Teleradiology

Part II. Limitations, Risks, and Opportunities[1]

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Teleradiology offers the promise to improve quality of care and quality of service to patients and referring providers while simultaneously improving the efficiency of the health care system and the productivity and quality of work life of radiologists. Hospital-to-home teleradiology is widely used in the United States for off-hours health care coverage (1), and teleradiology has become the basis for the formation of a number of commercial enterprises that provide outsourcing services for image interpretation.

The full potential of teleradiology to change paradigms of care is not yet known and likely will require substantial additional experience and experimentation to understand. In the meantime, there are still serious technical and operational limitations that need to be overcome before the advantages of teleradiology can be realized. There is also a daunting series of risks that need to be better understood before the myriad of opportunities associated with teleradiology can be fully explored and beneficially integrated into the health care system and the practice of radiology.

Technical and Operational Limitations of Teleradiology

Despite the many advances in electronic image management over the past 3 decades, the technical Achilles heel of teleradiology in clinical practice (2–4) is the general inability to integrate the image management systems that are resident in different information system security domains and to integrate teleradiology systems with other health care information systems when data are transmitted between different institutions or between an institution and outside providers who are using a different information system.

The simplest case is that of a radiologist covering services for his or her own institution. In this setting, a virtual private network, or VPN, can be used to access images and other information from the institution's various data sources, although it is often not possible to directly input a report into the radiology information system (RIS) from a remote site or to access work lists from the picture archiving and communication system (PACS). The Web-based image distribution systems used for hospital-to-home teleradiology typically do not offer the same range of functions—including image manipulation tools and navigation between image sets—that PACS workstations do; thus, their use is restricted to applications such as provisional interpretation of emergency examination results, in which prior images or prior reports may not be needed.

Working between different institutions or between an institution and a teleradiology outsourcing provider presents more challenges. Point-to-point connectivity for image transmission in no way implies true integration of systems. Even if the PACS systems used at the sending and receiving sites are from the same vendor, differences in registration numbers and security issues militate against an integrated exchange of data. Consequently, gaining access to images not originally sent as part of a teleradiology transmission is also problematic in these teleradiology settings, because the operational model is a "demand-push" model. This means that the sending site initiates the transaction by "pushing" a case into the system. Since the images are going through firewalls and security systems at the sending location and because the receiving system for image handling is not integrated with the sending site, additional images cannot be directly "pulled" by the radiologist interpreting the case should they be required. The interpreting radiologist has no direct means of accessing the data repositories of the sending site. Rather, he or she must communicate the need for additional image data to the

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originating site; this is a cumbersome process at best.

A corollary limitation is the lack of remote access to work lists. The off-site radiologist must rely on those managing the pushing of cases to know which cases to interpret and in what order to interpret them. This makes it difficult for two or more radiologists to work in parallel in a teleradiology setting without intervention by other personnel who at some point will be central to the work flow of the teleradiology process. Secondary distribution to the interpreting radiologist after initial data collection on a central server is the work flow model for some commercial teleradiology service companies. This second step can be automated but historically has required operator intervention.

Image data typically are resident in a PACS and are stored separately from other information about the patient, including reports of prior radiologic examinations held in the RIS and the basic clinical and laboratory information typically recorded in a hospital information system, electronic medical record, or paper-based medical record. Therefore, even the most basic collateral information, such as the indications for performing an examination, recent medical history, laboratory values, and pathology reports, typically must be collected by someone at the sending site and transmitted separately from the images. There are no widely promulgated standards, such as Digital Imaging and Communications in Medicine, or DICOM, for doing this yet. Apart from the Health Level 7 interface standard, no integrated information system platforms are generally available for interinstitutional use. Even if there were such standards, the same issues that bedevil PACS-to-PACS image transmission—namely, different registration numbers and security issues—would still apply.

