Creation of an Open Framework for Point-of-Care Computer-Assisted Reporting and Decision Support Tools for Radiologists

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Abstract

Decreasing unnecessary variation in radiology reporting and producing guideline-concordant reports is fundamental to radiology's success in value-based payment models and good for patient care. In this article, we present an open authoring system for point-of-care clinical decision support tools integrated into the radiologist reporting environment referred to as the computer-assisted reporting and decision support (CAR/DS) framework. The CAR/DS authoring system, described herein, includes: (1) a definition format for representing radiology clinical guidelines as structured, machine-readable Extensible Markup Language documents and (2) a user-friendly reference implementation to test the fidelity of the created definition files with the clinical guideline. The proposed definition format and reference implementation will enable content creators to develop CAR/DS tools that voice recognition software (VRS) vendors can use to extend the commercial tools currently in use. In making the definition format and reference implementation software freely available, we hope to empower individual radiologists, expert groups such as the ACR, and VRS vendors to develop a robust ecosystem of CAR/DS tools that can further improve the quality and efficiency of the patient care that our field provides. We hope that this initial effort can serve as the basis for a community-owned open standard for guideline definition that the imaging informatics and VRS vendor communities will embrace and strengthen. To this end, the ACR Assist™ initiative is intended to make the College's clinical content, including the Incidental Findings Committee White Papers, available for decision support tool creation based upon the herein described CAR/DS framework.

Key Words: Radiology, quality, guideline, clinical decision support, reporting, structured, standardized, value

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INTRODUCTION

Radiologists practice in a broad field, where even a single imaging examination can present significant findings that cross multiple systems and specialty guidelines. For example, an abdominal CT might show congenital pathology of the hepatobiliary system, traumatic injury to the musculoskeletal system, or an infectious disease of the genitourinary tract. Thus, a radiologist must feel comfortable interpreting across a wide range of imaging findings complicated by an even wider range of clinical contexts to produce diagnostic impressions that meaningfully guide clinical care and remain concordant with the variety of prevailing clinical standards. To provide the necessary flexibility to meet this challenge, radiology has traditionally embraced an open-ended style of reporting. However, this open-ended reporting practice has also resulted in undesirable variability between radiologists that can frustrate referring physicians and complicate patient care [1-4].

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To reduce unnecessary report variability, there has been a robust push in recent years toward increased structure and standardization in radiology reporting. The most notable example is in the field of breast imaging where the ACR developed and promulgated the BI-RADS. BI-RADS includes a standardized lexicon for description of breast imaging findings and their clinical management. Backed by a federal mandate, the BI-RADS system has achieved ubiquitous use throughout the United States, resulting in a much lower degree of variability in the reporting of breast imaging findings.

Partially driven by the success of BI-RADS, other areas of radiology have promulgated similar report standardization efforts across a variety of clinical scenarios. For instance, CMS has required since 2015 the use of standardized lung nodule identification, classification, and reporting system for reimbursement for lung cancer screening. Many screening programs are using the Lung CT Screening Reporting and Data System (Lung-RADS) to meet this requirement—a structured reporting system similar to BI-RADS [5,6]. Likewise, professional groups have developed a panoply of evidence- and consensus-based guidelines, practice parameters, and technical standards (henceforth referred to in aggregate as "clinical guidelines" for the sake of simplicity), including the ACR white papers on incidental findings, the Fleischner Society for Thoracic Radiology guidelines for management of pulmonary nodules, and the Society of Radiologists in Ultrasound guidelines on the management of thyroid nodules, just to name a few [7-9]. However, unlike BI-RADS and Lung-RADS, use of these clinical guidelines and practice standards has been inconsistent at best, with a high degree of report variability persisting in these imaging areas [10-15].

ADDRESSING UNNECESSARY REPORT VARIABILITY IN RADIOLOGY

Many explanations have been proffered for the ongoing widespread variation in radiologist practice from published guidelines. One important contributing factor has been the limited integration of clinical guidelines into the radiologist workflow. Point-of-care clinical decision support solutions, such as electronic medical record (EMR)-based "best practice alerts," have been shown to improve compliance with guidelines in other areas of medicine [16,17]. However, these EMR-based systems are less likely to be effective in meaningfully impacting radiologist practice given that the EMR is not typically central to the radiologist workflow. A more successful point-of-care integration strategy in radiology would instead focus on the PACS or voice recognition software (VRS).

Our group set out to develop a computer-assisted reporting and decision support (CAR/DS) framework that could systematically integrate clinical guidelines into the VRS, the radiologist's tool for report generation [18]. Our CAR/DS framework is intended to allow guideline-creating groups, like the ACR, to define clinical guidelines in a standard, open definition language. Commercial VRS and PACS could then leverage these guideline-specific definitions to present the clinical guidelines as a clinical decision support interaction at the time of interpretation.

For example, the ACR could encode the available ACR white paper guidelines for the workup/management of an incidentally discovered adrenal nodule on CT into the CAR/DS framework. Then, when a radiologist encounters an incidental adrenal nodule in clinical practice, the CAR/DS tool within the VRS could aid the radiologist to provide the necessary descriptions of the adrenal nodule (eg, size, presence of macroscopic fat, stability from prior imaging examinations), determine the appropriate workup/management based on the guidelines, and automatically generate and insert standardized language of the imaging findings and necessary clinical follow-up into the report. We believe that this type of workflow-integrated tool would improve standardization of radiologist descriptions across clinical scenarios and result in significantly higher compliance with prevailing care guidelines [19].

CAR/DS GUIDELINE DEFINITION LANGUAGE

A CAR/DS guideline must define all the potential data elements that serve as the inputs and outputs of radiologic clinical guidelines. Likewise, it must define the branching logic rules by which inputs are turned into outputs and specify the appropriate report language for each of these potential outputs. Therefore, at the highest level, a CAR/DS guideline definition contains descriptive metadata, data element definitions, a flowchart-like logic tree, and a set of templates associated with the possible end points. Extensible Markup Language (XML) with a defined schema was chosen as the default base file format to express the clinical guidelines as structured, machine-readable definition documents [20]. We used RelaxNG Compact Syntax as the syntax for expressing the guideline definition language schema [21]. RelaxNG Compact Syntax has the advantages of compactness and ease of use, with freely available tools that permit the transformation of this schema into the more widely supported XML Schema Definition syntax.