussion about the overall goal and potential impact of describing LV systolic function, the majority of the panel felt that uniformity should be attempted, and the final consensus was that, as a required data element, this section incorporates only 4 categories for systolic function: normal, mildly reduced, moderately reduced, and severely reduced. It was also agreed that a range of quantitative values should be elucidated for differing degrees of LV dysfunction. For purposes of reporting a specific value, the mid point of the range may be used, such that moderate LV dysfunction would be reported as 35%.

The quantitative value for ejection fraction was recommended to be reported as an optional item. The measured quantitative ejection fraction could be reported as a specific value (e.g., 64%) or a 5% range (e.g., 30% to 35%). The mid point of the range would be used for data collection/storage. It was noted that, overall, the precision on this measure is poor, as is its reproducibility for some modalities; however, the error range for this measurement is implicit. Although the quality of the images is critical, other factors, including

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volume status, arrhythmias, and conduction disturbances, all lead to variability. Differing methodological approaches (e.g., count-based, 3-dimensional count-based) further increase variability. When reported as a numerical value, the imaging modality and method of analysis (visual, quantitative) should be specified.

The Writing Committee felt that a standard for LV function must be established, although cognizant of the controversies and challenges. One option for future research may be the use of a regression analysis, whereby a given ejection fraction obtained using a specific method could be converted into a "universal ejection fraction," thereby eliminating modality-specific differences in ranges of dysfunction. However, at the current time, the category of LV function was felt to be the most useful parameter, with modality-specific definitions contained within each category.

To attain consistency between methods, regional systolic function is defined using the 17-segment scheme. Broad categories of hypokinesis, akinesis, and dyskinesis are recommended to describe regional dysfunction (16). The panel recognized that differentiation among these wall motion categories may be difficult and subjective, and that the clinical relevance between akinesis and dyskinesis may not be high. However, it was agreed that additional layers of granularity for hypokinetic regions was likely not useful. For reporting purposes, if global hypokinesis is present, scoring for each segment should be performed.

Table 7. Study Findings—LV Function

Element Name	Definition
LV diastolic function (Recommended)	Indicate the overall assessment of LV diastolic function. Choose 1 of the following: • Normal for age • Abnormal for age • N/A
Resting LV systolic function: Global wall motion abnormalities: Ejection fraction (EF)/LVEF (Optional)	Indicate the calculated ejection fraction (actual value or midpoint of range). Or not applicable.
Method of LVEF calculation (Optional)	Indicate the method of LVEF calculation. Choose 1 of the following: • Visual • Quantitative
Resting LV systolic function: Global function: Ejection fraction (EF) (Recommended)	Indicate the ejection fraction category. Choose 1 of the following: • Hyperdynamic: greater than 70% • Normal: 50% to 70% (midpoint 60%) • Mild dysfunction: 40% to 49% (midpoint 45%) • Moderate dysfunction: 30% to 39% (midpoint 35%) • Severe dysfunction: less than 30%
LV wall motion abnormalities—17 segment (Recommended—SPECT, echo, CMR) (Optional—CCTA)	Assess regional function in each of the 17 myocardial segments by indicating if it was normal, hypokinetic, akinetic, dyskinetic, or not visualized. *An example of how this information could be collected, along with a diagram of the 17 segments, is included in Appendix E.*
LV wall motion abnormalities—10 segment (Optional—LVG)	Assess regional function in each of the 10 myocardial segments by indication if it was normal, hypokinetic, akinetic, dyskinetic or not visualized. *An example of how this information could be collected, along with a diagram of the 10 segments, is included in Appendix F.*

N/A indicates not applicable.

H. Study Findings—Cardiac Morphology

In the reporting of cardiac morphology, presentation of 3-dimensional volumetric data in regards to LV end-diastolic and -systolic volumes, LV mass, and ejection fraction is optimal. In the absence of 3-dimensional data, calculations of volumetric data from geometric assumptions from 2-dimensional data sets can be substituted. Alternatively, 2-dimensional measures of chamber sizes and wall thicknesses could be reported.

Assessment of severity of valvular regurgitation and stenosis should follow current ACC/AHA 2006 Guidelines for the Management of Patients With Valvular Heart Disease (17).

