

Implementation of a Teleradiology System to Improve After-Hours Radiology Services in Kaiser Permanente Southern California

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Abstract

Kaiser Permanente Southern California (KPSC) has implemented a teleradiology service to provide after-hours radiology services to its 11 medical centers from 7:00 pm to 7:00 am each day of the week. Features of the service include a Web application that is used to manage the workflow associated with teleradiology exams and to provide reports of the teleradiologists' findings to referring clinicians. Currently, two teleradiologists who can be located at any KPSC facility (varies from day to day) are used to provide preliminary interpretations of CT, MRI and ultrasound exams. However, the service is scalable and could be easily reconfigured to accommodate additional teleradiologists if needed. The service also includes a quality monitoring system that tracks significant discrepancies between the teleradiologist's findings and the subsequent final report of a medical center's staff radiologist. Clinicians who utilize the teleradiology service have been highly satisfied with the responsiveness of the service—median time between performance of an exam and availability of a wet read is 19 minutes.

For several years, the Southern California Chiefs of Radiology explored various technology options to improve the efficiency of after-hours services. Until 2002, on-call radiologists at each of the 11 medical centers provided after-hours radiology services for their local Emergency Departments (ED) in Kaiser Permanente Southern California (KPSC). This process had been in place for many years and reflected the medical group's political structure (essentially 11 separate groups of radiologists). The time lag between when a radiologist received

a page and when s/he arrived at the medical center produced inevitable delays in providing radiology consultations to EDs. In most cases, the radiologist was needed only to provide image interpretation, not to perform the exam.

The Chiefs discussed a variety of options, including providing each on-call radiologist with the ability to view exams and transmit interpretations from home. This and other potential solutions did not prove to be feasible for various reasons, including: concern over the quality of images viewed on home

computers, the challenge of remotely supporting a variety of home systems and the Southern California Permanente Medical Group compensation structure. After much discussion, the Chiefs, with the support of administration, elected to implement a teleradiology system that would station a radiologist in a central location to provide image interpretation for CT, MRI and ultrasound exams from 7:00 pm to 7:00 am seven days a week for all KP Southern California medical centers. "Wet read" reports would be communicated via fax to the referring ED.

However, when working out the final details of the implementation, two important changes were made. First, the single central location plan was abandoned. The radiologists strongly preferred an alternative option that provided the ability to access the teleradiology studies from any of KPSC's 11 medical centers. This alternative permitted each teleradiologist to work from his/her home medical center, or another if more convenient. This change was made due to concerns about the willingness of radiologists interested in working a teleradiology shift to

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travel to a central location (for example radiologists who normally worked in San Diego to travel more than 125 miles to Pasadena). Doing so offered the advantage of having the teleradiologist work in a familiar setting, using familiar equipment and traveling no more than for a typical workday. Second, the plan to communicate the teleradiologist's findings via fax was replaced by a Web application that would provide the ability to track a request for teleradiology services throughout the entire process, as well as communicate the findings to the referring site.

Workflow

Two different components of teleradiology needed to be managed as part of the workflow (Figure 1): information and images. Information workflow begins with the ED initiating a request for an exam. Required information during this first step includes the patient's name, medical record number, date of birth, clinical reason for the exam, radiology exam requested, and name and contact information of the clinician who needs the results. Next, a radiologic technologist performs the requested exam. At the completion of the exam, the technologist can add comments to the information record that could be useful to a radiologist interpreting the exam (eg, technologist's impressions during an ultrasound exam are particularly helpful to radiologists remotely reading the resulting images). The technologist documents that the exam has been performed and the images sent to the teleradiologist. Step three is the teleradiologist reading the exam and documenting his/her preliminary findings ("wet read"). The Web application makes these available to the referring site where the clinician

