Augmented Image Interpretation Through the Use of Advanced Health Record Technology

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INTRODUCTION TO THE PROBLEM

Current adoption and dissemination of electronic health record (EHR) systems has been driven by the initiatives of the Health Information Technology for Economic and Clinical Health Act of 2009 and its "meaningful use" incentive program. The impetus behind this subsidy stemmed from a body of literature demonstrating that health care technologies such as EHR systems can improve aspects of care in which the United States has fared poorly, namely, quality, safety, efficiency, and cost [1-3]. David Blumenthal, the former national coordinator for health IT at the Department of Health and Human Services, has argued that EHR systems will "improve caregivers' decisions and patients' outcomes" and "mark our progress toward electronically connected, information-driven medical care" [4]. Given this backdrop and the now high diffusion of EHR systems, there will be increasing pressure on caregivers to leverage EHR data to deliver higher quality services [5]. The question is, how will imaging departments respond to this charge and are they equipped to do so?

An EHR is a software system that serves as a database, capturing and storing a wide range of clinical information and events in a health care enterprise. This information can be leveraged to achieve health care performance goals across specialties. At the same time, although EHR information has the potential to improve the quality and safety (and, indirectly, the cost) of imaging services, many radiologists experience delay and difficulty integrating relevant clinical EHR information in a timely and organized fashion into their workflow [6]. Moreover, this inability to access relevant information at the time of care delivery may lead to increased recommendations for additional imaging, further exacerbating inappropriate imaging utilization [7].

WHAT WE DID TO ADDRESS THE PROBLEM

To address these limitations, a team of clinicians and software developers within the Massachusetts General Hospital informatics division developed the Queriable Patient Inference Dossier (QPID), a health intelligence platform for the EHR on which search queries can be programmed. QPID allows the automation of information retrieval by clinical concept and can serve as a tool to study the integration and added value of automated EHR information retrieval in imaging. Such retrieval offers key advantages over existing systems that provide no or limited manual search, including the ability to search on the basis of a clinical question such as "Does my patient have a history of cancer?" and the ability to integrate a series of searches into a clinician-driven dashboard tailored to the type of care delivered by a specialist.

Preliminary data suggest that these capabilities can improve imaging workflow efficiency and safety [8]. Moreover, previously published data indicate that radiologists expend up to 21% of their diagnostic effort in manually searching the EHR for salient information necessary to formulate their interpretations, making automated information retrieval a tool that can improve the efficiency of diagnostic interpretation [9].

The purpose of our study is to assess whether QPID-driven dashboards, specifically tailored for abdominal MRI, can reduce interpretation time when integrated into the clinical workflow.

Testing the System

The research was conducted under institutional review board approval (Partners HealthCare institutional review board protocol 2010 P001849). Initial identification and mapping of salient data points were conducted in conjunction with domain experts in abdominal MRI to program QPID searches to cull relevant information, both

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structured and unstructured data, from the EHR. The accuracy and completeness of the resulting queries were validated against a manual EHR search across 60 abdominal MRI requisitions using a previously published methodology [10]. Next, specialized dashboards to display QPID query results were constructed for three abdominal MRI examination types: liver, prostate, and rectal. In addition to the search queries, cancer staging tables and other helpful resources, dubbed RadAdvisor, were added to the dashboards to assist radiologists in their image interpretations (see Fig. 1).

Imaging Studies

Forty-eight consecutive MRI examinations (16 each of liver, prostate, and rectal) performed between January and February 2013 were selected randomly and divided into two equal groups on the basis of anatomic location and level of history provided with the study request (limited or detailed). Examples of a limited history include "focal liver lesion," "prostate cancer," and "rectal cancer." Any additional information, such as "cancer staging," reference of subtype of liver lesion favored by the referring physician, or prostate-specific antigen level, for example, qualified the case for the detailed history group.