Table 8. Study Findings—Cardiac Morphology

Element Name	Definition
Chamber volume: Left ventricle (Recommended)	Choose 1 of the following: • Normal • Enlarged • Small • Not reported
Chamber volume: Left ventricle, systolic (Optional)	Described in ml or not reported.
Chamber volume: Left ventricle, diastolic (Optional)	Described in ml or not reported.
Chamber size: Right ventricle (Recommended—TTE, TEE, CMR) (Optional—CCT)	Choose 1 of the following: • Normal • Enlarged • Not reported
Chamber size: Left atrium (Recommended—TTE, TEE, CMR) (Optional—CCT)	Choose 1 of the following: • Normal • Enlarged • Not reported
Chamber size: Right atrium (Recommended—TTE, TEE, CMR) (Optional—CCT)	Choose 1 of the following: • Normal • Enlarged • Not reported
Wall thickness: Left ventricle: Septum: end-diastolic thickness (Optional)	Indicate the end-diastolic thickness of the mid-septum, in mm.
Wall thickness: Left ventricle: Inferolateral wall: end-diastolic thickness (Optional)	Indicate the end-diastolic thickness of the mid-inferolateral wall, in mm.
Wall thickness: Right ventricle: Free wall: end-diastolic thickness (Optional)	Indicate the end-diastolic thickness of the mid-free wall. Choose 1 of the following: • Normal • Increased • Not reported
Left ventricular myocardial mass (Optional)	Indicate assessment of left ventricular myocardial mass. Choose 1 of the following: • Normal • Increased • Not reported
Left ventricular myocardial mass: By body surface area (Derived)	Indicate the left ventricular myocardial mass indexed by body surface area. Choose 1 of the following: • Normal • Increased • Not reported
Pulmonary veins (Optional—CMR, CCT)	Assessment of pulmonary venous configuration in preparation for pulmonary vein isolation/radiofrequency ablation of atrial fibrillation. Choose 1 of the following: • Normal (4 pulmonary veins, normal pulmonary venous drainage into left atrium) • Variant (variant number of pulmonary veins (usually 3 or 5), but with normal pulmonary venous drainage into left atrium) • Anomalous (anomalous drainage of 1 or more pulmonary veins into a chamber other than the left atrium)
Intracardiac (nonvalvular) mass: Type (Optional)	If an intracardiac mass is present, indicate the type of intracardiac mass. Choose 1 of the following: • None • Vegetation • Thrombus • Neoplasm • Unknown

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Table 8. Continued

Element Name	Definition
Intracardiac shunt (Optional)	Indicate if the patient has evidence for an intracardiac shunt and etiology. Choose 1 of the following: • None • PFO • ASD • VSD • PDA • Other
Pericardial: Effusion (Recommended—TTE, TEE, CCT, CMR)	Indicate if pericardial effusion is present. Choose 1 of the following: • Present • Absent
Pericardial: Effusion: Size (Optional)	If pericardial effusion is present, indicate the overall assessment of its size and/or the maximal end-systolic dimension of the pericardial effusion. Choose 1 or more of the following: • Trivial • Small • Moderate • Large
Pericardial effusion: Evidence of increased intrapericardial pressure (Optional)	If pericardial effusion is present, indicate if tamponade is present. Choose 1 of the following: • Present • Absent • Equivocal • Not assessed
Pericardial: Thickness (Optional)	Indicate the thickness of the pericardium. Choose 1 or more of the following: • Normal • Thickened • Calcified • Not assessed
Valvular: Aortic: Structure (Recommended—TTE, TEE, CCT, CMR)	Indicate if the structure of the aortic valve is abnormal. Choose 1 of the following: • Normal • Abnormal • Prosthetic • Not assessed
Valvular: Aortic: Structure: Cause of abnormality (Optional)	If the aortic valve is abnormal, indicate the cause of abnormality in the aortic valve. Choose any of the following: • Congenital leaflet abnormality • Leaflet thickening/calcification • Vegetation/mass • Other • None • N/A
Valvular: Aortic: Stenosis (Recommended—TTE, TEE, CMR, cardiac cath)	Indicate the severity of stenosis in the aortic valve. Choose 1 of the following: • Mild • Moderate • Severe • None • Not assessed

