

Review Article

The Evolution and Future of Radiology in the United States

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In the last 30 years the landscape of radiology has changed dramatically. Advances in imaging technology have made medical images increasingly detailed, requiring ever increasing anatomical knowledge, but ironically easier for non-radiologist clinical specialists to interpret. Under fee-for-service and with decreasing reimbursement, clinicians have had incentives to assume some of the previously acknowledged imaging services of radiologists. Today, under the Affordable Care Act, American medicine is moving from a fee-for-service system to one of over-arching capitation where reimbursements are fixed by covered lives and risk is transferred to the clinical provider. This inevitably means fewer diagnostic imaging studies, laboratory examinations and other activities that will reduce the margin of the capitated provider. What is unclear is whether radiologists themselves ultimately will be regarded as a luxury that need not be consulted for all imaging. Thus, radiologists are currently threatened not only by an expected decrease in imaging utilization, but potentially also a reduction in their utilization. To maintain their place in medical care, the specialty will need to adapt, assume new roles and reconsider their traditional work model.

Keywords: Radiology; Imaging; Competition; Capitation; Economics**Introduction**

Economics and politics have in a very short time completely altered the healthcare economic playing field. Fee-for-service is disappearing from American medicine. It is being replaced by large-scale capitation with economic risk transference from the insurer alone to the provider, at least as a partner. This shift has momentous in its implications. It implies a complete change in the economic incentives that all providers face and to which they will respond. In overview, it means a change from a piece-work payment system where the more care provided the more revenue generated, regardless of health outcome, to a fixed payment world where the incentive is to strike a balance between the amount of care delivered and optimum patient health outcomes. In this new world, providing more care doesn't mean more revenue to providers; in fact, it may mean less. Similarly, failing to provide for the best possible health for each individual patient will mean more care consumption and hence lower margins to providers. Thus, a new paradigm is coming into place, where in order to optimize margins; providers must learn just how much care results in the best health outcomes.

It is in this new environment that radiologists must figure out how to remain an integral part of the healthcare delivery system. By virtue not only of the current political and economic changes in American healthcare, but also the massive technological evolution that the field has witnessed in the last decades, the traditional concept of practicing radiology in a central department needs to be reexamined closely and thoughtfully altered or perhaps done away with altogether. Furthermore, with these new incentives, the role of radiologist as thoughtful gatekeeper now merits consideration.

With the development of Computed Tomography (CT) in the

late 1970's and the development of Magnetic Resonance Imaging (MRI) less than a decade later, the field of radiology expanded by leaps and bounds. What was once potentially obscure "shadows" on images have all at once become increasingly evident, detailed and clear, i.e. the sensitivity, specificity and accuracy of imaging studies has greatly improved.

Indeed, advances in these technologies over the subsequent decades have improved to the point that anatomic detail can now be rendered in minute detail at near instantaneous speeds in the case of CT and with very reasonable imaging times in the case of MRI. In fact, these technologies, using state of the art scanners, have made possible dynamic imaging. As a result, CT and MRI scanners have, in large part, supplanted the need for some forms of invasive imaging, particularly diagnostic catheter angiography. What once required a skilled radiologist, using knowledge of vascular flow, anatomy, catheter techniques and some minor surgical skills, can now often be performed using an intravenous catheter and a prescribed imaging algorithm built into the computer of a CT or MR scanner.

Even plain radiographic detail has continued to improve. Because of the development of digital imaging technology, the "shadows" have become progressively clearer and more detailed. This has made analysis of images easier and made some subtleties clearer.

Ultrasound (US) too has undergone marked improvement in imaging capability. Progressively increased megahertz transducers and processing techniques have made US imaging more detailed and easier to interpret. Today, US imaging detail, as with that of CT and MRI, has surpassed that only imagined at the end of the 20th century. US has become something that many specialties, besides cardiology, obstetrics and radiology, use routinely in their practices and thus

has become a common clinical tool integrated into the practice of medicine. In the USA we are seeing non-radiologist-involved US imaging by obstetricians, cardiologists, emergency department and urgent care physicians, physical medicine and rehabilitation physicians, rheumatologists and anti-pain physicians.