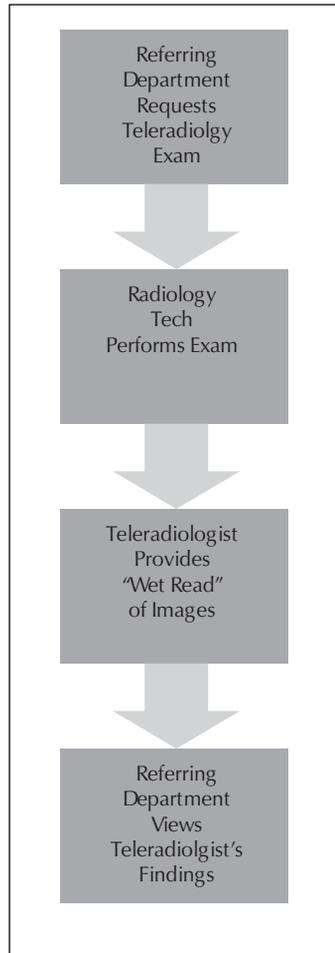


Figure 1. Teleradiology exam workflow.

or staff, who originally requested the exam, views the findings as the fourth step. Any user can view the up-to-date status for each exam (requested, performed, read). In addition, the Web application alerts teleradiology support staff when the referring site has not accessed the interpretation after 30 minutes so that they can follow-up with the site.

Images are the second component of the teleradiology workflow. Images produced during an exam need to be delivered to the teleradiologist for interpretation. Because the location of the teleradiologist varies from day to day, there was concern that images could be frequently

misrouted to the wrong location if technologists had to check schedules and send the completed exam's images directly to the teleradiologist. This design would also have required that each possible teleradiologist location (at least 11 sites) be configured on each of the 50+ possible imaging systems used for the exams. For these reasons, a central image router serving all of Southern California was installed. Exam images are communicated via Digital Imaging and Communications in Medicine (DICOM) from the originating imaging system (eg CT scanner) to the router. DICOM is a non-proprietary industry standard for communicating images in digital form between medical devices. The router then automatically sends the images directly to the workstation at the location of the teleradiologist for that day. Changes in teleradiologist location are easily accommodated by changing the destination configuration of the router.

Initial Launch, Expansion and Scalability

EDs in 5 of the 11 medical centers in Southern California were included in a pilot of the teleradiology service in August 2002 so that the process could be refined before expanding the service to the entire Region. As the remaining six medical centers were brought online, the workload grew to the point that a single teleradiologist was no longer sufficient. Furthermore, although originally designed to support the EDs, workload increased substantially due to addition of urgent after-hours inpatient and some outpatient studies. The design flexibility of both the image router and the Web application accommodated this increase in workload with the addition of a teleradiologist.

In this expanded model, the Region was divided into two groups, with a teleradiologist assigned to each group. Medical centers were assigned to a group on the basis of their historical workload so that the total workload for each group would be roughly equal. This method of balancing the workload among teleradiologists also insured that multiple exams performed on the same patient during a shift would be read by the same teleradiologist. The image router sends the exam to the workstation of the appropriate teleradiologist on the basis of knowledge of the medical center from which the exam was submitted. Consequently, each teleradiologist only sees a worklist of the exams requested by the medical centers in his/her group.

The ability to have multiple groupings for workload division and to route images on the basis of their source allows the teleradiology service to expand as workload grows in the future and more teleradiologists are needed. The design will also support variable shift schedules should these be developed.

Monitoring Quality

One of the concerns that surfaced during the development of the teleradiology service was how to monitor the quality of the teleradiologists' findings when the teleradiologist was, in most cases, providing preliminary reads of exams originating from medical centers other than his/her own. To address this issue, the Web application used to support the exam workflow was enhanced to include a post-exam quality monitoring process. Since the teleradiology findings are only "wet reads," all teleradiology exams are subsequently interpreted by a staff radiologist at the originating medical

center. The local staff radiologist's interpretation is the official diagnostic report for the exam. This practice is identical to that used for any preliminary interpretation.

The first step in the quality monitoring process is comparison by the staff radiologist of the teleradiologist's preliminary findings with his/her official diagnosis for the same exam. The staff radiologist uses the Web application to enter whether there was a significant difference in findings and to add any pertinent comments.