Table 8. Continued

Element Name	Definition
Valvular: Aortic: Regurgitation (Recommended—TTE, TEE, CMR, cardiac cath)	Indicate the severity of regurgitation in the aortic valve. Choose 1 of the following: • Mild • Moderate • Severe • None • Not assessed
Valvular: Mitral: Structure (Recommended—TTE, TEE, CMR)	Indicate if the structure of the mitral valve is abnormal. Choose 1 of the following: • Normal • Abnormal • Prosthetic • Annuloplasty ring • Not assessed
Valvular: Mitral: Structure: Abnormal (Recommended—TTE, TEE, CMR)	If the mitral valve is abnormal, indicate the location of the abnormality of the mitral valve. Choose 1 or more of the following: • Congenital leaflet abnormality • Leaflet thickening/calcification • Vegetation/mass • Flail • Prolapse • None • Not assessed
Valvular: Mitral: Annular calcification (Recommended—TTE, TEE, CCT, CMR, cardiac cath)	Indicate if there is annular calcification in the mitral valve. Choose 1 of the following: • Present • Absent • Not assessed
Valvular: Mitral: Stenosis (Recommended—TTE, TEE, CMR, cardiac cath)	Indicate the severity of stenosis in the mitral valve. Choose 1 of the following: • Mild • Moderate • Severe • None • Not assessed
Valvular: Mitral: Regurgitation (Recommended—TTE, TEE, CMR, cardiac cath)	Indicate the severity of regurgitation in the mitral valve. Choose 1 of the following: • Mild • Moderate • Severe • None • Not assessed
Valvular: Tricuspid: Structure (Recommended—TTE, TEE, CMR)	Indicate if the structure of the tricuspid valve is abnormal. Choose 1 of the following: • Normal • Abnormal • Prosthetic • Annuloplasty ring • None • Not assessed

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Table 8. Continued

Element Name	Definition
Valvular: Tricuspid: Stenosis (Recommended—TTE, TEE, CMR)	Indicate the severity of stenosis in the tricuspid valve. Choose 1 of the following: • Mild • Moderate • Severe • None • Not assessed
Valvular: Tricuspid: Regurgitation (Recommended—TTE, TEE, CMR)	Indicate the severity of regurgitation in the tricuspid valve. Choose 1 of the following: • Mild • Moderate • Severe • None • Not assessed
Valvular: Pulmonic: Structure (Recommended—TTE, TEE, CMR)	Indicate if the structure of the pulmonic valve is abnormal. Choose 1 of the following: • Normal • Abnormal • Prosthetic • None • Not assessed
Valvular: Pulmonic: Stenosis (Recommended—TTE, TEE, CMR)	Indicate the severity of stenosis in the pulmonic valve. Choose 1 of the following: • Mild • Moderate • Severe • None • Not assessed
Valvular: Pulmonic: Regurgitation (Optional)	Indicate the severity of regurgitation in the pulmonic valve. Choose 1 of the following: • Mild • Moderate • Severe • None • Not assessed
Aorta: Dissection (Recommended—TTE, TEE, CMR, CCTA, cardiac cath)	Indicate if the aorta is dissected. Choose 1 of the following: • Present • Absent • Not assessed
Aorta: Dissection: Present: Stanford Classification (Recommended—TTE, TEE, CMR, CCTA, cardiac cath)	If the aorta is dissected, indicate the type of dissection that is present in the aorta. Choose 1 of the following: • Stanford type A—all dissections involving the ascending aorta regardless of site of origin • Stanford type B—all dissections not involving the ascending aorta
Aortic Root: Dilation: Enlarged	Indicate if the aortic root is dilated. Choose 1 of the following: • Present • Absent • Not assessed

N/A indicates not applicable.

I. Study Findings—Summary

In order to provide an overall conclusion regarding study findings, Table 9 was developed to report an overall impression of results related to Tables 6, 7, and 8.

Table 9. Study Findings—Summary

Element Name	Definition
Report conclusions: Overall summary (Recommended—ICA)	Indicate conclusions derived from ischemic heart disease assessment. Choose 1 of the following: • Normal • Abnormal • Equivocal • N/A
Report conclusions: Ischemia (Recommended—CCTA, ICA, stress SPECT, stress echo)	Indicate whether there is evidence for ischemia on the study. Choose 1 of the following: • Yes • No • Equivocal • N/A
Report conclusions: Ventricular function (Recommended)	Indicate the conclusion derived from the ventricular function assessment. Choose 1 of the following: • Normal • Equivocal • Abnormal • N/A
Date of Prior Study (Recommended)	Indicate the date of prior imaging study done.
Significant changes from prior study (Recommended)	Indicate if there are significant changes from prior study. Choose 1 of the following: • Yes —Describe changes from prior study • No • N/A
Report finalized with signature date (Recommended)	Indicate the date the report was finalized and signed by the interpreting physician.

