Radiology practice guidelines have been developed to help radiologists achieve quality and safety in their clinical practice. One means to promote the use of practice guidelines in radiology is through the wider use of reporting templates, also known as “structured reporting.” This article presents specific examples in which radiology reporting templates can promote adherence to guidelines, gather data for quality improvement efforts, and facilitate compliance with performance incentive programs.

**Key Words:** Clinical practice guidelines, reporting, quality, education, evidence-based radiology

physician order entry are tied to medication order entry, it is anticipated that the use of decision support eventually will encompass imaging as well. Such decision support systems require a solid base of evidence [5]. There is also an incentive for radiologists (and all physicians) to document compliance with specific imaging metrics via the linked CMS Physician Quality Reporting System (PQRS) [6]. By 2015, as with the meaningful use incentive, lack of participation in the PQRS will result in a penalty rather than an incentive.

The goal of this article is to present specific examples in which the use of radiology reporting templates, also known as structured reporting, can promote adherence to guidelines, provide data for quality improvement efforts, and support the meaningful use of EHRs.

**RADIOLOGY REPORTING TEMPLATES**

The RSNA has developed a library of more than 210 reporting templates contributed by radiology societies, institutions, and individuals [7]. This effort was undertaken in response to consensus at the 2007 ACR Inter-society Conference that the radiology report is a key area for practice improvement [8]. The open, online library (http://www.radreport.org) offers the templates both in text format, resembling dictation systems’ “speech macros,” and in extensible markup language for interoperability with information systems. DICOM Supplement 155, currently under development, seeks to define a standardized structure for radiology reporting templates and how reports based on such templates will be transmitted to EHR systems.

Unlike the ACR’s practice guidelines, which have been developed by expert panels, reviewed extensively, and approved by the ACR Council, the RSNA’s reporting templates are not intended to serve as national standards at this time. Radiologists may adapt and apply these templates to meet the needs of their clinical practice. The templates are designed to provide more standardized language and content yet offer a flexible way for radiologists to generate reports using existing reporting technologies. The elements of each reporting template are linked to terms in controlled vocabularies such as RadLex® [9,10] and the Systematized Nomenclature of Medicine—Clinical Terms® [11,12]. These vocabularies define the semantics of the terms used in the reporting templates and allow interoperability across different institutions, between different reporting systems, and even across languages.

**PRACTICE GUIDELINES**

To explore how template-based reporting might facilitate compliance with radiology practice guidelines, we explored 4 ACR practice guidelines in detail. We selected guidelines across a variety of scenarios: radiographic and digital imaging examinations, adult and pediatric patient populations, and diagnostic and interventional procedures. The guidelines included esophagography [13], radiographic skeletal survey (for suspected physical child abuse) [14], noncontrast head CT in the setting of stroke [15], and percutaneous nephrostomy [16].

**Esophagography**

**Clinical Indications.** Single-contrast and double-contrast (biphasic) examinations of the esophagus are proven and useful procedures for evaluating the presence, nature, and extent of esophageal disease. The ACR Practice Guideline for the Performance of Esophagrams and Upper Gastrointestinal Examinations in Adults [13] itemizes indications for esophagography (Table 1). The corresponding reporting template provides this list as a set of optional items to be incorporated into the report. By listing potential indications, the radiology report can be used to capture data about the patient, including the symptoms that prompted the examination. If an item is included, one can provide additional details that pertain to that item. For example, one might include the element for “dysphagia” and provide a comment to indicate “present for 3 months, worse with solids.” The reporting template includes “free text” fields to allow radiologists to incorporate information other than the preselected items (Fig. 1).

