Bridging the Gap: Linking a Legacy Hospital Information System With a Filmless Radiology Picture Archiving and Communications System Within a Nonhomogeneous Environment

R.K. Rubin, C.J. Henri, and R.D. Cox

A health level 7 (HL7)-conformant data link to exchange information between the mainframe hospital information system (HIS) of our hospital and our home-grown picture archiving and communications system (PACS) is a result of a collaborative effort between the HIS department and the PACS development team. Based on the ability to link examination requisitions and image studies, applications have been generated to optimise workflow and to improve the reliability and distribution of radiology information. Now, images can be routed to individual radiologists and clinicians; worklists facilitate radiology reporting; applications exist to create, edit, and view reports and images via the internet; and automated quality control now limits the incidence of "lost" cases and errors in image routing. By following the HL7 standard to develop the gateway to the legacy system, the development of a radiology information system for booking, reading, reporting, and billing remains universal and does not preclude the option to integrate off-the-shelf commercial products.

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FOR THE PAST 25 years, the Montreal General Hospital has been supported by a hospital information system (HIS) for maintaining its electronic patient records. Radiology consultation reports are stored on the HIS, but not electronic images. In 1995, the Department of Radiology developed and implemented a filmless ultrasound picture archiving and communication system (PACS).¹ Based on the success of this ultrasound mini-PACS, the system was expanded and further developed to include magnetic resonance imaging (MRI) and computed tomography (CT) modalities. By February 1997, the department was operating a completely filmless PACS conforming to the Digital Imaging and Communications in Medicine (DICOM) standard for these three modalities.² This vision to make the shift to electronic soft copy

includes radiology reports as well; therefore, a method to bridge the HIS and the PACS was needed so that radiology reports and images could be accessed as one object.

Since the HIS did not previously have health level 7 (HL7) connectivity, a gateway needed to be developed to transfer radiology reports and patient information between the PACS and the HIS. To address this need, a collaboration was established between the Information Services Department of the hospital and the radiology PACS development team. The ideal gateway would support two-way push-and-pull functionality between the PACS and the HIS. As well, the radiology consultation requisition (RCR) would be sent to radiology immediately after being keyed into the HIS. Rather than wait for the ideal, certain features were trimmed from the design in order to deploy the gateway sooner, with the intention of adding the remaining features as they are developed.

HL7 GATEWAY

In October 1998, our HL7 gateway was put into operational service. Currently, we have partially satisfied the ideal design goal by implementing a gateway that allows data to be pushed in either direction. However, it does not yet support a query/retrieve mechanism. Furthermore, the trigger for the RCR transfer is the record complete procedure (RCP) event, which only occurs after the radiology technician has completed the imaging procedure.

Based on this new gateway and the availability of patient records on the radiology network, a number of new applications have been developed by the PACS development team to create, view, and manage linked reports and images. A web-based radiology reports suite is used by the department to manage all aspects of reporting, which were previously in the sole domain of the HIS. The HIS continues to be updated with radiology information, but the additional value comes from the integration of images and reports using web technol-

From the Department of Diagnostic Radiology, McGill University Health Centre, Montreal, Quebec, Canada.

Address reprint requests to Rick Rubin, MEng, Montreal General Hospital, 1650 Cedar Ave, Montreal, Quebec, Canada H3G 1A4.

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ogy. To integrate images and reports, a resolving process is needed to link the two objects. When a RCR is received by the gateway, it will try to find a corresponding image study based on a best match for a number of data values (ie, accession number, medical record number, modality, study date, and study description). This redundancy increases the accuracy of the resolving process by making it less sensitive to a mistyped field.

WEB-BASED REPORTING SUITE

The web-based reporting suite consists of four main modules: the report editor, the radiologist worklist, the report viewer, and the report management tools. The report editor is used by the typists to transcribe the dictated reports and it is used by radiologists to correct reports and finalize them. It has the functionality of a basic word-processor, such as cut and paste, undo, soft word-wrap, and drag and drop editing. It displays the details of the procedure and basic patient information, and it has a link button to call up the associated images for the study. The radiologist worklist provides a personalized web-based listing of pending reports that need to be proofed and finalized. The radiologist can sort and filter the list by a number of criteria and select multiple reports from the list. The worklist will then loop through the selected list, successively displaying the report editor to allow the radiologist to view and edit each report. The report viewer displays the report and all of the relevant information for the patient and study, and provides hyperlinks to the images. The management tools are used by administrators to delete results, resend results through the gateway to the HIS, audit user activity, and track historical changes to the report.