N/A indicates not applicable.

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Key Words: ACC/AHA Data Standards ■ cardiac imaging ■ data elements ■ data definitions.

APPENDIX A. AUTHOR RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES—ACC/AHA/ACR/ASE/ASNC/HRS/NASCI/RSNA/SAIP/SCAI/SCCT/SCMR/SIR 2008 KEY DATA ELEMENTS AND DEFINITIONS FOR CARDIAC IMAGING

Name	Research Grant	Speakers' Bureau/ Honoraria/ Expert Witness	Stock Ownership/ Equity Interests	Consultant/ Advisory Board/ Steering Committee
Dr. Robert C. Hendel	• GE Healthcare	None	None	• Adenosine Therapeutics Limited • Astellas Pharma • GE Healthcare
Dr. Matthew J. Budoff	None	• GE Healthcare	None	None
Dr. John F. Cardella	None	None	None	None
Dr. Charles E. Chambers	None	• GE Healthcare	None	None
Dr. John M. Dent	None	None	None	None
Dr. David M. Fitzgerald	• Ablation Frontiers • Cryocor • Johnson & Johnson/Biosense • Medtronic • St. Jude Medical	• Johnson & Johnson/ Biosense • St. Jude Medical	None	None
Dr. John McB. Hodgson	• Boston Scientific* • GE Medical* • RADI Medical* • Volcano*	• GE Healthcare • Merck* • MICA* • Pfizer	• Volcano*	• Volcano*
Dr. Elizabeth Klodas	None	None	• CVIC Software	None
Dr. Christopher M. Kramer	• Astellas* • Merck* • Siemens Medical Solutions*	• Merck/Schering-Plough	None	None
Dr. Arthur E. Stillman	None	• Astellas • Siemens	None	None
Dr. Peter L. Tilkemeier	None	None	None	None
Dr. R. Parker Ward	• Pfizer Pharmaceuticals*	None	None	None
Dr. Wm. Guy Weigold	• Philips Medical Systems	• Partners Imaging LP	None	None
Dr. Richard D. White	• Siemens Medical Solutions*	• Bayer Schering	• Franklin & Seidelmann	None
Dr. Pamela K. Woodard	• GE Healthcare • Siemens Medical Solutions	• Covidien • GE Healthcare	None	None

This table represents the relationships of committee members with industry and other entities relevant to this topic that were reported orally at the initial writing committee meeting and updated in conjunction with all meetings and conference calls of the writing committee during the document development process. It does not necessarily reflect relationships with industry at the time of publication. A person is deemed to have a significant interest in a business if the interest represents ownership of 5% or more of the voting stock or share of the business entity, or ownership of $10,000 or more of the fair market value of the business entity; or if funds received by the person from the business entity exceed 5% of the person's gross income for the previous year. A relationship is considered to be modest if it is less than significant under the preceding definition. Relationships in this table are modest unless otherwise noted. *Significant (greater than $10 000) relationship.

APPENDIX B. PEER REVIEWER RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES—ACC/AHA/ACR/ASE/ASNC/HRS/NASCI/RSNA/SAIP/SCAI/SCCT/SCMR/SIR 2008 KEY DATA ELEMENTS AND DEFINITIONS FOR CARDIAC IMAGING

