The Future of Radiology in the New Health Care Paradigm: The Moreton Lecture

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Health care reform will catalzye a wave of experimentation with new forms of Medicare payment as well as reorganization of the care system. These changes could profoundly affect not only the discipline of radiology but the evolution of its core technologies. To respond successfully to these challenges, radiology must aggressively build out the prognostic power of its imaging tools. It must also help create new, subspecialty clinical disciplines to use those tools and develop new payment models that capture the value created for patients and for society.

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On March 23, 2010, President Obama signed into law the Patient Protection and Affordable Care Act of 2010. This legislation extends health insurance coverage to approximately 30 million more Americans.

It pays for this extension in part by trimming Medicare payment to health plans and providers, including reducing technical payments for radiologic examinations. It also charters a wave of experimentation with new payment methods for Medicare and Medicaid that could potentially have far-reaching effects on the organization and financing of imaging and radiologic professional services. How radiologists respond to these challenges, and how they extend the technological platform they have helped build, will have a major effect on the future shape of radiologic practice.

"He Whom the Gods Will Destroy, He First Gives Forty Years of Prosperity"

Peter Drucker's warning applies with special force to radiology, which has enjoyed extraordinary success as a clinical discipline in the past 40 years. Radiologists were the first to recognize the power of digital standards to extend and broaden access to imaging findings and interpretation. Thanks to Digital Imaging and Communications in Medicine, radiologists became the first global medical discipline and extended radiologic interpretation into a 24/7, "read anywhere" activity.

Radiology was also the first purely diagnostic discipline to extend its reach into curative medicine through interventional radiology. Radiology was also among the first clinical specialties to recognize the need for an empirically based methodology for professional payment, responding by creating a relative value system that was incorporated largely unmodified into the Medicare Resource-Based Relative Value Scale system in the early 1990s. Radiologists have been leaders among clinical specialties in developing appropriateness criteria to inform diagnostic decision making. And by incremental development, radiologists have collaborated with their partners in industry to refine and extend the major imaging modalities—CT, MR, ultrasound, and PET—which have become the indispensible core of the modern diagnostic process.

And, as a consequence of these innovations, radiology has had remarkable economic success. In an era of fiscal restraint, however, that success has made radiology and imaging a prime target for cost reduction. Policymakers have decried "the imaging boom" and made not only nonincremental Medicare payment reductions but also advocated the extension of costly and intrusive cost containment methods such as prior authorization to Medicare patients.

FUTURE CHALLENGES TO THE DISCIPLINE

The future of radiology as a discipline will rest largely on how the profession responds to challenges in 3 broad areas:

1. advancing and leveraging technology

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2. influencing the changing structure of professional imaging practice
3. inventing new economic models to support radiologic practice

Advancing and Leveraging Technology

The eminent biologist, the late Lewis Thomas [1, pp31-6], warned us about "halfway" technologies that did not definitively cure diseases but rather mitigated their symptoms at great societal cost. Radiology might be thought of as a "two-thirds way" diagnostic technology. Advanced imaging now provides striking images of clinical problems, in many cases far superior to what can be seen by the naked eye. The steady accretion of technical improvements in these mature technologies has enabled remarkable acuity of images from advanced imaging modalities such as CT and MRI, as well as fusion imagery of metabolic processes when combined with PET.

Although radiologic diagnosis has become sufficiently developed to eliminate much exploratory surgery, it is still not developed sufficiently to avoid triggering costly follow-up studies. Because imaging cannot determine in many cases how much clinical risk is embodied in a potentially threatening finding, today's advanced imaging examinations still generate excessive cost and patient anxiety. What a patient shown an imaging finding of a potentially dangerous narrowing of key coronary arteries really wants to know is, "Does this lesion threaten my life and require acute intervention?" What a patient shown an imaging finding of a mysterious small mass in the lung really wants to know is, "Is this aggressive cancer that needs to be removed right now, or a benign nodule left over from an earlier illness that can be left alone?"

Contemporary imaging technology cannot definitively answer these questions in a single session. And in a litigious malpractice climate, clinicians have almost no choice but to schedule a wave of costly and often invasive follow-up tests to determine how to respond. These costs, as much as the costs of the initial imaging examination, are what concern policymakers seeking to control imaging expense.

