

# Circulation

JOURNAL OF THE AMERICAN HEART ASSOCIATION



## ACCF/ACR/AHA/ASE/ASNC/HRS/NASCI/RSNA/SAIP/SCAI/SCCT/SCMR 2008 Health Policy Statement on Structured Reporting in Cardiovascular Imaging

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*Circulation* 2009;119:187-200; originally published online Dec 8, 2008;

DOI: 10.1161/CIRCULATIONAHA.108.191365

Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX  
72514

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ISSN: 1524-4539

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# Health Policy Statement

## ACCF/ACR/AHA/ASE/ASNC/HRS/NASCI/RSNA/SAIP/ SCAI/SCCT/SCMR 2008 Health Policy Statement on Structured Reporting in Cardiovascular Imaging

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This document was approved by the American College of Cardiology Foundation Board of Trustees in September 2008, the American College of Radiology Board of Chancellors in October 2008, the American Heart Association Science Advisory and Coordinating Committee in September 2008, the American Society of Echocardiography Board of Directors in October 2008, the American Society of Nuclear Cardiology Board of Directors in October 2008, the Heart Rhythm Society Board of Trustees in October 2008, the North American Society for Cardiovascular Imaging Board of Directors in November 2008, the Radiological Society of North America Board of Directors in October 2008, the Society for Atherosclerosis Imaging and Prevention Board of Directors in November 2008, the Society for Cardiovascular Angiography and Interventions Board of Trustees in October 2008, the Society of Cardiovascular Computed Tomography Board of Directors in October 2008, and the Society for Cardiovascular Magnetic Resonance Board of Trustees in October 2008.

The American Heart Association requests that this document be cited as follows: Douglas PS, Hendel RC, Cummings JE, Dent JM, Hodgson JM, Hoffmann U, Horn RJ III, Hundley WG, Kahn CE Jr, Martin GR, Masoudi FA, Peterson ED, Rosenthal GL, Solomon H, Stillman AE, Teague SD, Thomas JD, Tilkemeier PL, Weigold WG. ACCF/ACR/AHA/ASE/ASNC/HRS/NASCI/RSNA/SAIP/SCAI/SCCT/SCMR 2008 health policy statement on structured reporting in cardiovascular imaging. *Circulation*. 2009;119:187-200.

This article has been copublished in the *Journal of the American College of Cardiology*.

Copies: This document is available on the World Wide Web sites of the American College of Cardiology ([www.acc.org](http://www.acc.org)) and the American Heart Association ([my.americanheart.org](http://my.americanheart.org)). A copy of the document is also available at <http://www.americanheart.org/presenter.jhtml?identifier=3003999> by selecting either the "topic list" link or the "chronological list" link (No. LS-1936). To purchase additional reprints, call 843-216-2533 or e-mail [kelle.ramsay@wolterskluwer.com](mailto:kelle.ramsay@wolterskluwer.com).

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(*Circulation*. 2009;119:187-200.)

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*Circulation* is available at <http://circ.ahajournals.org>

DOI: 10.1161/CIRCULATIONAHA.108.191365

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### 1. Preamble

This document is an official American College of Cardiology Foundation (ACCF) Health Policy Statement. This category of documents is intended to promote or advocate a position or is informational in nature and may offer guidance to the stakeholder community regarding the ACCF's stance on health care policies and programs. Health policy statements are not intended to offer clinical guidance and do not contradict existing ACCF clinical policy.

These documents fall under the purview of the ACCF Quality Strategic Directions Committee (QSDC). The ACCF QSDC is responsible for developing and implementing all policies and procedures related to topic selection, commissioning writing committees, and defining document methodologies.

The QSDC brings together various areas of the College such as the Advocacy Committee, the National Cardiovascular Data Registry, the Performance Measurement Task Force, the Practice Guidelines Task Force, the Appropriateness Criteria Steering Committee, and the Task Force on Performance Assessment, Recognition, Reinforcement, Reporting

and Reward (PAR<sup>4</sup>). The QSDC recommended the development of this Health Policy Statement to document the generally accepted position of the cardiovascular imaging community regarding structured reporting for cardiovascular imaging. Medical specialty societies must provide guidance on the design and implementation of key imaging quality program elements, to influence stakeholder perspectives and also provide meaningful guidance to members in this important area of modern cardiovascular practice. As the growth in imaging has caused payers to reduce costs by limiting access and reducing reimbursement, such attention to quality becomes even more important.

The Writing Committee made every effort to avoid any actual, potential, or perceived conflict of interest that might arise as a result of industry relationships or personal interest. Specifically, all members of the Writing Committee, as well as peer reviewers of the document, were asked to provide disclosure statements of all such relationships. Please see Appendix 1 for a listing of the author relationships with industry. Relationships with industry of peer reviewers are listed in Appendix 2.

*Joseph P. Drozda, Jr, MD, FACC, Chair  
ACCF Quality Strategic Directions Committee*

### 2. Introduction and Rationale

The final report is an essential component of any cardiovascular imaging test. It captures critical elements of the study(s) with their interpretation, recording this information for future use. It is often the only communication from the interpreting physician to the caregiver, and is therefore a critical component in the imaging chain of care and imaging quality.<sup>1,2</sup> In addition, a report may be used for billing, quality improvement (QI), teaching, and informing patients and their families. By documenting a discrete episode of care, the report may become legal evidence. Accordingly, producing the highest quality report possible is an important goal in cardiovascular (CV) imaging practice for both optimal outcomes and cost efficiency.