Peer Reviewer	Representation	Consultant	Speaker	Ownership/ Partnership/ Principal	Research	Institutional, Organizational, or Other Financial Benefit	Expert Witness
Dr. David Bluemke	Official Reviewer—ACR	None	None	None	None	None	None
Dr. Craig Clark	Official Reviewer—ACCF Board of Governors	None	• Forest Pharma, Inc. • Merck	None	None	None	None
Dr. Pamela Douglas	Content Reviewer—Cardiovascular Imaging Structured Reporting Health Policy Statement	None	None	None	None	• American Society of Echocardiography Past President and Board of Directors (nonvoting)	None
Dr. Daniel Edmundowicz	Official Reviewer—SAIP	None	None	None	None	None	None
Dr. Thomas Gerber	Official Reviewer—SAIP	None	None	None	None	None	None
Dr. Raymond Gibbons	Official Reviewer—AHA	None	None	None	• King Pharmaceuticals*	None	None
Dr. Christopher L. Hansen	Official Reviewer—ASNC	None	None	None	None	None	None
Dr. Vincent Ho	Official Reviewer—NASCI	None	None	None	None	• GE Healthcare*	None
Dr. Ami E. Iskandrian	Official Reviewer—AHA	None	None	None	None	None	None
Dr. Frederick Kusumoto	Official Reviewer—HRS	• Medtronic • Boston Scientific	None	None	None	None	None
Dr. Christine H. Lorenz	Official Reviewer—SCMR	None	None	None	None	• Siemens Corp. Research, Inc. Employee*	None
Dr. Patricia Pellika	Official Reviewer—ASE	None	None	None	None	None	None
Dr. Miguel Quinones	Official Reviewer—ACCF Board of Trustees	None	None	None	None	None	None
Dr. Subha Raman	Official Reviwer—SCMR	None	None	None	• Siemens*	None	None
Dr. Geoffrey Rubin	Official Reviewer—ACR	None	None	None	None	None	None
Dr. Yoram Rudy	Official Reviewer—ASNC	None	None	• CardioInsight Technologies*	None	None	None
Dr. J. Bayne Selby, Jr.	Official Reviewer—SIR	None	None	None	None	None	None
Mr. Harry Solomon	Content Reviewer—Cardiovascular Imaging	None	None	None	None	• GE Healthcare Employee	None

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Peer Reviewer	Representation	Consultant	Speaker	Ownership/ Partnership/ Principal	Research	Institutional, Organizational, or Other Financial Benefit	Expert Witness
Dr. Kim Allan Williams	Content Reviewer—ACC Imaging Council	• CV Therapeutics* • GE Healthcare* • King Pharmaceuticals*	• Astellas Healthcare* • Bracco Diagnostics • GE Healthcare*	None	• Bristol-Myers Squibb* • CV Therapeutics* • GE Healthcare* • Molecular Insight Pharmaceuticals*	None	None

This table represents the relationships with industry that were disclosed at the time of peer review. It does not necessarily reflect relationships with industry at the time of publication. A person is deemed to have a significant interest in a business if the interest represents ownership of 5% or more of the voting stock or share of the business entity, or ownership of $10 000 or more of the fair market value of the business entity; or if funds received by the person from the business entity exceed 5% of the person's gross income for the previous year. A relationship is considered to be modest if it is less than significant under the preceding definition. Relationships in this table are modest unless otherwise noted. Names are listed in alphabetical order within each category of review. *Significant (greater than $10,000) relationship.

ACC indicates American College of Cardiology; ACCF, American College of Cardiology Foundation; ACR, American College of Radiology; AHA, American Heart Association; ASE, American Society of Echocardiography; ASNC, American Society of Nuclear Cardiology; HRS, Heart Rhythm Society; NASCI, North American Society for Cardiovascular Imaging; SAIP, Society for Atherosclerosis Imaging and Prevention; SCMR, Society for Cardiovascular Magnetic Resonance; and SIR, Society of Interventional Radiology.

APPENDIX C. TABLE FOR VISUALIZATION OF THE CORONARY TERRITORY

Coronary Territory	Not Visualized	Percent Stenosis			
		Less Than 50%	50% to 70%	Greater Than 70%	Occluded (100%)
1. Left main					
2. Proximal LAD and 1st diagonal branches					
3. Mid/distal LAD, D2, and D3 branches					
4. LCX, OMs, LPDA, and LPL branches					
5. RCA, RPDA, RPL, and AM branches					
6. Ramus					
7. LIMA, if applicable					
8. RIMA, if applicable					
9. SVG to —, if applicable					

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APPENDIX D. TABLE FOR ASSESSMENT OF ISCHEMIA AND SCAR BASED ON 17 MYOCARDIAL SEGMENTS