Just as remarkable, but perhaps no less surprising, given the strides in technology that integrated circuits have brought, has been reduction in the size and also the cost of US machines. Lower resolution, low-cost US machines are now small enough to be carried in small portable cases. Some have remarked that US is in the process of replacing the stethoscope as a bedside diagnostic tool [1-3].

While CT and MRI have not miniaturized to the point that these modalities are ported easily beyond the confines of a radiology department a basic portable CT scanner is now on the market, primarily for diagnosis of acute cerebral hemorrhage [4]. While this may improve the care of stroke patients, it also represents an opportunity for non-radiologists to interpret CT. Furthermore, some scanners on the market, both CT and MRI, require comparatively little space, little site preparation and relatively little financial investment. Indeed, some specialties, orthopedists and neurologists, for example, have for some time purchased and run their own scanners, whether directly or indirectly through investment in imaging centers, Stark Laws notwithstanding [5-7].

What do all of these technological imaging advances mean for the radiologist? On the one hand, higher detail imaging means that finer and finer anatomic detail is displayed. This clearly indicates that ever increasing anatomic knowledge is required to interpret advanced images. Thus, one might predict that improved technology has assured the role of the radiologist in caring for patients, assuming that their anatomic knowledge keeps pace with advances in imaging.

On the other hand, the very detail that medical images now display and the ability to reconstruct images in arbitrary planes make it easier than ever to understand the imaged anatomy. While the radiologist who spends all of his working time interpreting images may have supremacy in terms of understanding the findings on images, it is clear that many images, whether basic plain radiographs or advanced cross sectional imaging studies, can be interpreted ever more easily by physicians in other specialties. Certainly, orthopedists always have interpreted radiographs of fractures without the need of a radiologist. The same is true in most cases of neurologists and neurosurgeons with respect to head CT and MRI scans of the brain. Cardiologists always have taken an active role in interpretation of their patients' images if not actually taking the imaging modality completely for themselves. In fact, one may argue that clinical specialists regardless of specialty have adequate anatomical and pathological knowledge to compete successfully with radiologists in the interpretation of imaging studies specific to their specialty. The increased detail and capabilities of current imagers further evens the playing field, reducing radiologists' advantages in interpreting images.

In the ongoing economic climate of decreasing reimbursements [8-11], there have been, in fact, strong incentives for clinical specialists to seek sources of income beyond the routine care of their patients. From clinicians' perspectives imaging, in a fee-for-service environment, often is perceived as a good source of additional revenue. Indeed, a large proportion of medical imaging

is already done and interpreted by non-radiologists, litigation fears notwithstanding. It should be noted further that since reductions in reimbursements for medical services are system wide, in addition to inciting competition for turf, reductions also directly impact professional radiology revenues.

The fact that clinicians, by virtue of their first-hand personal relationship, control patients' fates while radiologists only see them in consultation is no small matter. When private practice specialists see a patient, they have the ability to determine the management of the patient and overtly or otherwise, select which medical care facility the patient uses. This power, as long as private practice is the model of medical care delivery, means that administrators of healthcare facilities will be inclined to appease the desires of clinicians who indirectly hold the reins of the facility's economic success. Thus, if enough clinicians as a group or even a single large admitter want to do a certain procedure or test and can prove competency to do it, the administration of the healthcare facility will likely endorse the desire despite protestations from radiologists. As such, cardiac catheterization long ago left the radiological domain for that of the cardiologists. As non-invasive imaging supplants diagnostic cardiac catheterization, cardiologists have moved to interpret cardiac vascular imaging now performed on cross sectional imagers, both CT and MRI. Not only has this motivated cardiologists to interpret CT and MRI images, their control of their patients coupled with their specialty expertise have allowed them to pursue this desire virtually unimpeded.

Yet another problem is that PACS have made radiologists the unseen colleague. In the days of film and paper, clinicians had little choice but to seek consultation with radiologists in their reading rooms. Today, with PACS and computers, images and information are widely disseminated and easily accessible, not only within a hospital but even to remote locations. Thus, while radiologists' interpretations may be important, the radiologists themselves have become relatively invisible, and it's always easier to take from someone or something unknown than someone with whom one has a personal relationship. To this end, it behooves radiologists to go where the clinicians are.