**Fluoroscopy Time.** The esophagography reporting template includes a field to indicate fluoroscopy time (in minutes). This field prompts the reporting physician to incorporate this important piece of information, which can be used to meet the goals of PQRS measure 145 to compute the percentage of final reports for procedures using fluoroscopy that include documentation of patient radiation exposure or exposure time [6]. Furthermore, the fluoroscopy times can be averaged by the radiologist and provided as feedback to the division or department for comparison of these times per radiologist to arrive at a reasonable target for the group. Achieving a target fluoroscopy time also may be used for individual focused professional practice evaluation and ongoing profes-

<table>
<thead>
<tr>
<th>Table 1. Indications for esophagography</th>
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<tr>
<td>1. History and symptoms</td>
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<tr>
<td>a. Chest pain of suspected noncardiac origin</td>
</tr>
<tr>
<td>b. Symptomatic or suspected gastroesophageal reflux</td>
</tr>
<tr>
<td>c. Dysphagia</td>
</tr>
<tr>
<td>d. Odynophagia</td>
</tr>
<tr>
<td>2. Conditions to evaluate</td>
</tr>
<tr>
<td>a. Suspected or known motility disorders</td>
</tr>
<tr>
<td>b. Esophagitis</td>
</tr>
<tr>
<td>c. Strictures</td>
</tr>
<tr>
<td>d. Varices</td>
</tr>
<tr>
<td>e. Neoplasms</td>
</tr>
<tr>
<td>f. Esophageal obstruction</td>
</tr>
<tr>
<td>g. Postoperative assessment</td>
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Use of Coded Information. The schema for reporting templates provides a specification for coded information, such as dose indices, to be extracted from imaging procedure information. The esophagography report template is coded with a RadLex Playbook identifier, which identifies the procedure so that equivalent procedures can be mapped across institutions (http://rsna.org/RadLex_Playbook.aspx). Indications, such as dysphagia, are mapped to terms in RadLex and/or the Systematized Nomenclature of Medicine—Clinical Terms. In that way, one can easily extract information from the completed reports to correlate the indications for the examination and whether the results were positive. Ideally, one would wish to correlate the indications and test results more broadly with other health outcomes. The coded value for fluoroscopy time will allow information to be extracted from the report for entry into radiation dose registries. Although not presently collected as part of the ACR Dose Index Registry or the General Radiology Improvement Database, fluoroscopy time is envisioned for incorporation within the next few years (L. Coombs, personal communication, March 2012). By consistently recording fluoroscopy time, radiologists will be better able to track this information, identify best practices, and potentially reduce radiation dose and thus improve patient safety.

Skeletal Survey for the Investigation of Child Abuse

Clinical Indications. The ACR–Society for Pediatric Radiology Practice Guideline for Skeletal Surveys in Children [14] identifies 3 possible indications for skeletal survey examinations, for which the condition may be known or suspected: (1) physical abuse in infants and young children; (2) skeletal dysplasias, syndromes, and metabolic disorders; and (3) neoplasia and related disorders. By prompting for these reasons as part of the reporting template, one can capture statistical data about the indications for the examination and the corresponding number of examinations with abnormal (positive) results.

Procedure Performed. The minimum complete skeletal survey examination consists of 21 radiographs, as detailed in Table 2. A radiologist’s reporting template could allow one to check off the views obtained or to flag those not obtained; such information could be used to monitor examination quality.

Detection and Communication of Abnormalities. The official interpretation of the examination should provide a concise description of all sites of definite and suspected abnormality. The practice guideline stipulates, “When a constellation of radiographic findings is sufficient to raise strong suspicion of abuse, this should be so stated in the radiology report and communicated to the referring physician, and this communication should be documented in the final report.” Because one is often legally required to notify local child protection authorities in cases of suspected child abuse, there are settings in which the radiologist may be required to do so if the referring physician does not report the case. The reporting template could be structured to provide a field to capture informa-