The designated QA radiologist for each medical center performs the second step in the process. This radiologist reviews each exam noted to have a significant difference in interpretation between the teleradiologist and staff radiologist. The QA radiologist also uses the Web application to enter whether s/he agrees that a significant difference in findings exists and to record pertinent comments.

The third process step is performed by four radiologists who meet quarterly to collectively review those teleradiology exams for which both the interpreting staff radiologist and the medical center's QA

radiologist agreed there was a significant difference from the teleradiologist findings. The conclusions of this group of four are recorded in the Web application and the teleradiologist is notified of any exam for which the group agreed there was a significant difference between the group's findings after reviewing the actual images and the original teleradiology findings. Quality statistics for each teleradiologist are maintained in this fashion for all exams.

Staff Support

During each teleradiology shift, regional staff is on duty and immediately available via telephone to support the teleradiology workflow. Typically, requested support consists of determining the cause of any delays that may occur in performing or interpreting requested exams and following-up on exams with completed findings that have not been viewed by the requesting department within a reasonable amount of time. The goal is to assure that clinicians are aware of the teleradiologist's findings. This staff is also responsible for implement-

Sidebar: Teleradiology statistics

Statistics for the six months of teleradiology activity from March 1 to August 31, 2005:

Average number of exams per 12-hour shift: 125

Annualized number of exams per year: 46,000

Number of teleradiologists per shift: 2

Proportion of exams by imaging modality:

CT: 80%

Ultrasound: 19%

MRI: 1%

Proportion of teleradiology requests by referring department:

ED: 85%

Outpatient: 9%

Inpatient: 6%

Median delay from exam performed to teleradiologist wet read: 0:19 (hrs:min)

Median delay from exam requested to teleradiologist wet read: 1:17 (hrs:min)

Busiest teleradiology hours (based on time read): 8:00 PM to midnight (50% of exams)

ing a manual method of communicating teleradiology results if the Web application fails. In the event of technical problems with the Web application or with the image router, staff can contact on-call imaging technical support staff.

Regional staff support the quality monitoring process and collect the images for the exams that need to be reviewed for the third process step, compile the group's findings and provide communications of the findings to teleradiologists.

Future Directions

As the teleradiology workload increases, methods to incrementally increase capacity in an efficient manner continue to be investigated. Rather than simply adding another teleradiologist for an entire 12-hour shift, it may be advantageous to add teleradiologist capacity only during the peak hours of activity (see sidebar: Teleradiology Statistics). For example, three teleradiologists

could be scheduled for the first half of the shift and two for the remainder of the shift.

Another process improvement under investigation is provision of the complete official diagnostic findings by the teleradiologist, rather than only reporting preliminary findings as is currently the case. Several operational and technical challenges will need to be adequately addressed in order to implement this change in teleradiology practice: a) teleradiologist staffing will need to be adjusted to allow for the longer interpretation times required for final reports as compared to preliminary findings; b) conversion of the imaging modalities to a filmless environment will need to be complete across the Region in order to support efficient retrieval of prior exams required to support final reports; and c) the dictation/transcription process for radiology reports will need to be modified to accommodate any radiologist providing a report for any

medical center from any location.

Conclusion

The KPSC teleradiology service has improved Radiology's support of EDs by significantly decreasing delays in providing after-hours interpretation of CT, MRI, and ultrasound exams. The Chiefs of Emergency Medicine have been enthusiastic about the prompt service that minimizes the time required for clinical management decisions in EDs, enhances throughput and helps improve ED capacity. The service has also made it possible to more effectively manage the Region's collective radiologist resources and to provide a process to assure the ongoing quality of those services—developments that have produced a high level of confidence in the results among emergency physicians. In addition, radiologists have experienced an improved quality of life due to the significant reduction of "callbacks" when on call for their medical centers. ❖

To Win

Pick battles big enough to matter, small enough to win.

—Jonathan Kozol, b 1936, non-fiction writer, educator, and activist