In a narrow sense, structured reporting refers to the displayed clinical report of a CV imaging procedure, when communicated using standardized content and definitions in a coherent, clinically relevant, and predictable format. However, in a broader sense, structured reporting is the process of organizing data by abstracting and integrating all of the evidence collected during the procedure (procedure logs, physical findings, images, waveforms, measurements, and interpretations) to create an integrated and comprehensive clinical report. It may include procedure data in "structured evidence" formats amenable to automated or semiautomated abstraction for reporting. Other types of standardized formatted reports, such as for quality or performance measures, may be created by a similar process, and may be included in the broad definition of structured reporting. For the purposes of this document, the term "structured reporting" will refer to both the underlying structured data that are collected and stored as part of an imaging procedure when this is done in a coded and structured manner (as opposed to free text, or unstructured data), as well as the displayed version of that data, the clinical report.

Structured reporting is important for several reasons.<sup>3–6</sup> Imaging quality may be improved and QI activities may be facilitated through imposed consistency of structured data collection and reporting. Key report components and data elements will not be omitted if the report is structured and elements are listed systematically within a standard template. Common lexicons are used to standardize descriptors. Referring physicians may find it easier to understand displayed imaging reports and to extract pertinent results if they are in an expected location and in standard defined terminology. Redundant testing may be reduced, potentially sparing patients from unnecessary exposures to the risks inherent in different imaging tests. Similarly, comparison between studies would be facilitated. Structured reporting and underlying structured data are critical to interoperability between electronic medical record systems, which are dependent on compatible document formats and parallel data structures. Cost savings may be achieved by added efficiency for the imager, the referring physician, hospital systems, and purchasers of health care.

The structured reporting principles discussed in this document apply broadly to all forms of cardiovascular imaging. However, their application in certain cases, such as vascular imaging and congenital heart disease, may require additional consideration. Detailed discussion of the implementation of structured reporting in such cases, as well as in each imaging modality, is beyond the scope of this document.

Much of the rationale for and underlying principles of structured reporting are similar to those for Health Information Technology in general and specific efforts such as Computerized Physician Order Entry in particular. Thus, structured reporting can be seen not only as a quality improvement vital to “best practices” in imaging laboratories, but also as critical to patient care and safety. This broader significance makes the definition and implementation of structured data and reporting both a health policy and clinical practice imperative.

Through the creation and endorsement of this document, the organizations involved not only recognize the critical importance of structured reporting to the achievement of quality in cardiovascular imaging, but also call for its use as essential to quality cardiovascular imaging practice. This would include that imaging laboratories collect data in structured format, that physicians practice structured reporting procedures, that imaging and information systems support structured data archiving and reporting formats, and that reporting software implements structured composition and other required features for interoperability. Both in the narrowest clinical sense, as well as in the broader definition of production, interpretation and exchange of imaging based data, adherence to structured reporting principles is necessary to societal and professional efforts to measure, report, and improve quality.

### 3. Principles of Structured Reporting

#### 3.1. General Principles

Several key principles are essential to optimal structured reporting, the most important of which is clinical relevance (Table 1). If structured reporting fails to meet this standard, it will have failed to provide a useful tool to improve imaging

**Table 1. General Principles of Structured Reporting**

---

Clinical relevance
Completeness
Clarity
Consistency
Reproducibility
Practical, easy to apply
Applicable to all modalities
Able to evolve over time
Adequate for billing
Balanced approach

---

quality. Other principles include completeness, clarity, consistency, and reproducibility. Standards should provide a broad enough framework to be applicable to all CV imaging modalities; for example, descriptions of morphology and function should appear similar regardless of modality. Similarly, standards should be adaptable to apply to all forms of cardiovascular diseases. There must be a consistent minimal data set, with uniformity in data definitions, and a data structure that permits portability while allowing flexibility in presentation. Finally, structured reporting should be pragmatic, striking a balance between consistency and flexibility, conciseness and completeness, and ease of use and rigor. Above all, structured reporting should enhance clarity and facilitate care.

A structured report and its components should contain all of the requisite data for demonstrating medical necessity, appropriateness determination and for billing including documentation of lab characteristics (e.g., accreditation), reasons for study, relevant image acquisition parameters and interpretation. Furthermore, these data should be compatible with billing systems, in addition to clinical information systems.

#### 3.1.1. The Need for a Balanced Approach

Critical considerations in implementing these principles are practicality and balance (Table 2). The design and mechanics of any structured report, to be clinically useful, must be well balanced among numerous dichotomies in order to be most practical. First, the reporting mechanism (software) must strike a balance between consistency (achieved by retaining the same data elements in every report) and flexibility (the ability to modify the data elements captured by the reporting mechanism). While much of the benefit of structured reports comes from their consistency and adherence to inclusion of at least a minimal data set, the ability to add “optional” data elements or patient-specific details to this minimal data set would make such reports more practical and useful by providing additional details that are not found among the standard data elements. Such additional detail may be needed when structured reports are used for internal reporting, quality assurance, research, and clinical care of patients with rare disorders. For example, structured reports for imaging studies performed on patients with congenital heart disease may require unique elements to convey needed clinical information.