Table 2. Skeletal survey radiographs for the evaluation of nonaccidental trauma

<table>
<thead>
<tr>
<th>Appendicular skeleton</th>
<th>Axial skeleton</th>
</tr>
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<tbody>
<tr>
<td>● Humeri (AP)</td>
<td>● Thorax (AP, lateral, right and left obliques), to include ribs, thoracic and upper lumbar spine</td>
</tr>
<tr>
<td>● Forearms (AP)</td>
<td>● Pelvis (AP), to include the mid lumbar spine</td>
</tr>
<tr>
<td>● Hands (PA)</td>
<td>● Lumbarosacral spine (lateral)</td>
</tr>
<tr>
<td>● Femurs (AP)</td>
<td>● Cervical spine (lateral)</td>
</tr>
<tr>
<td>● Lower legs (AP)</td>
<td>● Skull (frontal and lateral)</td>
</tr>
</tbody>
</table>

Note: AP = anteroposterior; PA = posteroanterior.
tion about the communication of the results to the referring physician and child welfare authorities. Placeholders in the report template can help ensure that the correct actions take place and that radiologists record those actions appropriately (Fig. 2).

Noncontrast Head CT for Stroke
The ACR and the American Society of Neuroradiology have defined a practice guideline for the performance of CT of the brain [15]. PRQS measure 10 requires that every noncontrast head CT examination identify whether a mass, an intracranial hemorrhage, or an acute infarction is present [6]. Because radiologists’ reimbursement from Medicare eventually will depend on their compliance with this requirement, it is useful to incorporate such information into the reporting template.

The PQRS measure is defined as follows: “For patients aged 18 years and older with either a diagnosis of ischemic stroke or TIA [transient ischemic attack] or intracranial hemorrhage OR at least one documented symptom consistent with ischemic stroke or TIA or intracranial hemorrhage that includes documentation of the presence or absence of each of the following: hemorrhage and mass lesion and acute infarction.”

Thus, the noncontrast head CT report template might prompt the radiologist to state, “There is no evidence of hemorrhage, mass lesion, or acute infarction” or, if the radiologist chooses, to specify the presence or absence of each observation individually.

Percutaneous Nephrostomy
The ACR and the Society of Interventional Radiology have defined a practice guideline that sets out proper indications, materials, and reporting standards for the performance of percutaneous nephrostomy [16] as well as a guideline on the reporting and archiving of interventional radiology procedures [17]. Proper documentation of interventional procedures requires a record of informed consent, preprocedural time-out, description of the procedure performed, materials used, patient complications, and fluoroscopy time. By prompting the radiologist to incorporate these elements in the report, the reporting template promotes compliance with the corresponding practice guideline and ensures complete documentation for billing, compliance initiatives such as PQRS measure 145 for fluoroscopy time, and quality review.

Clinical Indications. The practice guideline lists the most common indications for nephrostomy. By listing potential indications, the radiology report can systematically and uniformly capture patient-specific and procedure-specific data, including the symptoms that prompted the examination. The guideline also suggests a trigger for a quality assurance review if, in more than 5% of cases, the procedure is performed for non-standard indications.

Complication Rates and Thresholds. The Society of Interventional Radiology has developed a standardized terminology for reporting complications of interventional radiologic procedures [18,19]. Such an approach could allow radiologists to aggregate information about complications from individual radiology practices into a regional or national data registry. Registries allow benchmarking (comparing one’s own practice with national norms) and trend analysis (tracking national or local complication rates over time). Each interven-
tional radiology report should contain structured fields for documentation of the most frequent complications so that they may be tracked. For example, nephrostomy procedures have risks of septic shock, hemorrhage, and pleural complications. The literature suggests that the success rate for relieving obstruction is 85% to 98% and that the complication rate is 0.1% to 14% [20]. By incorporating specific elements into the template, it is possible to evaluate performance relative to evidence-based expectations.

**DISCUSSION**

This article draws upon practice guidelines and reporting templates for 4 specific radiologic procedures to illustrate how structured reporting can improve consistency, capture mandated quality metrics, and promote guideline-based care. The primary goals of structured reporting initiatives to date have been to facilitate the creation of imaging reports and to make them easier for referring physicians to read and understand [21]. However, template-based reports clearly have additional advantages. By prompting the reporting physician to include specific pieces of information, the templates can make reports more uniform and complete. Detailed information within the report can help ensure that performance-related data are described systematically. Standardized text can assist the radiologist in disseminating professional society guidelines. Structured reports can provide a framework from which coded values may be extracted routinely into a database to allow data mining. Finally, structured reporting can facilitate the capture and encoding of information that is necessary for decision support.