With the advent of the Affordable Care Act (ACA), aka Obama care, new cost reduction initiatives are being superimposed on preexisting ones. These include new bundling of care models [12-15]. The ACA calls for the creation of Accountable Care Organizations (ACO). ACO's are structured so that a group of healthcare providers who form an ACO are paid what is essentially a bundled or capitated rate for the lives covered by the ACO [10,11]. With bundled payments and ACO's, all clinical activities, including laboratory and imaging examinations, are paid for out of the total capitation.

As bundling replaces fee-for-service, incentives will change. Clinicians, instead of desiring to interpret imaging studies, will be inclined to reduce the amount of imaging studies that they obtain. This is because every dollar spent on imaging or other laboratory examination obtained under bundling will increase costs to the organization and thus lower net revenue to the clinician. One may argue that this will create a moral hazard problem for ACO's and other instances of bundled care, but that is beyond the scope of this discussion. The point is that the economic driver in the future will be to reduce the utilization of medical imaging [16,17]. Indeed, at

the extreme one might even conceive of a system where imaging is interpreted by clinical specialists, not radiologists, as a means of lessening revenue sharing.

Given the mounting pressures on radiology and radiologists in particular, it is easy to see how the specialty, once riding a wave of new technology, growth and economic attractiveness, is now threatened by multiple changes in circumstance. Somehow, this has already been communicated to medical students who once ranked radiology among the most desired residencies but now find it much less attractive [18]. The current state of the specialty brings a time of humble and honest self-examination as to what value the radiologist adds to the care of patients. There is no question that medical imaging provides value. What we need to ask ourselves is how much value the radiologist adds. Will radiologists' interpretive services eventually be seen as superfluous in an age of increasing constraints on healthcare expenditures, bundled payments and highly accurate and detailed imaging?

Beginning to answer these questions requires examination of current imaging interpretive practices. First, as has been pointed out, it is difficult to argue that clinical specialists cannot compete successfully with radiologists in interpreting medical imaging related to their own specialties. In fact, one might say that because clinicians typically have more intimate knowledge of their patient's history, they may arrive more directly at clinically relevant diagnoses. As has already been pointed out, many areas traditionally considered to be the domain of radiologists have been under siege for several years now by specialty services: cardiac imaging, neurological imaging, and spinal imaging and, of course, vascular imaging and interventional procedures.

The other side of the argument is that specialists, when viewing studies, likely do not conduct the same intensive interpretive process as radiologists. While clinicians may be equipped to interpret imaging in their specialty, they may not be as thorough in evaluation of these studies, and they may not recognize some less common findings or pathology in unrelated organ systems. Thus, specialists may miss some imaging findings and potentially diagnoses that are atypical or subtle or, perhaps, unrelated to the patient's complaint or findings on the study that are not in the specialists' field of expertise.

Although fears of missed diagnoses are real, the ultimate questions are how much impact non-related diagnoses would have on patient care, how often clinically significant misses would occur and how much additional litigation might result from clinicians' misinterpretations? Not only are there these essential issues of care and outcomes, but also relevant is balancing the economic cost of specialists' misses with the cost of having radiologists read all studies to make these findings.

One might suspect that the economic cost of radiologists to assure presumably higher levels of diagnostic accuracy and hence better healthcare is a value without which our system cannot function. This is not necessarily so. For example, many imaging studies performed on patients in the British National Health Service (NHS) system are not interpreted by a radiologist unless a clinician makes a specific request for a read [19]. In fact, technologists interpret a substantial portion of medical US imaging in the United Kingdom (UK). Even with this practice in place, according to the Organization of Economic

Cooperation and Development (OECD) there has been little impact on either quantity or quality of life but a real impact on the economics of healthcare [20,21]. In fact, data from the OECD suggests that the UK outranks the US in many measured areas while spending less than half per capita on healthcare [21,22]. Should we adopt such a system in the US, the potential effects to health outcomes, rates of litigation and the economics of care delivery are currently unknown. Certainly, some important unrelated diagnoses are discovered when radiologists examine studies, but some also might be discovered by clinical specialists interpreting the same images.