An important initiative called Integrating the Healthcare Enterprise, or IHE, which is supported by the Radiological Society of North America (3) and other organizations, seeks to address this lack of interinstitutional integration; however, it has not reached widespread practical implementation. In current practice, patient information must be faxed or e-mailed after someone at the teleradiology sending end has redacted it to a manageable form. Again, interactivity is highly problematic, so the receiving radiologist is typically left with what someone at the sending site thinks is appropriate. Any additional information must be requested, found, redacted, and transmitted—again, a cumbersome process.

Even within a single institution, the integration between systems is often less than ideal because the PACS resides in the domain of the Digital Imaging and Communications in Medicine standard, while the RIS, hospital information system, and electronic medical record reside in the domain of the Health Level 7 standard. This means that special interfaces or "brokers" must be employed to send information between the PACS and the RIS and radiologists are faced with the constant need to switch between systems to access the information they need on a case-by-case basis. As noted by Siegel and Channin (4), "this lack of consensus by various hospital and radiology information systems, PACS, and modality vendors on how to use existing standards has thwarted our efforts to automate processes."

Sending reports back to the initiating site completes the cycle of teleradiology and represents another major point of nonintegration. There is typically no practical way to electronically generate reports and send them for direct inclusion in the RIS of the initiating site. In practice, this means another set of e-mails or faxes. If the hospital or imaging center wishes to make these reports available to referring physicians through an RIS or hospital information system, the reports must be secondarily transcribed or copied into the system electronically, with no practical way for the interpreting radiologist to verify the transcription.

From a distance, teleradiology may look like a technologic marvel, but direct experience reveals that it is operationally challenging because of the lack of systems integration. The lack of integration and the demand-push operational model make each step of the traditional teleradiology process cumbersome. For small-scale operations—for example, a few cases per night from a hospital to a radiologist's home—this cumbersomeness can ordinarily be subsumed by the efforts of existing personnel, and the radiologist can confirm the interpretation the next morning when he or she has access to the complete record. For larger operations between an institution and an outsourcing provider, however, addressing these issues requires the addition of more personnel to fill in the gaps in communications and the gaps resulting from the inability to integrate data flow between disparate PACS and information systems. With current technology, establishing large-scale operations for conventional teleradiology is a personnel-intensive process, contrary to its high-tech image.

The issues are far less daunting when teleradiology is practiced within an institution or distributed delivery system with common information system components in all locations or within a common firewall or set of security systems. In our core practice at Massachusetts General Hospital (Boston, Mass), we staff six sites, including the hospital and various outpatient centers and imaging centers that require the presence of a radiologist, and we oversee three additional practice locations that do not require on-site radiologists but from which we receive images. Since all locations are networked together and use the same information systems, all imaging and nonimaging data are equally available at all locations including access to work lists that govern the distribution of images to individual radiologists. In this scenario, a "demand-pull" operational model is used, meaning that it is the radiologist who initiates the interpretive process, calls up all the necessary images onto the PACS workstation monitor, and calls up other information onto a second workstation that is used to access the RIS and hospital information system. Each radiologist is likely to interpret images from multiple locations through the course of a day and may not even take note from one case to the next of where the images were originally obtained. We have used the term *wide-area PACS* to describe this integrated model and to distinguish it from conventional point-to-point teleradiology.

With advances in the Web distribu-

tion of images and reporting systems, it is now feasible to extend this integrated model to locations that are not part of the institution's network or security domain. To solve a particular staffing issue in our department at Massachusetts General Hospital, our information technology group, under the direction of Keith Dreyer, DO, PhD, recently developed a system that we have dubbed "PACS in a briefcase," which allows access to all hospital systems, including the voice-reporting system and radiology work lists. This customized system has the nominal requirement of a personal computer that is linked to the institution by means of an appropriate security system via a virtual private network over the Internet. The system can run on a laptop computer with flat-panel display that can be carried in a special case. In this customized system, all images and patient information are accessible in the demand-pull model, eliminating the gaps typically encountered in teleradiology. It is likely that such systems will become generally available in the next several years and thus address many of the technical limitations facing the practice of teleradiology today. However, the customization of this approach for different institutions with disparate systems will remain challenging.