The CMS PQRS provides incentive payments to physicians who voluntarily and satisfactorily report data on quality measures for covered professional services. The PQRS is mandated by federal legislation and implemented through a series of published regulations. In 2012, successful reporting of measures will qualify individual providers for payments equal to 0.5% of their total estimated Medicare Part B Physician Fee Schedule allowed charges. However, after 2014, this incentive will become a penalty [6]. Two of 5 PQRS measures relevant to radiologists are described in detail in the examples provided above. With a field for fluoroscopy time in the esophagography report, it becomes a simple process to compute the percentage of fluoroscopy procedures that document radiation exposure time (to meet the 50% minimum target). By requiring the systematic documentation of hemorrhage, mass lesion, and acute infarction in the noncontrast head CT template, the radiologist can provide appropriate patient care and avoid penalties for omitting required information.

Standardized report text could help the radiologist capture information to develop benchmarks for practice and to disseminate professional society guidelines. For percutaneous nephrostomy, a template can provide the information for which consistently defined data could be collected across enterprises and aggregated to build national registries of clinical outcomes, radiation dose, and complication rates. As more data are collected from benchmarking, the quality thresholds might be tailored to represent more accurately the acuity mix at a given institution.

Reporting templates can serve as an educational tool to help radiologists achieve best practices. Direct evidence of this benefit of structured reporting does not yet exist. However, studies have highlighted gaps in compliance with PQRS measures and variability in practice recommendations [22,23]. In one study, only 58% of CT and MRI examinations for suspected stroke specifically documented the presence or absence of hemorrhage, mass, and acute infarction to comply with PQRS measure 10 [23]. A 2008 survey [24] demonstrated a gap between knowledge of the Fleischner Society guidelines for the management of small, incidentally detected lung nodules [25] and their use in practice. In one series, only 34% of radiology reports included recommendations consistent with the guidelines [22]. Unlike practice guidelines, which may not be available at the point of care, reporting templates provide a ready-made reminder script that radiologists can choose to apply. BI-RADS is the best known example of the use of controlled terminology and structured reporting to promote adherence to guidelines [26,27].

By creating standardized text that is easily inserted into a report at the time of dictation, one can improve the dissemination of guidelines, compliance with guidelines, and study of their impact. Many radiology residents train at institutions with speech recognition systems for dictating reports that typically include “macros” of prespecified text or “fill-in-the-blank” forms. By incorporating reporting templates into their training, residents are prompted to include necessary elements in their reports [28]. With the establishment of benchmarks, it will be possible to conduct studies that evaluate which specific tools, including structured reporting, best enable radiologists to adapt to changing practice requirements.

The examples in this article demonstrate potential benefits and opportunities created by template-based reporting. It is important to acknowledge significant limitations in the current state of structured reporting. A study that systematically compared the quality of reports created using a structured reporting system with that of free-text dictation found that structured reporting reduced both accuracy and completeness; participants indicated that the reporting system was constraining and time inefficient [29]. On the basis of this experience, it was suggested that structured reporting systems be further optimized to focus on ease of use and on agreement with standardized lexicons. There remains a gap between the currently available structured templates, the ease with which they are incorporated into speech recognition and
dictation systems, and the measurement of their benefits. However, both the template library and systematic review of current practice are creating the tools and opportunities for radiology reporting practices to change and adapt to compliance requirements.

CONCLUSIONS
As the ACR practice guidelines state in their preamble, “Guidelines are an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. They are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care.” Radiology reporting templates can promote the use of practice guidelines to improve the quality and safety of clinical practice and can form a framework to support evidence-based radiology. We believe that the ACR should work to refine and improve radiology reporting templates and should recommend their use.

REFERENCES