**Table 2. Competing Principles of Structured Reporting That Must Be Optimally Balanced to Achieve the Most Practical Result**

1	Consistency	Requiring same elements and definitions; same organization and structure
	Flexibility	Allowing addition of elements, details, and free text
2	Completeness	Inclusion of all relevant fields and sufficiently detailed descriptions
	Conciseness	Minimize time required to read; easily understood
3	Required elements	Address key clinical findings expected of the modality; ensure appropriately thorough clinical evaluation of the study
	Optional elements	Useful across modalities; facilitate data entry; avoid burdensome user experience
4	Universality	Commonality to the process and content
	Proprietary	Allow opportunities for product development

Second, the scope of the report must strike a balance between completeness and conciseness. Reports must be sufficiently inclusive of relevant, detailed data elements to accurately describe the findings, but must not be so lengthy as to be unhelpful to the busy, time-pressured clinician. Similarly, while it may be tempting to collect every piece of data that can possibly be extracted from a study, such a collection process would be burdensome for the reporting laboratory, and therefore unlikely to be widely accepted.

Third, the number of elements designated as required must be sufficient to produce robust reports that are consistent in content across different laboratories, but not so numerous as to burden laboratories with the collection of unnecessary elements.

Finally, while the whole purpose of structured reporting is to create a widely utilized mechanism that results in a universally recognized clinical document, there must be a balance between requiring conformity across reports and allowing innovation in the development of reporting products and tools, including commercially viable products. As an example, future speech recognition software may use intelligent computer algorithms to populate predefined data elements.

### 3.2. Technical Characteristics

The major technical characteristic of structured reporting is interoperability, or the characteristic that ensures that electronic records can be effectively used by a variety of recipients.<sup>7</sup> Interoperability includes 5 major aspects that must be addressed in an integrated structured reporting solution (Table 3):

1. *Portability*—The use of standardized message formats to exchange data between disparate equipment and systems is essential. This is often called syntactic interoperability, and allows integration of exchanged data into electronic medical record systems. The primary standards include those from

**Table 3. Technical Characteristics of Structured Reporting**

Portability
Standardized context and outputs
Compatibility
Multimodality comparability
Performance in multiple contexts and environments

Health Level Seven (HL7; <http://www.hl7.org/>), Digital Imaging and Communications in Medicine (DICOM; <http://dicom.nema.org/>), and Health Information Technology Standards Panel (HITSP; <http://www.hitsp.org/>).

2. *Standardized content and outputs*—Standard sets of data elements and coded terminology must be used whenever available. This is often called semantic interoperability, and enables receivers to precisely understand the message content. The primary standards include Systematized Nomenclature of Medicine-Clinical Terms (SNOMED-CT; <http://www.ihtsdo.org/>), Logical Observation Identifiers Names and Codes (LOINC; <http://www.loinc.org/>), and data sets defined by specialty societies. The use of standard data sets is tested in the clinical setting through the Integrating the Healthcare Enterprise initiative (<http://www.ihe.net>) or similar methodology.
3. *Compatibility*—This allows data capture in an interoperable format at its origination, or the initial point of collection or production, reducing data re-entry errors and allowing electronic consolidation of all study data with traceability to the source. For example, a sonographer's worksheet of preliminary measurements should be sent in a standard format to the over-reading cardiologist's workstation, where it can be reviewed with the digital images and validated for the clinical report.
4. *Multimodality comparability*—Uniform and comparable data sets and elements across different imaging modalities must be used. While different modalities may have different capabilities or accuracies, they are measuring the same anatomic structure or physiologic function (e.g., ejection fraction measured by cardiac catheterization or by echocardiography). Comparability allows evaluation of a patient's history across the care continuum. Cross modality comparability is addressed more fully by a standards document defining data elements that has been endorsed by the same societies supporting this health policy statement.<sup>8</sup>
5. *Performance in multiple contexts and environments*—The collected structured report data should support clinical and nonclinical activities such as billing, research, and outcomes reporting, without requiring additional data entry. While these purposes may require data at a different level of aggregation, in greater detail, or in an altered format, the structured report data must be sufficiently detailed to allow automated, computerized extraction for nonclinical use. Thus, critical data elements of the structured report should be stored in a "searchable" or "trackable" format within electronic medical records and not in text or string format that is difficult to access.

**Table 4. Components of a Structured Cardiovascular Imaging Report**


---

Administrative information and laboratory identification
Patient demographics and billing information
Study referral data
History and risk factors
Study description
Study findings, interpretation, and conclusions
Other reporting parameters

---

## 4. Components of a Structured Imaging Report

The components of a structured report represent categories of information that should be present in every cardiovascular imaging report. Most of the specific statements within each category may be considered data elements, which have been defined in another standards document.<sup>8</sup> The examples included are meant to be illustrative, and do not represent mandated content, suggested verbiage, or an exhaustive listing of what might appear in a given report (Table 4). Although it is outside the scope of this document to consider the communication of results beyond structured reporting, it is important to note that there is an American College of Radiology standards document related to this topic.<sup>9</sup>

### 4.1. Administrative Information

The administrative section contains pertinent, nonvarying identifying information related to the specific laboratory and site performing the examination, including such information as: laboratory name, site location and type of facility, address and phone, and accreditation entity and status.

