Radiology

Toward Best Practices in Radiology Reporting[1]

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The goals and current efforts of the Radiological Society of North America Radiology Reporting Committee are described. The committee's charter provides an opportunity to improve the organization, content, readability, and usefulness of the radiology report and to advance the efficiency and effectiveness of the reporting process.

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Under the auspices of the American College of Radiology 2007 Intersociety Conference, representatives of the participating organizations recommended the use of structured reports to improve communication of radiology procedure results (1). Structured reports allow radiology report information to be recorded so that it can be retrieved and reused. Ideally, a structured report is divided into meaningful, consistently ordered sections and contains standardized language (2,3). Structured reporting organizes the contents of the radiology report and can facilitate retrieval of report content by both human readers and information systems.

The Radiological Society of North America (RSNA) subsequently established a Radiology Reporting Committee to identify and promote best practices in radiology reporting. The Committee, part of the Radiology Informatics Committee, includes radiologists and imaging informatics experts. The Committee convened a workshop in June 2008 to address the current state of structured reporting and to suggest a road map for the eventual adoption of structured reporting throughout radiology. Representatives of all radiology subspecialties were invited to the workshop, and more than 50 radiologists, medical physicists, and imaging informatics specialists participated. Fourteen speakers discussed the goals and challenges of radiology reporting. Representatives from cardiology, oncology, and surgical pathology organizations described the structured reporting initiatives and experiences in their fields. Small-group discussions focused on the clinical, operational, and technical aspects of reporting in radiology. This report presents the conclusions of the reporting workshop and lays out the work that the RSNA Radiology Reporting Committee will undertake in the year ahead.

Reporting as Communication

The clinical report is an essential part of every imaging procedure. A radiology report documents the important components of the study and the interpreting physician's analysis of the findings; it communicates information to the referring physicians, records that information for future use, and serves as the legal record of the episode of care. In addition to its clinical function, the radiologist's report may be used for billing, accreditation, quality improvement, research, and teaching. The report also may serve as a means for communication to the patient.

The primary goal of the radiology report is to communicate the results of the imaging procedure to the referring physician and/or the patient. The report must be accurate, easily understood, and appropriately thorough. Reports should employ clear, unambiguous language.

The information in radiology reports can have additional uses as well. For example, a radiology resident might wish to search reports to find recent examples of noncardiogenic pulmonary edema. A researcher might wish to identify patients with appendicitis whose computed tomographic (CT) reports described the appendix as normal. An oncologist might wish to graph the size or volume of tumors over time to better understand the effects of a specific treatment. Radiologists engaged in a practice-based quality improvement effort might wish to track whether or not their group's head CT reports explicitly mentioned the presence or absence of subarachnoid hemorrhage. Radiology report information that has been entered by using consistent formats and terminology can be more easily retrieved and analyzed to support medical research and quality improvement analyses and to assess features of the report itself.

Construed narrowly, structured reporting means the use of predefined formats and terms to create reports; in this sense, structured reports are those based on templates or checklists. In a broader sense, however, structured reporting can integrate additional information collected during the imaging procedure, such as clinical data, technical parameters, measurements, annotations, and key images (3). The rationale for structured reporting has been defined in a recent health policy statement endorsed by several medical specialty societies (4).

Structured reports allow automated or semiautomated abstraction of reporting data. These data can be used for research, teaching, and clinical quality improvement. Structured reporting tools provide the means for careful review of diagnostic accuracy and outcomes and can serve as the backbone of computerized clinical decision support during the interpretation and comparison of imaging studies. Structured reporting is the means to ensure the value added by radiologists to patient care. Because structured reporting benefits from the use of a well-defined, consistent, and universally adopted lexicon, this effort builds on the RSNA's RadLex® vocabulary, which provides a uniform approach to nomenclature for clinical radiology (5–7).

Components of a Radiology Report

The radiology report should include basic elements defined in the American College of Radiology's Practice Guideline for Communication, such as patient identifiers, imaging procedure descriptions, clinical indications, imaging findings, and summary information (8,9). The RSNA Radiology Reporting Committee established an initial consensus regarding the contents of report sections (Table).

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Abbreviations:
RSNA = Radiological Society of North America
XML = extensible markup language

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In addition to these essential report elements, reports may contain images and multimedia data, record critical results communication, and integrate information for decision support, data mining, quality improvement, and regulatory compliance. Reports containing critical findings should document the finding, its level of criticality, the person notified, and the date and time of notification. Reporting systems should tailor the presentation of reports to the needs of different report readers, such as patients, general practitioners, specialists, and radiologists. Workshop participants expressed the vision that reports should be modular, so that elements can be highlighted, deemphasized, or combined when reports are created or displayed on the basis of the needs of the user.