Furthermore, the issue of unrelated and incidental findings touches on three fundamental issues in radiologists' interpretation of medical images that have caused widespread complaints from clinical colleagues. The first is the discovery and listing of a host of unrelated findings that have no real clinical impact on patient care. In the best of cases these serve only to document anatomic variances or benign pathology, some portion of which perhaps may become important later in a patient's life. In the worst of cases, these unrelated findings lead to additional medical testing and expense that in the end does not augment patients' health. So, although radiologists might contribute value to patient care by diagnosing overlooked or unexpected diagnoses, this process also involves identification of clinically unimportant or misleading findings.

The second and likely most easily remedied problem that clinicians have with some radiological reports is that they list only findings, providing no analysis or diagnosis. The lack of analysis, differential diagnosis and suggested final diagnosis in some reports indicates that the radiologist has provided less value than might be expected. On the one hand, one reason that this occurs is that radiologists may not have the necessary clinical history to offer a differential diagnosis or a definitive diagnosis. Were the same studies to be interpreted by a clinician caring for the patient, this relevant background information, by definition, would be available. This suggests that if radiologists move to integrate more closely into clinical practices, then imaging analysis might realize an optimum of expert image analysis combined with a greater knowledge of the clinical background.

The third issue that clinicians complain about in the radiologists' oft expressed uncertainty in the meaning of findings. Arguably, this type of interpretation is unavoidable because every test has its sensitivity and specificity for any given diagnosis. It is part of the responsibility of a radiologist to report findings that stand apart from the norm, with the further necessity to relate these findings to the clinical issues at hand. Regardless, uncertainty often causes some annoyance on the part of the clinicians who read the report, particularly when no guidance as to further evaluation or meaning of the finding is offered. Findings of this sort create a new quandary for the clinician to manage and often generate more medical expenditures in order to resolve the issue, whether clinically cogent or not. Again, having radiologists working side-by-side with their clinical colleagues may help to ameliorate this issue or at the very least open a door to discussion of findings of uncertain meaning and how to handle them.

One potential source of added value that radiologists' readings provide is that of a check and balance against a potentially self-interested interpretation by the treating clinician. Leaving a specialist to interpret their own studies may have two potentially harmful and

expensive effects. The first is that failure to separate imaging services from clinical services may be an inducement to moral hazard on the part of clinicians. Clinicians may have a tendency to over-order imaging when they may profit from their subsequent interpretation. Such behavior has been documented in studies comparing imaging rates among physicians with and without financial incentives [22-27], certainly does not benefit patients and possibly even causes some harm.

The larger issue is again how much self-referral and potentially unnecessary care costs relative to the costs of radiologists' services to control this behavior. In other words, does the cost of radiologists compare favorably with the cost of clinician self-referral, or do radiologists actually cost more without preventing enough potential clinical harm in the form of radiation and unnecessary imaging? Furthermore, it is worth noting that with the changing medical payment system and ACO's such self-serving imaging practices may become moot.

The second way that radiologists serve as a check and balance in medical care is by providing unbiased second opinions. Without a radiologist's unbiased interpretation, a clinician may be inclined, either consciously or unconsciously, to see and act on what he believed to be the problem before obtaining an imaging study. For example, a surgical specialist's desire to operate, whether from the benign motivation of helping a patient or from financial incentive might promote unnecessary surgery if the clinician acts only on his, potentially biased, interpretation of the imaging findings. Having an independent second party examining the same information and rendering an unbiased opinion may help to prevent unnecessary procedures.

At this juncture again one might reasonably ask if the radiologist should be the one to perform this function or if another clinician in the same specialty, but independent of the former, should do this. The latter case might lead to an intra-specialty system of cronyism. On the other hand, it is also not unheard of for radiologists to receive and comply with calls from clinicians requesting that reports be changed so that the clinician is not impeded in his management of the patient. Because of referral patterns, politics and economics the radiologist is at a disadvantage when refusing such a request. Thus, under current practice conditions, the effectiveness of radiologists at preventing unnecessary therapy is probably limited. Again, the question ultimately may come down to the politics and expense of having an entire class of imaging specialists who perform an ombudsmen function to reduce the costs –economic, medical and social – of unnecessary care.