### 4.2. Patient Demographics

The demographics section provides personal information and unique patient identifiers to link the patient to the report. Demographic elements should uniformly include the patient's full name at the time of the test, prior names used for previous tests, medical record number, date of birth, gender, and race. All of these should be included to provide sufficient redundancy to correct errors and to allow comparison of data over time and across providers. Special care must be taken in the identification of fetal, newborn, and pediatric patients as names and other identifiers change following birth and naming. Information required to generate a correct bill, including insurance or other payer information, may be included.

### 4.3. Study Referral Data

Study referral data describe the clinical situation and questions, study indication, and referring provider identification. This portion may also include date and time of the order, study priority (routine, urgent, stat), and special handling instructions such as a call back number for results. Consideration should be given to including the referring physician's National Physician Identifier, a unique identifier of a specific physician. This would allow for linkage of referring physicians, patients, and studies; study of referral practices; and

longitudinal tracking of physicians' referrals regardless of geographic location or institutional venue.

### 4.4. History and Risk Factors

The patient's relevant medical history, risk factors, medications, and allergies play a critical role in image acquisition and interpretation, and should be standardized as are other components of the report. In addition, elements should allow tracking application of relevant Appropriateness Criteria and Practice Guidelines recommendations. Important historical information is best provided by the referring physician who is most familiar with the patient, as well as by the patient. However, some data may only be available by report (rather than verified by the laboratory), or may not be routinely available to the imaging laboratory. Thus the report may document the source of the information as well as any pertinent gaps.

### 4.5. Study Description

The imaging modality, technical specifications of image acquisition, and all components of the test should be described in detail, ideally using generic rather than proprietary verbiage. If there is a unique study identifier or accession number, it should be included. The name, dose, and method of administration of contrast agents or medications, if used, should be documented. If the imaging modality utilizes radiation, dose-reduction strategies employed in the study and the estimated dose or exposure received by the patient during the examination should be included. If the test involves imaging during stress, the method of inducing stress (exercise and/or pharmacological) and the stress protocol used should be indicated. Overall study quality should be noted, with mention made of any limitations due to patient- or equipment-related reasons or other circumstances. Sufficient identifying information should be included to facilitate retrieval of essential components of the examination, regardless of storage medium.

### 4.6. Study Findings

Specific study findings will vary substantially, depending upon the imaging modality employed, the imaging protocols used, the clinical question asked, the actual results themselves, and other factors. A common practice in structured reporting is to group all quantitative measures, qualitative assessments, and calculated data on a given structure (eg, left ventricular size, shape, and wall thickness, and systolic and diastolic function should appear in adjacent items), with each evaluated structure considered in logical sequence. Measurements should be properly referenced to norms for body size, gender, and age, and they should be reported with corresponding Z-scores when relevant. Physiological and hemodynamic changes observed during a study, whether spontaneous or in response to stress or other interventions, should be included. The report should also include clearly identified fields for interpretation of findings, comparison to prior studies (if available), conclusions and impressions, and any recommendations as a result of the study. The original question for which the study was performed should be explicitly answered.

Standard features or sets of investigative tasks for each type of study, as developed and recommended by cardiovascular imaging societies, should be reported using standard data elements and anatomic, morphologic, and functional descriptions. For example, the 17-segment model (Figure) is a consensus standard for left ventricular description by tomographic imaging<sup>10</sup> and should be used in both stress and rest reports to document any ischemia, scarring, or wall motion abnormalities. Additional multimodality data elements for adult cardiac imaging are delineated in the companion multisocietal standards document on this topic.<sup>8</sup>

#### 4.7. Other Reporting Parameters

The report should include the name and identifiers of all individuals involved in the study including names and credentials of the technicians, trainees, nurses, and physician assistants involved in study performance and the interpreting physician. It should include the date and time of the examination as well as the date and time of the finalized report. An attestation clause may be added if any portion of the examination or report was performed by a trainee. Documentation of transfer of care may be included when either routine results or a “critical finding” on the imaging test is reported either in person or via phone conversation to the referring physician and may include the date, time, and name of the receiving individual. Any amendments to a finalized report should include the date, time, and name of the responsible individual.

### 5. Implementation

Many of the preliminary steps needed for the implementation of structured reporting have been completed, including the definition of key data elements for specific imaging modalities<sup>11–16</sup> as well as standardized multimodality data elements for adult cardiac imaging<sup>8</sup> and congenital heart disease.<sup>17</sup> The Society of Thoracic Surgeons and the International Society for Nomenclature of Paediatric and Congenital Heart Disease have been working to further define a standardized system of anatomical descriptors that could be applied to the standardized reporting of cardiovascular imaging studies in pediatric and congenital heart disease. Additional efforts must be made to identify data elements for vascular imaging. The increasing use of commercial software for generating clinical reports has prepared laboratories for the use of standardized reporting. Nevertheless, implementation of structured reporting will require the enthusiastic support of practitioners, professional societies, national standards-setting organizations, and industry. More detail on the roles of each of these types of entities is provided below.

An additional important component of the implementation of a policy of mandatory structured reporting is to ensure that any unintended consequences regarding access to care are mitigated. Such concerns may be particularly relevant for solo providers or rural practices that may not have extensive information technology capabilities. Structured reporting solutions need not be complex or expensive; Web-based tools such as those offered by the American Society of Echocardiography’s Echo ToolBox (<http://www.echotoolbox.com>) should place needed resources within the reach of every imaging laboratory.

