

Electronic Health Record—Driven Workflow for Diagnostic Radiologists

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Abstract

In most settings, radiologists maintain a high-throughput practice in which efficiency is crucial. The conversion from film-based to digital study interpretation and data storage launched the era of PACS-driven workflow, leading to significant gains in speed. The advent of electronic health records improved radiologists' access to patient data; however, many still find this aspect of workflow to be relatively cumbersome. Nevertheless, the ability to guide a diagnostic interpretation with clinical information, beyond that provided in the examination indication, can add significantly to the specificity of a radiologist's interpretation. Responsibilities of the radiologist include, but are not limited to, protocoling examinations, interpreting studies, chart review, peer review, writing notes, placing orders, and communicating with referring providers. Most of the aforementioned activities are not PACS-centric and require a login to one or more additional applications. Consolidation of these tasks for completion through a single interface can simplify workflow, save time, and potentially reduce the incidence of errors. Here, the authors describe diagnostic radiology workflow that leverages the electronic health record to significantly add to a radiologist's ability to be part of the health care team, provide relevant interpretations, and improve efficiency and quality.

Key Words: Electronic health records, EHR, radiology information system, RIS, EHR-driven workflow

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INTRODUCTION

Most radiologists agree that clinical data are important for creating focused and relevant reports [1,2]. Radiologists can use patient-specific information to help generate a useful differential diagnosis and drive an educated second look at an area of clinical concern [2-6]. Unfortunately, important clinical data are often missing from the order [1].

Here, we share a model of radiology workflow that enhances a radiologist's ability to provide more meaningful interpretations and interact with the health care team through the shared electronic health record (EHR). We term this model EHR-driven workflow. We have used this model through local configuration of our EHR (Epic versions 2010-2014; Epic Systems, Verona,

Wisconsin) since 2011 at our large academic practice. Benefits include centralization of radiologist tasks, streamlining of workflow, improved interoperability, and placement of clinically relevant data points at the radiologist's fingertips during image interpretation. The purpose of this report is to describe EHR-driven workflow.

EHR-DRIVEN WORKFLOW

The Concept

Workflow in radiology can be described by the interface with which the radiologist interacts to select a study for interpretation, whether it is a PACS, a radiology information system (RIS), a third-party workflow engine, or the EHR. The EHR is understood to be the potentially all-inclusive system for accessing, entering, and storing patient data and managing workflow throughout a health care enterprise.

PACS-driven workflow is appropriately named because radiologists interpret studies on the basis of work lists in the PACS. Most commonly with this workflow today, the only clinical information immediately available to the radiologist is the "reason for examination" accompanying the order; however, a small but growing

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Dr Gaskin receives author royalties from Thieme Medical Publishers and Oxford University Press. Dr. Geeslin has no conflicts of interest related to the material discussed in this article.

number of practices have integrated their EHRs or other third-party applications to stay synchronized in patient context with the PACS to improve accessibility of clinical data. A limitation is that there may be discrepancies in examination status (ie, unread, read, preliminary, final, or addendum) between the PACS and the true master of examination status, which is the RIS-EHR.

In RIS-driven workflow, the radiologist still performs interpretations with the PACS, but imaging studies are queued for interpretation by work lists in the RIS. In this setting, the radiologist interacts with the RIS to drive the PACS; therefore, smooth integration of the applications, often across different vendors, is crucial. This additional complexity may be one reason RIS-driven workflow is much less common than PACS-driven workflow, despite added potential benefits to include fewer discrepancies in examination status, easier sharing of technologist-examination data, and enhanced features for prioritization.

EHR-driven workflow can be performed most naturally with a single-vendor RIS-EHR. In this setting, the EHR containing a RIS-like module can be used to generate a reading work list, which then directs the PACS to display selected studies. Because study selection originates in the EHR, it creates opportunities to (1) prescribe relevant patient data from the EHR for automated display and (2) set up easy access to any remaining EHR data. The radiologist reads the study in the PACS with the full electronic chart open, not just in patient and study context but with prescribed clinical data already on display. Because workflow is centered in the EHR, when the radiologist is not reading studies, he or she is naturally positioned to do other physician tasks, including protocoling studies; signing orders; signing reports; peer review activities; critical results tracking; results review; teaching files; clinical note writing; reviewing schedules, administrative reports, and audit trails; and communicating with referring providers about patients through the EHR in the same manner as these providers communicate among themselves. Because this single-vendor RIS-EHR workflow is distinct from RIS-driven workflow as described earlier, we call it EHR-driven workflow.

The Practice

Depending on reading room environment, our diagnostic workstations for radiologists may use two to four monitors dedicated to image display with the PACS (Carestream Vue PACS; Carestream Health, Rochester, New York). We use an additional 24-inch administrative

monitor in portrait mode to simultaneously display our EHR and our speech recognition software. We find it convenient to have sufficient monitor size to simultaneously display both the EHR and the speech recognition software.

User-configurable dashboards of clinical activities can be created within the EHR because the application intrinsically houses the relevant information. For example, a dashboard might include items such as protocoling work lists, reading work lists, signing work lists, peer review activities and productivity statistics, as well as chart work pending completion such as orders to sign, laboratory results to review, and messages from referring providers or other health care workers. The dashboard offers an at-a-glance status update for gauging obligations at any moment while also functioning as a launch pad to initiate activities on the basis of preference or the most pressing need.

The EHR can provide a highly functional workflow engine because it intrinsically houses the relevant clinical information. Consider that when one uses the PACS or a third-party engine to drive workflow, the data used for sorting or prioritizing studies originated in the EHR. Therefore, the EHR is strategically positioned for routing and prioritizing studies on a reading or protocoling work list without need for an interface or a third-party application. Rules may simply be applied to data already housed in the EHR to drive workflow. For example, at our site, we have subspecialty-specific reading work lists, which include inpatients, outpatients, emergency department (ED) patients, interpretations of outside studies, and teleradiology studies folded into common work lists. These unified lists allow workload sharing across multiple readers and sites, leading to improved utilization of radiologist resources and best opportunity to get urgent studies read first by the next available radiologist. Studies are prioritized for reading on the basis of a nine-point prioritization score [7] and secondarily by time since examination completion.

If a radiologist believes a study appears on his division's work list in error, he can easily reassign it to the proper work list or to a specific individual. Because all information regarding the examination is housed within the EHR, a convenient audit trail allows any radiologist to see the path of any study from order placement to its current state.

Schedules. Radiologists may be interested in a variety of schedules, which are readily available through EHR-driven workflow because this information typically

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