Operational Considerations

The clinical goal of a radiology department is to provide high-quality, cost-effective imaging services, which depends on intelligently designed processes, efficiently deployed resources, and effective performance monitoring (10). Structured reporting can address major operational needs of radiology practices, including patient throughput, report turnaround time, documentation of service, billing, regulatory compliance, and quality assurance. In academic and community practice settings, the most critical priorities from an operational standpoint are tools to improve results communication, regulatory and billing compliance, and quality assurance within a comprehensive document that catalogues the entire radiology encounter. A variety of quality metrics can be derived from the radiology report and related data (Figure).

We identified critical results reporting as an initial priority for development of structured reporting. Documentation of this communication is extremely important because a substantial number of clinical care errors involving radiology relate to flaws in the chain of communication (11,12). Instead of one-way communication from radiologist to referring physician, the radiology report could serve as an interactive medium to record the referring physician's acknowledgment of the observations and the actions taken to address them. Clear documentation of services provided and recommendations for care could be captured and mapped to appropriate administrative codes that will aid in billing and quality assurance.

The radiology report should record interactions between the patient and technologists, nurses, residents, or other individuals. For example, the technologist might document the contrast material dose and views or sequences, the nurse might record the medications, the resident might document the preliminary results, and the staff radiologist might enter the final interpretation (and double readings, if performed). The radiology report can provide multifaceted information about the patient's experience in the radiology department and culminates with

Components of the Radiology Report

Report Section	Content
Administrative information	Imaging facility
	Referring provider
	Date of service
	Time of service
Patient identification	Name
	Identifier (eg, medical record number or Social Security number)
	Date of birth
	Sex
Clinical history	Medical history
	Risk factors
	Allergies, if relevant
	Reason for examination, including medical necessity
Imaging technique	Time of image acquisition
	Imaging device
	Image acquisition parameters, such as device settings, patient positioning, interventions (eg, Valsalva maneuver)
	Contrast materials and other medications administered (including name, dose, route, and time of administration)
	Radiation dose
Comparison	Date and type of previous examinations reviewed, if applicable
Observations	Narrative description or itemization of findings, including measurements, image annotations, and identification of key images
Summary or impression	Key observations, inferences, and conclusions, including any recommendations
Signature	The date and time of electronic signature for each responsible provider, including attestation statement for physicians supervising trainees, if applicable

Quality metrics that can be derived from radiology report data
- Assessed quality of examination
- Compliance with appropriateness criteria
- Technical limitations
- Completeness of report
- Discrepancy from preliminary interpretation (either by direct comparison with the preliminary interpretation or by an indicator in the report of a discrepancy from preliminary interpretation)
- Errors in interpretation (by comparison with other information, such as secondary interpretations, clinical follow-up data, or subsequent imaging studies)
- Complications

List of quality metrics.

the imaging observations, inferences, conclusions, and recommendations. Because information in a structured report adheres to a predefined format and vocabulary, it is easier to integrate that information with generalized knowledge-based resources. Thus, one can more easily integrate the structured reporting process with clinical guidelines, collaborative staging tools, educational resources, and decision support.

Technical Considerations

To define the best practices in structured reporting, a technical framework is needed to store, disseminate, and implement reports in software applications. A knowledge representation that enables software applications to guide radiologists as they report cases is essential. One of the simplest and most practical knowledge representations is the report template: a list of reporting element placeholders that prompt radiologists as they create reports. The workshop participants recommended that such a knowledge representation be part of a broader technical framework for structured reporting that is based on open, standardized Web technologies such as extensible markup language (XML). XML documents can be viewed in Web browsers and can be edited in standard word processors (13). XML also facilitates interchange among health information systems through industry standards, such as the Health Level 7 Clinical Document Architecture and the Digital Imaging and Communications in Medicine Structured Reporting protocols.

The workshop participants agreed that controlled terminologies such as Systematized Nomenclature of Medicine–Clinical Terms (or SNOMED-CT) and RadLex enable unambiguous interpretation of reporting terminology. SNOMED-CT is a comprehensive clinical terminology, originally created by the College of American Pathologists, and is now owned, maintained, and distributed by the International Health Terminology Standards Development Organisation, a not-for-profit association in Denmark. RadLex, a lexicon developed, maintained, and distributed by the RSNA, provides standard terms for diseases, observations, and radiology procedures (6). Each RadLex term is identified by a unique code and can be connected to related terms, such as synonyms, acronyms, more specific or more general terms, and related linguistic variants.