#### 5.1. Professional Societies and Accrediting Bodies

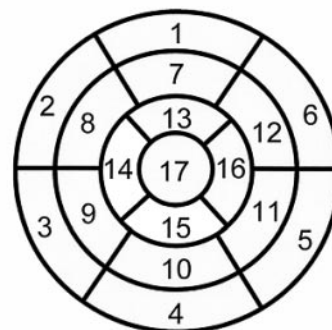
Cardiovascular professional societies have implicitly promoted structured reporting in guidelines for the performance, interpretation, and application of specific imaging modalities. Examples of explicit support include the multimodality standardization of myocardial segments and nomenclature endorsed several years ago<sup>10</sup> as well as single modality efforts.<sup>11–16</sup> However, this paper constitutes the first formal recommendation for mandatory structured reporting for all cardiovascular imaging modalities.

Current standards for laboratory accreditation do not mandate structured reporting, although many of the elements of complete reports are facilitated by its use. Given that an inadequate report is a frequent cause of accreditation denial, implementation of structured reporting should facilitate accreditation. Societies endorsing this policy document are also sponsors of accreditation efforts, and should play an important role in influencing revision of accreditation standards to include current policy.

#### 5.2. Standards-Setting Organizations

In the past decade, both the Digital Imaging and Communications in Medicine (DICOM) and Health Level Seven (HL7) consensus standards organizations have adopted formats for structured documents, known as DICOM Structured Reporting and HL7 Clinical Document Architecture (CDA). These general format standards are based on a hierarchical tree of textual, numeric, and coded observations complemented by content templates focused on structures and vocabulary for specific use cases. Continued, active participation and leadership in these standards-setting organizations by the ACCF and other organizations endorsing this document are critical to ensure that the needs of the cardiology community are met and that interoperability standards are clinically relevant. A complete discussion of these entities and their outputs is beyond the scope of this document and can be found on the organizations’ Web sites.

### Left Ventricular Segmentation



- |                        |                       |                     |
|------------------------|-----------------------|---------------------|
| 1. basal anterior      | 7. mid anterior       | 13. apical anterior |
| 2. basal anteroseptal  | 8. mid anteroseptal   | 14. apical septal   |
| 3. basal inferoseptal  | 9. mid inferoseptal   | 15. apical inferior |
| 4. basal inferior      | 10. mid inferior      | 16. apical lateral  |
| 5. basal inferolateral | 11. mid inferolateral | 17. apex            |
| 6. basal anterolateral | 12. mid anterolateral |                     |

**Figure.** Seventeen-segment model for assessing left ventricular function. Reprinted from Cerqueira et al<sup>10</sup>.



### 5.2.1. DICOM

DICOM (<http://dicom.nema.org>), and particularly its Working Group 1 (Cardiology and Vascular Information) and Working Group 8 (Structured Reporting), have issued standard structured reporting templates for a variety of cardiology applications. DICOM Structured Reporting documents have robust capabilities for recording derivation of measurements and observations from referenced images or waveforms, and are managed within the same object management framework used for DICOM images. In conjunction with the relevant specialty societies, structured reporting document templates have been developed for evidence collected for the catheterization laboratory,<sup>18</sup> echocardiography,<sup>19</sup> intravascular ultrasound,<sup>20</sup> quantitative arteriography and ventriculography,<sup>21</sup> and cardiac stress testing.<sup>22</sup>

### 5.2.2. HL7

HL7 (<http://www.hl7.org/>) develops both message- and document-oriented standards and has a working group devoted to cardiology. The HL7 CDA standard focuses on human-readable displayed reports with optional structured supporting data based on the HL7 v3 Reference Information Model and encoded using Extensible Markup Language. The similarity in function and structure of the DICOM Structured Reporting and CDA has led to continuing efforts through a joint DICOM-HL7 working group to clarify the appropriate use of each. While DICOM Structured Reporting is appropriate for measurements and assessments made directly from DICOM images, the CDA may be more appropriate for reports to referring physicians. DICOM Structured Reporting may be best suited for internal use within the performing cardiologist's work environment and for archiving acquired images, while CDA may be best suited for external communication of results and integration into the electronic health record.

### 5.2.3. Terminology Standards

In addition to the multimodality adult cardiac imaging data elements standards,<sup>8</sup> at least 2 major organizations have produced controlled and coded terminology for medical purposes. Both terminology standards are referenced extensively by the DICOM and HL7 document templates and are regularly updated with additional cardiovascular concepts based on input from DICOM and HL7. They are:

- International Health Terminology Standards Development Organization (<http://www.ihtsdo.org/>) developers of the Systematized Nomenclature of Medicine—Clinical Terms (SNOMED-CT). The SNOMED-CT lexicon is a primary source for medical terminology in cardiology and other disciplines. Structured reporting standards like those from DICOM and HL7 utilize SNOMED terms and provide feedback for improvements to SNOMED. SNOMED-CT is a very comprehensive clinical healthcare terminology, including terms for anatomy, morphology, procedures, and clinical findings. This terminology is routinely updated twice per year for adult imaging, and less frequently for pediatric or congenital cardiovascular imaging.
- Logical Observation Identifiers Name and Codes (LOINC) (<http://loinc.org>) and the Radiological Society of North

America's RadLex (<http://www.rsna.org/Radlex/index.cfm>) extend SNOMED terminology to include operational procedures, document indexing, and document structuring, providing standard identifiers for many cardiovascular measurements and documenting structuring concepts (report and section titles).