Myocardial Segment	Not Visualized	Type of Abnormality				Severity, If Abnormal		
		Normal	Scar	Ischemia	Mixed	Mild	Moderate	Severe
1. Basal anterior								
2. Basal anteroseptal								
3. Basal inferoseptal								
4. Basal inferior								
5. Basal inferolateral								
6. Basal anterolateral								
7. Mid anterior								
8. Mid anteroseptal								
9. Mid inferoseptal								
10. Mid inferior								
11. Mid inferolateral								
12. Mid anterolateral								
13. Apical anterior								
14. Apical septal								
15. Apical inferior								
16. Apical lateral								
17. Apex								

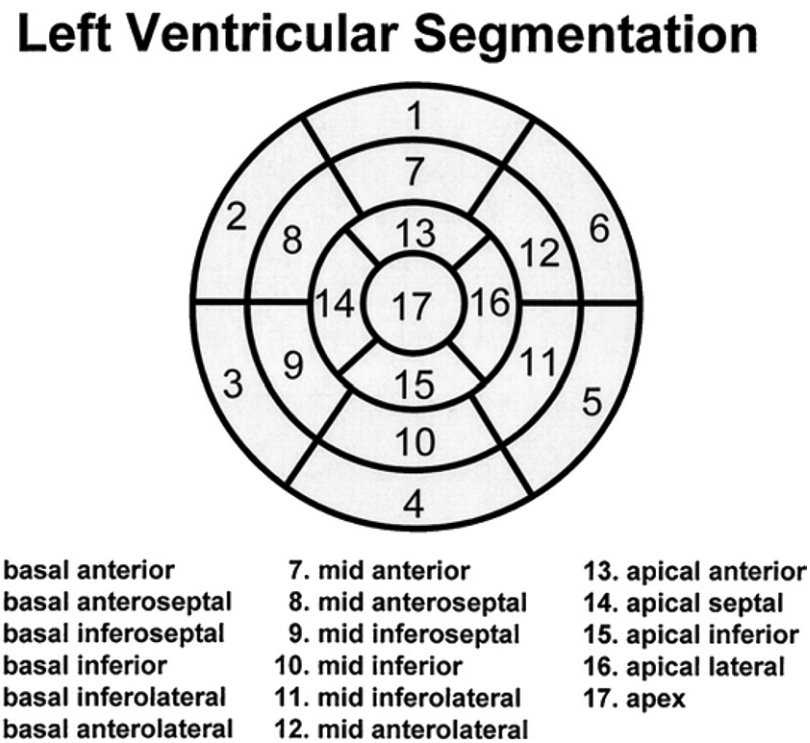

Figure D1. Left Ventricular Segmentation

Adapted from Cerqueira MD et al. (8).

APPENDIX E. TABLE FOR THE ASSESSMENT OF REGIONAL FUNCTION OF THE MYOCARDIAL SEGMENTS

Myocardial Segment	Regional Function				
	Normal	Hypokinetic	Akinetic	Dyskinetic	Not Visualized
1. Basal anterior					
2. Basal anteroseptal					
3. Basal inferoseptal					
4. Basal inferior					
5. Basal inferolateral					
6. Basal anterolateral					
7. Mid anterior					
8. Mid anteroseptal					
9. Mid inferoseptal					
10. Mid inferior					
11. Mid inferolateral					
12. Mid anterolateral					
13. Apical anterior					
14. Apical septal					
15. Apical inferior					
16. Apical lateral					
17. Apex					