Radiologists frequently apply measurements or other annotations to images. Such annotations often provide critical information to support observations and inferences that could be added to a radiology report. For example, with regard to an image that highlights an abnormality, a radiologist might tag the coordinates of the lesion with an appropriate term, label the images as a key image of the examination, and include it as part of the report. Additionally, measurements may form a critical part of an examination. For example, measurement of crown-rump length and biparietal diameter are key measurements of an antenatal obstetric ultrasonographic examination.

To represent these image annotations, including size measurements and other quantitative imaging information, the Reporting Committee intends to explore the use of the annotation and image markup project (14), which was developed as part of the U.S. National Cancer Institute's Cancer Biomedical Informatics Grid (known as caBIG) initiative. Annotation and image markup specifies what information to capture when making an annotation or an image markup. It contains placeholders for regions of interest, geometry, anatomic entities, observations, observation characteristics, and calculations that are typically included in annotations. Annotation and image markup also provides a means to communicate this information in either Digital Imaging and Communications in Medicine or XML representations, which can be included directly or indirectly in structured reports. Annotation and image markup allows one to replace the sentence, "There is a 4-cm mass, best seen in image 42," with well-defined, precise, and computable reference to the same information.

The workshop participants identified the Integrating the Healthcare Enterprise® initiative as a key partner in fostering the adoption of reporting standards by reporting system vendors. Integrating the Healthcare Enterprise is an organization that brings together commercial systems developers, nonprofit organizations, and consumers to define "integration profiles" that coordinate the complex interactions between systems to accomplish key clinical tasks. The Integrating the Healthcare Enterprise Radiology Reporting Workflow integration profile describes explicitly how a report creator interacts with a report manager and report repositories to accomplish a worklist-driven workflow. This integration profile may need to be revised, with requirements derived from the proposed structured reporting effort. A new integration profile could address the creation and access of a library of standard reporting templates.

Conclusions and Ongoing Activities

In the coming months, the RSNA Radiology Reporting Committee intends to do the following: *(a)* create and disseminate a best-practice template for the documentation of critical imaging test results in collaboration with the RSNA Quality Improvement Committee; *(b)* design an XML-based template format that could be used for collaborative authoring and that would be easily convertible into the current standards for radiology report format, including Health Level 7 Clinical Document Architecture and Digital Imaging and Communications in Medicine Structured Reporting; *(c)* develop at least one report template for an important clinical imaging scenario in collaboration with a subspecialty imaging group; and *(d)* establish a liaison to the Integrating the Healthcare Enterprise Radiology Planning Committee to coordinate with vendors of reporting systems.

The support and participation of general and subspecialty radiology organizations will be crucial to bring structured reporting into clinical practice, and the RSNA will continue to engage them actively. In particular, subspecialty societies are encouraged to begin considering clinically specific reporting templates, which will help guide the development of a standardized, open-source information model for radiology reporting. Once an integrated information model is developed, it will enable subspecialty societies and others to collaborate on the creation of reporting templates that can be adopted throughout the profession. These templates will serve as a resource for radiologists seeking a starting point to improve their reporting practices and for vendors seeking to incorporate structured information into their reporting products.

The goal of the RSNA Radiology Reporting Committee is not to define what content or format a specific report should include. Instead, it is the Committee's intent to help identify and promote best practices in radiology reporting templates that have been designed and approved by subspecialty societies, institutions, or radiology practices. The Committee hopes to create and make available a library of reporting templates that radiologists can adopt into their practices.

Appendix

The members of the RSNA Reporting Committee are Curtis P. Langlotz, MD, PhD, Chairman; Elizabeth S. Burnside, MD, MPH; John A. Carrino, MD, MPH; David S. Channin, MD; James R. Duncan, MD, PhD; Bradley J. Erickson, MD, PhD; Marta E. Heilbrun, MD; David M. Hovsepian, MD; Charles E. Kahn, Jr, MD, MS; Ramin Khorasani, MD; David S. Mendelson, MD; Daniel L. Rubin, MD, MS; Chris L. Sistrom, MD, MPH; and Ronald L. Arenson, MD, RSNA Board Liaison.

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