### 5.2.4. IHE

The goal of the Integrating the Healthcare Enterprise (IHE) effort, of which the ACCF and other endorsing organizations are members, is to promote the effective use of all standards. The IHE has specified an Evidence Documents Integration Profile<sup>23</sup> that describes how to use DICOM structured reporting and its specific cardiology templates in the diagnostic imaging workflow. For exchange of documents between referring and performing healthcare providers, IHE has specified a Cross-Enterprise Document Sharing (XDS) Integration Profile<sup>24</sup> and several associated content profiles for CDA documents and for DICOM images. XDS is the basis for interoperability specifications<sup>25</sup> recognized by the US Department of Health and Human Services and many health information exchange and regional health information organization activities.

### 5.2.5. Government

The US Government and other federal governments have made broad deployment of interoperable electronic medical records and development of health information networks a priority, and structured reporting is a critical component of that interoperability. In the United States, several federal regulations promoting this goal have been issued, including recognition of the above interoperability specifications. The US Health and Human Services–recognized interoperability specification from the Healthcare Information Technology Standards Panel (HITSP) is the basis for broad-scale electronic information/report exchange.<sup>25–27</sup> The ACCF has actively participated in the development of those specifications through the HITSP.

## 5.3. Industry

While structured reporting is not achievable without industry's participation and support, implementation of structured reporting features into commercially available products presents both opportunities and challenges to industry developers, including prioritization relative to other desirable product features, given constraints on development resources. Further, the natural inclination of vendors to differentiate their products must be overcome by customer demand and society pressure for standardized reporting systems. These efforts are assisted by a trend toward structured reporting requirements for certification, accreditation, and reimbursement. Compliance with structured reporting principles should be seen as an essential feature rather than a burden to develop.

Developers may take different approaches to implementation of interoperability features, depending on the messaging standards used and existing product capabilities. Products may incorporate support for standards-based messages directly into the software or may use an "interface engine" to convert between standards-based external messages and



product internal data structures. Neither approach should be viewed as inherently better or worse than the other, as long as a minimum data set of each vendor's output is interoperable with other information technology systems.

#### 5.4. Tools and Testing

Use of these standards and lexicons in products for the clinical environment requires significant testing and validation prior to integration into the clinical workflow. Development of appropriate test tools and an interoperable environment in which to test are essential for this to succeed. Testing of system features must use appropriate test tools and test data sets, which may be general validators or targeted to the specific features being implemented and simulate the wide range of real-world environments. Fortunately, open source interoperability test tools are under development by a collaboration of the Certification Commission on Healthcare Information Technology, Integrating the Healthcare Enterprise (<http://www.ihe.net>), and the National Institute of Standards and Technology.

Since implementation of interoperability features, such as structured reporting, require testing and validation with organizations outside the control of the developer, this adds the complex task of external testing to the feature development timeline, which is a significant challenge to industry. The resources needed to negotiate and perform cross-vendor interoperability testing can be minimized by participation in a vendor-neutral, industry-wide testing environment, such as IHE Connectathons (<http://www.ihe.net>). These provide a controlled environment, standardized test tools and procedures, and a definitive time frame that allows cost-effective validation with multiple partners at 1 event. Moreover, participation is negotiated once with the event sponsor under standard terms and conditions, rather than with each individual partner.

#### 5.5. Workflow and Economic Considerations

Positive economic benefits may be realized with structured reporting. Transcription costs may be substantially reduced or even eliminated, as will fax, mail, or other report distribution costs if electronic distribution is adopted. Efficiencies in care may be realized as data flows electronically rather than by paper transfer, often reducing total examination time and improving throughput, particularly in the case of complex anatomy and physiology such as in pediatric and congenital heart disease.<sup>28</sup> Care itself may be enhanced as referring physicians are provided with more complete, understandable information in a timelier manner. A structured report that is compatible with billing systems may facilitate complete and timely submission of bills to payers and reduce queries and delays in payment, thus improving billing and reimbursement efficiencies.

A potential, more far-reaching financial advantage of structured reporting is its inherent ability to exchange data between the report and an analytic database. Structured reporting therefore provides a framework for examining image quality metrics, including test appropriateness, analysis of diagnostic accuracy, and association with clinical outcomes; this may serve as a tool in the measurement of clinical performance. Therefore, the

economic benefit of structured reporting may ultimately be based on the ability of a laboratory or practice to provide demonstration of high-quality care, with an associated higher level of reimbursement.

While there is potential economic benefit to health plans and society, the implementation of structured reporting for cardiovascular imaging may cause laboratories and clinical practices to incur significant expenses. Proprietary software will require a purchase price point that offsets industry development costs. Additionally, customization, maintenance, and updating of a structured reporting system require ongoing expenditures. Personnel involved in the various portions of report construction, including administrative assistants, nurses, technicians/technologists, and physicians, will require training. Finally, it must be recognized that report construction using a structured reporting system may necessitate additional time for some laboratory staff, including the interpreting physician.