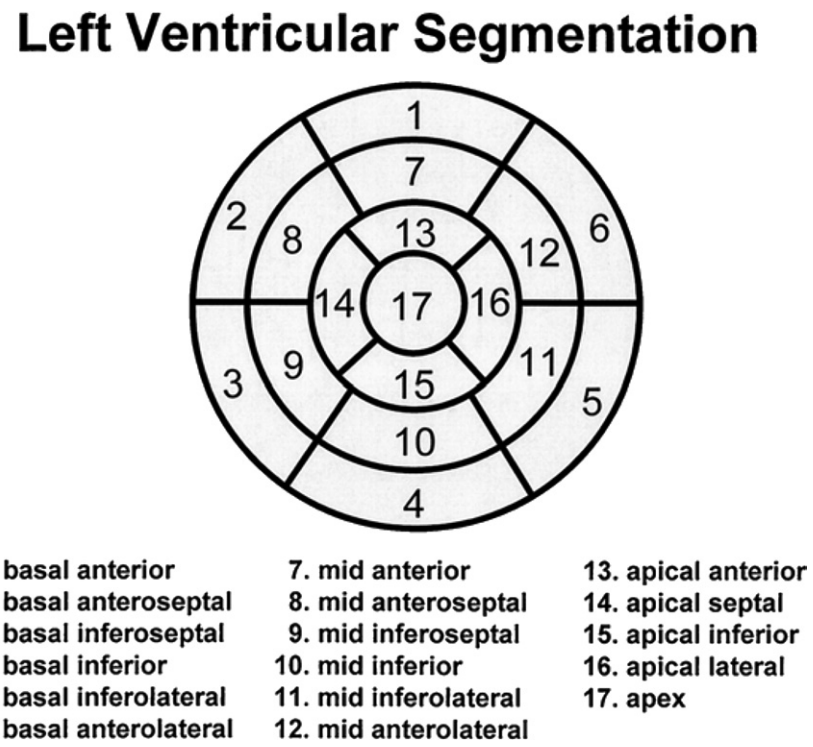

Figure E1. Left Ventricular Segmentation

Adapted from Cerqueira MD et al. (8).

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APPENDIX F. TABLE FOR THE ASSESSMENT OF REGIONAL FUNCTION OF THE MYOCARDIAL SEGMENTS (CONTRAST LEFT VENTRICULAR ANGIOGRAPHY)

Myocardial Segment	Regional Function				
	Normal	Hypokinetic	Akinetic	Dyskinetic	Not Visualized
1. Anterobasal					
2. Anterolateral					
3. Apical					
4. Diaphragmatic					
5. Posterobasal					
6. Basal septal					
7. Apical septal					
8. Posterolateral					
9. Inferior lateral					
10. Superior lateral					

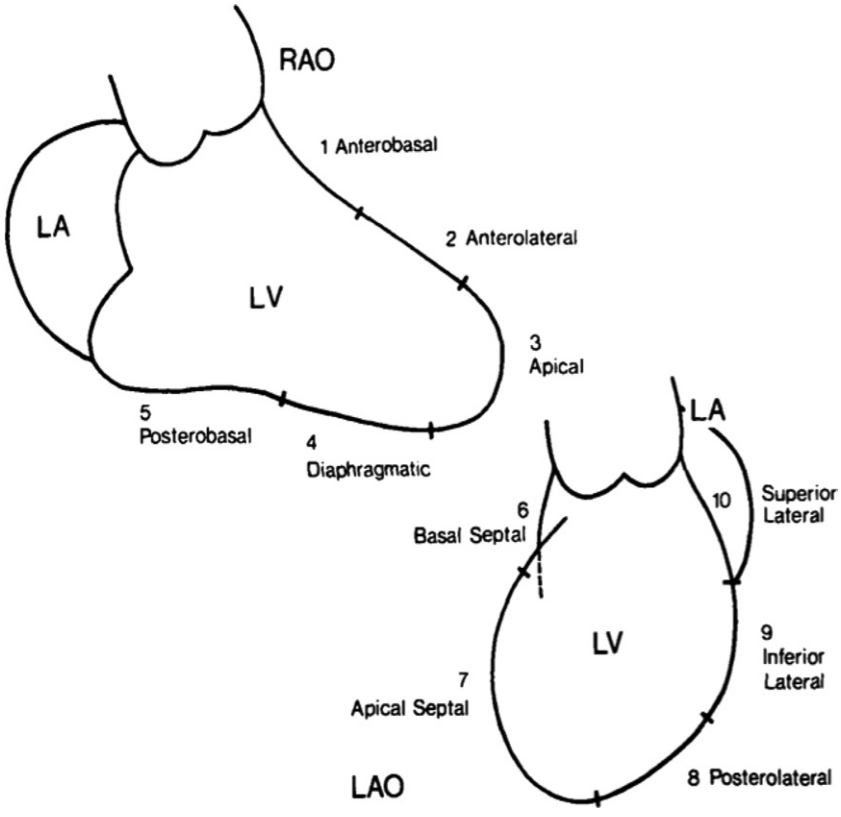

Figure F1. Diagrammatic Representation of RAO and LAO Views of the LV Obtained During Contrast Angiography Showing Division of the LV Wall Into 10 Numbered Segments

Adapted from Wexler LA et al. (16). LA indicates left atrium; LAO = left anterior oblique; RAO = right anterior oblique.