The idea of having radiologists act explicitly as ombudsmen is not new. This type of role has been suggested to help minimize unnecessary imaging examinations. In a setting of fixed payments for medical care as with Diagnosis Related Grouping (DRG), this concept makes economic sense. Even so, this role, when proffered explicitly to radiology practices, has been eschewed for political reasons. One of the easiest ways to fall onto the wrong side of a clinician is to conflict with his intended management. In a fee for service environment this can impact future referrals and hence a radiologist's revenue.

Another value that radiologists provide is quality control and protocol setting for imaging studies. While these are undeniably

important roles, one might reasonably ask if they couldn't be assumed by other individuals. For example, a physicist might provide image quality assurance. Protocols might be provided by a few radiologists who are employed by manufacturers who disseminate protocols for all users of a particular brand and type of machine. Again, while there is nothing to suggest that this type of change is in the offing, the point is that quality assurance and protocol setting roles do not necessarily protect radiologists' roles.

Perhaps the greatest value that a radiologist provides is interpretation of studies on patients sent by clinicians who do not feel competent to render interpretation. At the current time, this represents the majority of radiologist's interpretations, but this fact is no reason for complacency. If economic pressures continue to make turf battles attractive or alternatively induce a reduction in imaging, eventually clinical specialists could assume more and more of radiologists' current work, perhaps leaving nothing behind or leaving only low value studies for radiologists to interpret. Either of these outcomes is unsatisfactory to radiologists from both professional and economic points of view. In a worst case scenario, one could envision a tipping point beyond which clinicians assume all imaging interpretation, if not voluntarily then by governmental mandate.

Academic radiologists, from the early days of the specialty, have furthered our understanding of imaging and its applications through both clinical and laboratory research. Many advances in imaging have been realized by radiologists, for example, the development of the image intensifier and biplane angiography machines, initially designed by Dr. Chamberlain, or current day MR techniques such as metal suppression. These contributions, while not directly generating revenue, are a value added. As pressure to generate clinical revenue increases, clinical radiologists, even in academic centers, do not have as much time to conduct research as in times past.

In these times of change, it is important to reflect on what the future may hold and for radiologists to think about how to evolve. Economic pressures will continue to increase throughout the profession both directly in the form of reduced reimbursements and potential reduction in the volume of imaging as well as indirectly as clinical specialties attempt to claim imaging for themselves. The high quality of anatomic detail provided by today's imagers makes interpretation of images that much easier. Traditionally, papers such as this call for radiologists to network with their clinical colleagues and assume administrative roles in their hospitals and clinics. This is an impotent response to ever increasing pressure. Radiologists are now in a position to rethink proactively their role in medical care and how they work with their clinical colleagues. In this fashion, they can, at least to some degree, control the future of the specialty.

Radiologists may consider how to better align their interests with those of their clinical colleagues. Indeed, many of the turf issues faced by the specialty in the past have arisen from the fact that radiologists have seen themselves as a separate specialty. Instead of acting as independent consultants, the time might be right to think of more integration of care with radiologists working alongside their clinical colleagues as part of a single economic entity. As such, the incentive under fee for service for clinicians to perform imaging may be reduced, leaving clinicians and radiologists to do what each does best.

Even in a bundled care environment, having radiologists integrated into the same economic entity as referring clinicians will align incentives. Radiologists under these circumstances would have the same economic drivers as clinicians and so would more likely accept the role of ombudsman and direct appropriate imaging services. Furthermore, such integration would likely mean more clinical data available to radiologists at the time of interpretation as well as more personal consultation, both to the benefit of patients. Such alignment may lead to overall better clinical care at lower costs. It would further patient care as clinical integration would support the role of radiologist as a provider of unbiased opinions, an individual to set standards for imaging and, of course, the traditional role as the expert in imaging interpretation.

Conclusion

Radiologists, not imaging, are facing uncertain times. The Chinese ideogram for crisis is a combination of the ideograms for danger and opportunity. While there is danger in the air for radiologists, there may also be opportunity. Seizing the opportunity may take some radical thinking and a willingness to transform how radiology is practiced in the US. The current radiology model, though useful in many respects, needs to adapt to changing economic incentives and in one way or another align itself with those of the clinicians radiologists serve.

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