#### 5.6. Education and Outreach

For standardized reporting to succeed and be widely adopted, a large educational effort will be needed at a number of levels. At the most fundamental level, some physicians and laboratory personnel may need to be convinced that structured reporting will improve care and make them more efficient, while industry must believe that commercially viable products can incorporate structured reporting. Simultaneously, societies must engage industry, by both providing a vision for structured reporting and demonstrating enough commitment to the process to give industry confidence that a large market will exist for successful implementations. The success of this endeavor will require an outreach effort by all of the endorsing societies and accreditation organizations to their industry and member constituencies.

### 6. Future Directions/Potential Applications

#### 6.1. Training

Structured reporting will enhance important aspects of the training and teaching of residents, fellows, and practicing physicians. The structured reporting format will encourage a comprehensive approach to and assessment of imaging data. Development of a systematic "module-like" learning approach using the aspects of structured reporting described above will help to ensure training in each area. Structured reporting will encourage independent self-directed learning and lead to a more uniform use of appropriate terminology. Use of structured reporting will more easily allow the learner to compare his/her reports with the trainers' or across modalities to determine accuracy of measurements and interpretation. Finally, and perhaps most importantly, structured reporting can include an inherent ability to document and verify that trainees participate in performing and interpreting the required numbers of imaging procedures during training as outlined by COCATS.<sup>29</sup>

#### 6.2. Quality Improvement

A potential immediate benefit of structured reporting is an improvement in the imaging report's consistency, both in

terms of structure and content, that may result in an improvement in the value of cardiac imaging in general. Structured reporting also allows the capture of additional data inherent in imaging studies in a consistent and reliable format. These data may then potentially be used for a variety of quality improvement initiatives involving the tracking of quality indicator elements, which will enable a laboratory to track its own performance. Such quality indicators may be related to the reasons for test ordering including appropriateness and the reporting process itself, with metrics such as completeness and timeliness of reports. Other quality indicators may be related to patient safety, such as radiation dose, contrast agent dose, and techniques designed to reduce patient exposure to ionizing radiation such as electrocardiogram-controlled tube current modulation in computed tomography. If outcomes are tracked, a laboratory may be able to measure its own diagnostic and prognostic accuracy.

In addition, the availability of data from multiple laboratories would facilitate quality improvement initiatives. Comparison of individual patient results across modalities is important to determine test operating characteristics for a laboratory, and individual laboratories could compare their performance to national benchmarks. Furthermore, satisfactory achievement of selected quality indicator elements can be included as a requirement for laboratory accreditation. Finally, if data are collected regarding the clinical indications for the scan as well as elements of the procedure itself, then these data can provide feedback to guidelines-writing societies to further refine future iterations of appropriateness criteria and other guidelines and standards statements.

### 6.3. Registries and Research

Registries serve a wide range of purposes ranging from scientific inquiry to evaluation of quality, safety, and cost effectiveness. One of the major applications of structured reporting using a systematic uniform lexicon is the development of registries across institutions nationwide, regardless of equipment, institution, or operator, which can be subsequently used for investigational purposes. This would enable the collection of data on imaging use and results with systematic follow-up over a broad range of populations and institutions, significantly improving the ability of researchers to perform longitudinal analyses on a much greater scale. The ability to query such a registry in an independent manner could potentially increase the effectiveness of QI and guideline adherence programs. Additionally, registries may become critical to helping physicians and their institutions document appropriateness of imaging and cost-effective practice for “pay-for-performance.” Lastly, registries may also provide the ability to monitor and ensure safety of a variety of health care services provided. The ability to develop and query data based on a structured report may not only provide improved safety monitoring, but also aid in developing safer techniques by being able to easily compare data among institutions and/or with national averages.

### 6.4. Public Reporting/Accountability/Reimbursement

The use of performance measures for the purposes of public reporting and guiding remuneration for services has proliferated in many areas of medicine over the last decade. The substantial growth in the use of imaging, and the costs associated with that growth, have increased pressures to understand the quality of cardiovascular imaging services and to be accountable for quality.<sup>1,2,30</sup> Thus, performance measures for cardiovascular imaging are under consideration by such policy-setting organizations as the Centers for Medicare and Medicaid and the National Quality Forum, with the understanding that such measures will be employed for public accountability, if not as part of pay-for-performance programs.

Structured reporting using universal data standards will play an important role in the evolution of consistent performance measurement programs by substantially reducing the burden of data collection, facilitating the calculation of performance measures that apply consistently across sites, and enhancing the credibility of measures employed for the purposes of accountability. By standardizing data collected in the course of clinical practice—in contrast to using parallel data collection separate from clinical care, structured systems will also improve validity of the data used for performance measurement and limit “gaming” of the data used for performance measurement.

## 7. Conclusions

Reporting of cardiovascular imaging studies is the final and perhaps most critical component of an imaging procedure. As such, clarity and accuracy of the report and the data underlying it are required to ensure imaging quality.<sup>1</sup> Structured reporting addresses the content and components of both data storage and the displayable report and assists in the clear, consistent, and complete communication of results. Structured reporting requires that cardiovascular imaging laboratories collect data in a structured format, that physicians adopt compliant reporting procedures, that imaging and information systems support structured data storage and displayed report formats, and that reporting software implements structured composition and other required features for interoperability.