The lack of opportunity for face-to-face consultation with referring physicians is a shared limitation of all approaches to teleradiology that may be amenable—at least partially—to technology solutions. Video conferencing over the Internet is quite feasible today and has prompted a resurgence of interest in interactive telemedicine applications, and the same approach can be used for face-to-face consultations between radiologists and referring physicians. The major limitations for both parties are the cost of time and the logistics of scheduling the interaction.

Risks Associated with Teleradiology

Some of the risks associated with teleradiology are directly related to the technical limitations of the field. When it proves too cumbersome for a remote radiologist to obtain additional images or collateral information, there is a risk that examination results will be interpreted in a less complete fashion than they would be in conventional practice. The reason that emergency teleradiology coverage generally works quite well is largely the limited set of indications, the general lack of need to review prior examination results, and the limited amount of collateral information needed for interpretation. In comparison, follow-up examination of a patient in the middle of treatment for cancer or another complex medical condition generally requires comparison of the new imaging results with the prior examination results—possibly from a number of different imaging modalities, review of the prior radiology reports—often several, and review of other information such as pathology and laboratory reports. It is impractical to simply "push" everything to the remote reader, and a generic multisite solution to the problem of making information—including image data—available in a practical manner by way of conventional teleradiology is not yet at hand.

The quality of outsourced teleradiology services is another area of risk that any radiology group or institution must address. For hospitals, reappointment to the medical staff and regranting of privileges require assessment of a physician's performance. Therefore, anyone providing a teleradiology service who holds staff credentials must be periodically reviewed for the quality of his or her work. It is incumbent of the on-site radiology group and/or the institution to establish an appropriate system for overseeing quality. Even when this is done, it is interesting that some radiology groups that might ordinarily interview a number of potential candidates and perform background and reference checks before selecting a new group member now routinely accept services from any number of radiologists who are unknown to them except through the credentials submitted on their behalf by a commercial teleradiology services company.

Turning to outside teleradiology providers for off-hours coverage carries a risk to the reputation and professional standing of radiologists. Arguably, radiologists in an institution who cede a part of their practice to others are less important to the institutional care process than they were when they provided all professional radiology coverage. They risk their roles as consultants and may become less highly regarded professionally if their colleagues perceive what they do as radiologists to be a simple commodity that can be purchased on the open market. In a survey of referring physicians conducted by Lester et al (5) to compare local and international interpretations, cost and timeliness issues from the viewpoint of referring physicians were addressed. The survey results indicated that referring physicians prefer local interpretations unless the time and cost factors for local interpretation are very unfavorable. Local radiologists have substantial advantages, but they will lose them if they do not provide high-quality service.

Teleradiology may put entire radiology practices at risk. The shortage of radiologists over the past 10 years (6) and the challenges of recruiting personnel to certain locales have previously protected radiologists from competition or threats to what some may have regarded as their "franchise right" to provide coverage to a particular institution. Those radiologists who are perceived to have taken advantage of these factors by providing indifferent or worse service are now especially at risk of being replaced in sum or in part by teleradiology outsourcing service providers. Commercial teleradiology companies are clearly beginning to move into this service arena. Nighthawking has morphed into dayhawking.

Radiology groups that do not have subspecialty expertise are unquestionably at risk of having at least a portion of their practice taken away from them through teleradiology. A number of private groups and commercial companies are now dedicated to providing subspecialty interpretations. Referring physicians who are specialists—for example, neurosurgeons, orthopedists, or oncologists—are driving this particular trend. They value for themselves and their patients a subspecialty level of interpretation rather than generalist-level interpretation, as well as the ability to work with subspecialty-trained radiologists who understandably are expected to have greater familiarity with the clinical challenges and imaging correlates

associated with the more highly subspecialized disciplines of medical practice.