Image and Medical Record Analysis

Each examination was interpreted by four postgraduate year 5 trainees blinded to the original report and to the interpretations of the other readers. Interpretation included review of the images, review of the medical record, and generation of a formal report using voice recognition (Nuance Communications, Burlington, Massachusetts). Each reader was randomly assigned to one of two crossover arms: interpretation using an existing traditional EHR-driven workflow with manual information retrieval (Clinical Application Suite [CAS]; Partners HealthCare Information Systems, Boston, Massachusetts) or using a QPID dashboard–driven workflow after an initial baseline training period. Images were reviewed on a routine clinical workstation in the presence of a research assistant who recorded the interpretation time spent by each trainee for each study in both arms. Interpretation time started from the moment the images were opened and ended when the report signed off. Independent variables included sequential order of method used for review, review method, anatomic location, and level of history provided with the study request. The dependent variable was time expended on EHR search.

Statistical Analysis

Two sets of statistical analyses were conducted, one using unadjusted case review times and one using case review times adjusted for complexity of case.

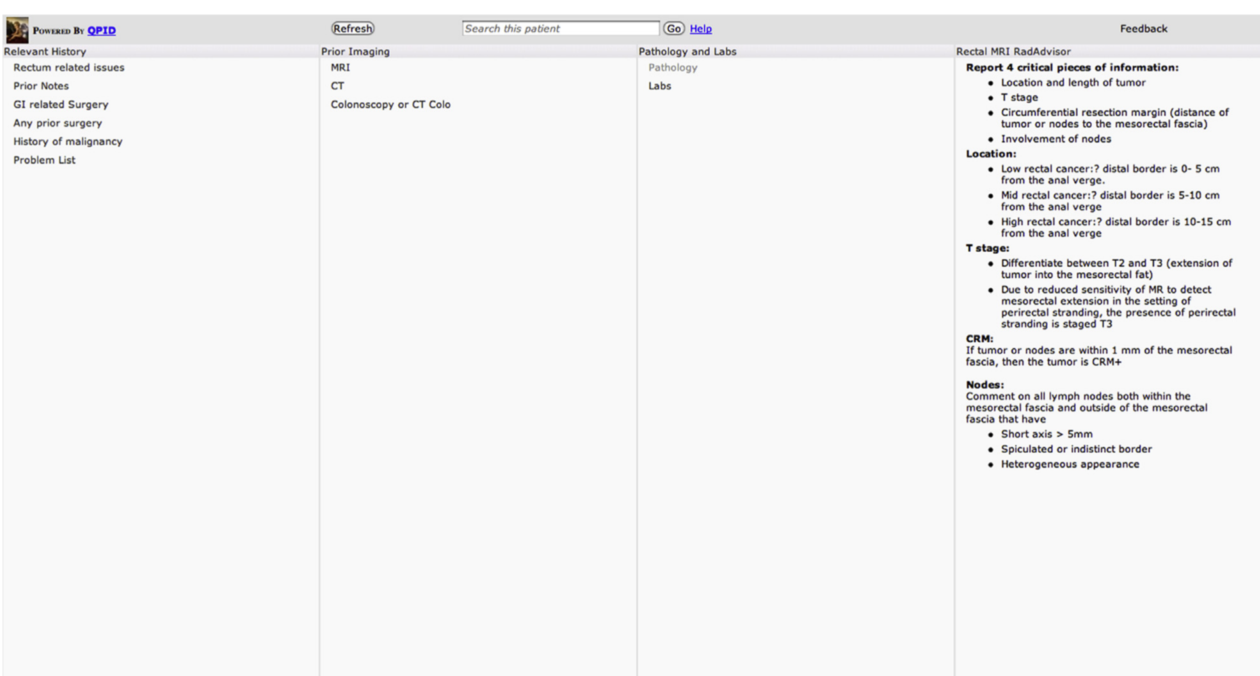

Fig 1. Queriable Patient Inference Dossier (QPID) dashboard for rectal MRI.