In addition to the central goal of improved clinical care, a structured report environment may facilitate integration of information from all modalities, permit incorporation into electronic information systems, and allow for data collection into registries and clinical databases. These latter functions may serve to facilitate billing and reimbursement, assist in quality improvement programs, document test appropriateness, and encourage teaching and research. The design and implementation of structured reporting allows the integration of data into healthcare systems and data repositories while keeping these various applications in mind.

As healthcare records are increasingly digital and portable, structured reporting is not only practical but is a quality imperative. The organizations endorsing this document support the goal of mandatory use of structured reporting as an essential component of improved cardiovascular health care.

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KEY WORDS: AHA Health Policy Statement ■ structured reporting ■ cardiovascular imaging ■ imaging quality ■ structured data ■ lexicon

**Appendix 1. Author Relationships With Industry and Other Entities—ACCF/ACR/AHA/ASE/ASNC/HRS/NASCI/RSNA/SAIP/SCAI/SCCT/SCMR 2008 Health Policy Statement on Structured Reporting in Cardiovascular Imaging**

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Dr. John McB. Hodgson	• Volcano*	<ul style="list-style-type: none"> <li>• Radi Medical</li> <li>• Volcano*</li> </ul>	• Volcano*	None	<ul style="list-style-type: none"> <li>• Boston Scientific*</li> <li>• GE Medical*</li> <li>• Radi Medical*</li> <li>• Volcano*</li> </ul>	• Endocarditis, 2007, Defense*
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**Appendix 1. Continued**

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Dr. Peter L. Tilkemeier	None	None	None	None	None	None
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\*Indicates significant relationship.

ASE indicates American Society of Echocardiography; ASNC, American Society of Nuclear Cardiology; NCI caBIG, Cancer Biomedical Informatics Grid™ (caBIG™) initiative, National Cancer Institute; DICOM, Digital Imaging and Communications in Medicine; GE, General Electric; NASCI, North American Society for Cardiac Imaging; and SCCT, Society of Cardiovascular Computed Tomography.

**Appendix 2. Reviewer Relationships With Industry and Other Entities—ACCF/ACR/AHA/ASE/ASNC/HRS/NASCI/RSNA/SAIP/SCAI/SCCT/SCMR 2008 Health Policy Statement on Structured Reporting in Cardiovascular Imaging**

Peer Reviewer	Representation	Consultant	Speaker	Ownership/ Partnership/ Principal	Research	Institutional, Organizational or Other Financial Benefit	Expert Witness
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Dr. Jon Elion	Official Reviewer— DICOM	• Agfa Healthcare*— ended May 2008	None	None	None	• Chief Medical Agfa Healthcare (formerly Heartlab, Inc)* — ended in August 2007	None
Dr. Scott Flamm	Official Reviewer— SCMR	None	None	None	• Philips Healthcare  • Siemens Medical Solutions	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. Steven Goldstein	Official Reviewer— ASE	None	None	None	None	None	None
Dr. Karanvir Grewal	Official Reviewer— ASNC	None	• Astellas	None	None	None	None

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Appendix 2. Continued

Peer Reviewer	Representation	Consultant	Speaker	Ownership/ Partnership/ Principal	Research	Institutional, Organizational or Other Financial Benefit	Expert Witness
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Dr. Raymond Kwong	Official Reviewer— SCMR	None	None	None	None	None	None
Dr. Lawrence Liebscher	Official Reviewer— ACR	None	None	None	None	None	None
Mr. Kevin O'Donnell	Official Reviewer— MITA	None	None	None	None	• Toshiba Medical Systems*	None
Dr. Patricia Pellikka	Official Reviewer— ASE	None	None	None	None	None	None
Dr. Michael Poon	Official Reviewer— SCCT	None	None	None	None	None	None
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Dr. Gilbert Raff	Official Reviewer— SCCT	None	None	None	• Bayer* • Blue Cross Blue Shield of Michigan* • Siemens Medical*	None	None
Dr. Geoffrey Rubin	Official Reviewer— NASCI	None	None	None	None	None	None
Dr. Leslee Shaw	Official Reviewer— AHA	None	None	None	• GE Healthcare* • Lantheus*	None	None
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## Appendix 2. Continued

Peer Reviewer	Representation	Consultant	Speaker	Ownership/ Partnership/ Principal	Research	Institutional, Organizational or Other Financial Benefit	Expert Witness
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Dr. Christopher Kramer	Content Reviewer—ACCF Quality Strategic Directions Committee	None	• Merck/Schering-Plough	None	• Astellas* • Merck • Reliant Pharmaceuticals* • Siemens Medical Solutions*	None	None
Dr. Kim Allen 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

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\*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; AHRQ, Agency for Healthcare Research and Quality; ASE, American Society of Echocardiography; ASNC, American Society of Nuclear Cardiology; DICOM, Digital Imaging and Communications in Medicine; HRS, Heart Rhythm Society; MITA, Medical Imaging and Technology Alliance; NASCI, North American Society for Cardiovascular Imaging; NIH, National Institutes of Health; RSNA, Radiological Society of North America; SAIP indicates Society for Atherosclerotic Imaging and Prevention; SCCT, Society of Cardiovascular Computed Tomography; and SCMR, Society for Cardiovascular Magnetic Resonance.