Radiologists and their practice colleagues should assess their situations to determine whether and how they are at risk. The radiology groups in the strongest position are those that *(a)* provide outstanding service with high patient and referring physician satisfaction, *(b)* take responsibility for 24 hour–7-day-a-week health care services themselves, *(c)* offer high-quality subspecialized interpretations, and *(d)* represent good institutional citizens with high participation in quality improvement programs and no conflicts of interest with their affiliated institutions. Groups with the opposite characteristics in whole or in part are at greater risk.

Opportunities Associated with Teleradiology

When used well by radiologists dedicated to high-quality service, teleradiology offers the opportunity to simultaneously improve medical care delivery and improve the quality of work life for radiologists. Creative application of teleradiology can also improve productivity and consequently the financial well being of radiologists as well. Radiologists in the United States have already adopted teleradiology into their practices to achieve substantial portions of these benefits. The questions facing the specialty now are how much further will things go and will the inevitable changes associated with teleradiology transform radiology practices in ways that most radiologists will like or will they drive the specialty in the direction of commoditization and corporate practice.

One direction that appears to offer major opportunity is that of radiologists using teleradiology to support each other in their practices and even create new business and practice models. Smaller groups within a state could join together in a larger group of sufficient size to provide "24-7" coverage and offer subspecialization. With teleradiology, one radiologist in such a coalesced group could cover several smaller institutions for off-hours emergency examinations; thus, the responsibility would be shared and spread over a number of people large enough to mitigate the negative quality of work life issues facing a smaller group trying to accomplish the task. Furthermore, aggregating the night responsibility for several institutions would improve the productivity of those providing the coverage. This is precisely the economic premise of commercial teleradiology companies, and there is no reason that individual groups cannot come together to achieve the same benefits with much less administrative overhead because all of the participants would already be licensed in their respective states.

The same model could be used to increase the capability of the expanded group to provide subspecialty coverage. One person or a number of people could take on the responsibility for each subspecialty area of importance to the institutions involved and provide coverage through a system similar to the described system that we use in our practice at Massachusetts General Hospital. Many radiologists practicing as generalists have already been also trained at a subspecialty level. Others could focus their continuing medical education efforts on a particular subspecialty and come to an academic center for a mini-fellowship.

Smaller groups could make arrangements with academic centers to provide over-read or consultative services for selected cases through teleradiology. It is interesting that pathologists have had a culture of asking colleagues for advice and second opinions for years. Such a widespread culture of consultation has not developed in the radiology field before for a number of reasons, including the cumbersomeness and cost of shipping hard-copy radiographs around the country and the frequent need in urgent and emergent cases to determine the imaging findings as quickly as possible and act on them immediately. In the age of teleradiology, these issues no longer constitute barriers in the same way to seeking consultation.

Conclusion

Prior to teleradiology, radiologists were protected in their practice sinecures by a variety of barriers to competition and had wide latitude to look at life according to their own viewpoints and self-interests. To their credit, most radiologists have not taken inappropriate advantage of this protected situation and have practiced at a high level of integrity and quality. Nonetheless, teleradiology is eclipsing the protected state of the radiology practice and replacing it with a new less-protected practice environment in which the unmet needs and expectations of patients, referring physicians, and hospitals in terms of better quality and service can now be readily addressed through choice among radiology providers.

It is likely that major consolidation in the practice of radiology will be fostered by means of teleradiology to achieve benefits of scale, provide more timely service, provide access to subspecialist clinical expertise, and better match supply with demand. Radiologists can be the initiators of this consolidation and realize many important benefits for themselves, including the preservation of their practices. To accomplish this, however, radiologists first need to recognize and accept that changes in organizational structure and service expectations are taking place in the health care system through the availability of teleradiology and are inevitable. Preserving the status quo is not a viable option in many situations, and if radiologists do not take the initiative to creatively use teleradiology to their advantage, others will.

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