Real-time Workflow Monitoring System for Emergency Radiology

Mark S. Frank, MD, MBA, Indiana University Health (Presenter); Alice M. Mitchell, MD; Marc D. Kohli, MD; Scott D. Steenburg, MD; Kenneth A. Buckwalter, MD, MBA

Background

Our multi-facility organization performs over 200,000 ER radiology examinations per year. Our emergency physicians report that a substantial portion of their verbal communication with the radiology department involves tracking the progress of pending radiology examinations and report availability. Occasionally an examination will become stalled in workflow secondary to idiosyncratic events that can occur in our medical imaging and reporting chain. An exam can go unreported for extended periods of time, potentially delaying diagnosis and care for a critically ill patient. Causes are many and include both human errors (e.g., exam accidentally marked as dictated in PACS but not actually reported) and technology errors (e.g., exam reverts from "complete" to an incomplete status on PACS whenever a modality sends additional data). In such cases, the unreported exam becomes invisible on PACS to radiologists. Finally, our ER clinicians report that lack of visibility of radiology work-in-progress encumbers their time management as well as their communication of helpful status information to patients.

We hypothesized that these conditions could be mitigated by providing a means for automated real-time monitoring of ER radiology workflow as an adjunct to our EMR and radiology information systems.

Case Presentation

Our strategy was to develop a system to give ER clinicians and radiologists user-friendly real-time end-to-end status information for ER radiology workflow. The system provides a web-centric automatically refreshing dashboard that conveys key workflow transitions for each and every radiology examination performed in our emergency department. An exam becomes listed on this dashboard as soon as an electronic order is placed in our EMR. For each exam, a clinician can confirm: 1) That an exam has indeed been ordered, 2) That the exam has actually been performed and that images are available, 3) That a dictation has been started and by whom, and 4) That a final-signed radiologist's report is available. Once an exam has been ordered, the dashboard displays waiting time for exam completion. When an exam has been completed, the dashboard displays the waiting time for a radiologist's interpretation with color coding (Figure 1) to facilitate early identification of outliers including examinations potentially lost in workflow. Exams with final reports are automatically removed from the dashboard after a prescribed period.
Our approach draws upon real-time electronic data transmitted in HL7 format by our electronic medical record (Cerner/Radnet) and our digital dictation system (Powerscribe 360), and includes order activity, radiology results, and dictation activity (Figure 2). The information is merged and analyzed in real-time to generate a comprehensive, dynamically refreshed overview of radiology work-in-progress. The dashboard displays workflow status for every exam along with one-click access to the patient's X-ray folder in PACS as well as one-click viewing of a final report when available.

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Outcome

The system addresses an unmet need for us, namely expeditious, user-friendly access to real-time workflow status for every ER radiology exam. In the absence of a consolidated means for real-time monitoring, the activities involved in finding and rectifying delayed and/or lost examinations are inexact, inefficient, and time-consuming, requiring ER and radiology personnel to interrupt clinical activities to survey multiple
reporting systems and initiate frequent phone calls to nurses, technologists, and other staff.

Our system typically reveals that 5 to 10 ER radiology examinations per day (of the several hundred performed by our emergency departments) become delayed or lost in workflow. Whenever an exam has been logged as completed in the EMR/RIS yet the EMR is without a radiologist's report for a prescribed period, the exam becomes color-coded on the dashboard to facilitate instant identification. Without early intervention, there is downstream delay in availability of a final report, often for several hours. In addition to providing real-time status information to our radiologists and clinicians, the system facilitates monitoring and intervention by staff members familiar with the steps involved in rectifying a delayed exam once discovered.

Clinicians also use the dashboard for an overview of pending radiology workflow and queue depth to facilitate their time management. The information is also used by ER clinicians and staff to provide updates to their patients regarding progress of their studies and expected wait times.

Discussion

Probably the most important benefit of a real-time workflow monitor is that of patient safety. Whenever a stat radiology exam becomes lost in workflow, care for a critically ill patient can be delayed. A mechanism for early recognition of such examinations, one characterized by consistency, reliability, and ease-of-use, can play a valuable role in mitigating potential delays in care and thus improve patient safety. We have found, however, that an organizational commitment is necessary for benefiting from such technology, including a systematic approach for using it. Clinicians are often too busy to continually monitor the dashboard and take the time to intervene with outliers. Although we are still experimenting with optimal "ownership" of the responsibility, our initial experience indicates that greatest efficiency derives from having a radiology assistant, i.e., somebody familiar with the nuances of workflow, in charge of monitoring the dashboard and initiating the appropriate steps to rectify delayed exams.

We are planning to add a "push" technology, optional at the discretion of a clinician via interaction with the dashboard, to automatically notify the clinician via simple text page when a radiology exam is completed with images available and/or when the radiologist's report is available.

Prior to implementation of the system we describe, a joint Rapid Improvement Event (RIE) held by our ER and radiology departments resulted in a more standardized process to communicate concerns about imaging delays. However, because of little capability to monitor workflow in real-time, the RIE could not address and mitigate many underlying causes of delay along with the associated patient-safety risks, an issue that our system addresses. In addition to intrinsically functioning as a quality-improvement tool, we are hopeful that real-time perspectives of workflow can facilitate future quality-improvement projects, and furthermore can be extended to other "stat" services (such as laboratory medicine) that employ real-time HL7 electronic messaging as does our system.

We informally polled approximately one quarter of our ED providers to estimate the time spent during their shift tracking radiology studies. These providers estimated that approximately 20 min per provider per 8-hour shift were spent on such activities. Our expectation is that a monitoring system as we describe can result in hundreds fewer hours per year of inefficiently spent time. As a benefit, we anticipate there will be more time available for higher-value clinical communication between the emergency department and radiology physicians and staff.
Conclusion

Real-time monitoring of ER radiology workflow offers several benefits including early discovery of delayed exams, improved patient safety, and more efficient use of time for clinicians and staff.

Keywords

Real-time monitoring, Radiology workflow, Emergency Radiology