The decision to base our reporting applications on Internet technology has allowed us to take advantage of its many benefits. For instance, since web browsers are available for Macintosh, Microsoft Windows, and UNIX platforms, our development could proceed without needing to incorporate platform-specific code. This greatly reduces development time and makes the applications accessible to every user on our nonhomogeneous network. Using the web also has the advantage of employing a familiar user interface—since most of our users have been previously exposed to a web browser, training can be focused strictly on the reporting application.

WORKFLOW MODIFICATION

The previous workflow paradigm for radiology reporting used to be as follows. The request for a RCR was entered on the HIS and transmitted to the Radiology Department. The patient was then scheduled by the Radiology Department for a visit. Once the patient was scanned and images were sent to the PACS, the radiology technician would RCP the event on the HIS. In the mean time, the radiologist reviewed the images and dictated the report into a Dictaphone system. A typist received the report and typed a preliminary version on the HIS and printed a hard copy for the radiologist to review. Corrections were made to the report (on paper or using the Dictaphone) and the corrections were retyped by the typist. The review process was repeated until a final version of the report was signed by the radiologist and the typist then had to update the report on the HIS and flag it as finalized.

Using the web-based results suite has had a dramatic effect on the reporting workflow by reducing paper traffic and the number of trips the report travels between typist and radiologist. Since an HL7 record is only sent to radiology via the gateway after the RCP event, the flow up to this point is not different in anyway from the previous paradigm. The dictation mechanism used by the radiologist to report the case is also unchanged. However, instead of typing the report into the HIS, the typist now enters the report using a web-based report editor. The greatest efficiency gains occur from this point on. As soon as the typist completes the transcription of the report, the radiologist will be able to access it through their web-based worklist. The worklist shows all preliminary reports that need the attention of the radiologist. The radiologist can then open the report, edit it, and finalize it. With each modification of the report, a copy of the record is transmitted through the gateway back to the HIS. Only when the report is finalized by the radiologist is a hard copy of the report generated.

DISCUSSION

The shift to electronic reporting has resulted in a major change in the day-to-day workflow of the radiologists. Surprisingly, despite this change, most were receptive and some were even enthusiastic about being able to correct their own reports. The benefits of paperless reporting evidently outweigh the learning curve associated with the editing of soft-copy reports. This change was also easier to

accommodate than the switch to a filmless operation, since it has only affected the department, whereas the switch to soft-copy images had a much larger radius of effect.

We chose to take a gradual approach to employing the system once the gateway was installed. We began with the nuclear medicine department as a pilot project, since it was well defined and small enough to troubleshoot effectively. Following a short trial period, we gradually switched the rest of the radiologists over to the new system at a rate of one or two per day. This gave us the opportunity to properly train each staff member and troubleshoot any problems on a person by person basis. A large part of the success of the project can be attributed to having a well-trained application specialist dedicated to supporting the users. This facilitated the important liaison between the users of the system and the systems developers and administrators, ensuring that the needs of the users shape the product to their satisfaction.

FUTURE DEVELOPMENTS

Since the remainder of the hospital has not yet accepted a digital signature in lieu of a hand-written one, the radiologists are still faced with having to sign the final copy of the report by hand. Therefore, we anxiously await approval for the digital signature so that paper may be eliminated altogether within the department, while only digitally signed hard copies will have to be printed for distribution to the rest of the hospital.

Currently, the gateway is missing two important mechanisms: (1) a query mechanism to pull HL7 objects from one system to another, and (2) the transmissions of RCR records occurring when they are first created, rather than after the RCP event.

These two issues require development on the HIS side of the gateway, which we expect will be implemented in the near future. Once we have this functionality, it will open the door for scheduling and workflow applications. As well, newer scanners will be able to receive DICOM modality worklists that should result in an increase in the accuracy of the resolving process by reducing errors in the fields that are used for linking.

In addition, we are in the process of evaluating voice recognition as a means to replace the dictation and transcription process. This would greatly streamline the reporting process by allowing the report to be dictated, corrected, and finalized in one session. The chief concern regarding this technology is its recognition accuracy and the financial cost to implement it throughout the department.

CONCLUSION

The decision to develop a PACS and reporting system within the department has resulted in a highly effective product that was developed at a fraction of the cost of purchasing a turn-key solution. Since the expertise to develop the system resides in the department, we are confident that the system will continue to evolve and integrate with hospital-wide information systems.

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