The technological solution to this problem is to build out the repertoire of molecular probes needed to characterize the biologic threat posed by an identified lesion. They appear on the horizon. For example, molecular probes that can characterize the aggressiveness of a tumor [2, p191] or identify unstable or inflamed coronary artery lesions that should be stented to avoid an acute episode later are in clinical testing. The validation of these molecular markers would enable definitive analyses and more rapid and effective treatment. This in turn will lead to appropriateness criteria that define the appropriate context for clinical intervention.

Other technological advances would extend imaging's usefulness and therefore radiology's clinical franchise. They include the ability to probe for stray tumor cells left behind in a surgical site after removal of a tumor, which uses molecular probes to identify errant cancer cells when illuminated with near-infrared light (R. Weissleder, personal communication, November 2008).

Another potential game-changing advance would be ultrasound applications that can both identify and target sites of internal bleeding for cauterization using high-intensity focused ultrasound (HIFU). Present HIFU applications include the removal of uterine fibroids and potential cancerous lesions. The Defense Advanced Research Projects Agency has funded applied research using Doppler ultrasound to locate arterial bleeding sites and HIFU signal to stop the bleeding [3]. This technology could play a critical role in saving lives presently lost in combat when improvised explosive devices sever soldiers' femoral arteries. The same technology could be used to find and cauterize sites of gastrointestinal bleeding in the hospital.

Another technology that could help solve real-world problems would be an imaging modality that could detect whether an accident victim or victim of sports injury had a severed or compromised spinal cord. Presently, emergency medical technicians are required to immobilize victims of potential spinal injuries before transporting them, causing potentially life-threatening delays in evacuation for treatment. An imaging tool that enabled emergency personnel to determine if nerve pathways to extremities were damaged could save lives and preserve function by enabling more rapid transport to the hospital.

Information technology innovation could also make a difference by increasing radiologists' productivity. Each successive increase in CT and MR computing power is generating larger data files that are challenging busy imaging departments to expand their data storage capacity [4]. In the commercial world, an increasing amount of data storage takes place "in the cloud," as data are transferred to remote servers accessible through broadband Internet and managed through sophisticated data management utilities. Increasingly, sophisticated data storage does not require owning the servers on which data are held. Robust data utilities that enable uploading imaging files into the cloud and rapid retrieval could save radiologists both time and dollars.

More powerful advanced imaging modalities are generating markedly greater quantities of images that must be reviewed individually by interpreting radiologists. In some modalities, such as mammography, computer-assisted image recognition software already can flag specific images for more detailed review, helping focus radiologists' time on the handful of images that contain clinically significant information [5]. It may be that ultimately, image recognition software will be the logical "first reader" of high-technology scans in the future, narrowing and focusing scarce radiologists' time and attention.

Radiologists have excelled at exploiting advances in electrical engineering and medical physics to create powerful diagnostic tools. Yet contemporary radiologists remain depressingly dependent, 115 years after Roentgen, on ionizing radiation as the principal source of radiant energy for diagnosis. According to the ACR, almost 74% of imaging sessions in 2008 required the use of ionizing radiation (including radiation therapy and interventional studies) [2, p86]. Given widespread public and professional concern about radiation exposure, reducing this percentage by discovering new or extending existing, less damaging sources of radiant energy should also be a high priority.

The workhorses of modern imaging—CT, MR, PET, and ultrasound—are mature technologies that have been in the clinical tool chest for 30 years or more. Although they have been refined through continuous collaboration between industry and the radiology community, it was inevitable that use of these tools would become democratized and accessible to nonradiologists. The profession devotes an extraordinary amount of its energy to fighting off incursions into its turf by other disciplines and not enough energy to expanding imaging's technical capacity and usefulness. Pushing the envelope of technical innovation in imaging to create new diagnostic and therapeutic tools is essential to extending radiology's usefulness to society in the next 20 years. In other words, the best defense is a good offense.

Influencing the Changing Structure of Professional Imaging Practice

Medical technology is constantly changing clinical practice and thus altering the boundaries of clinical disciplines. Present and future technological advances will alter the boundaries surrounding the practice of radiology, potentially spawning new clinical disciplines. Already, radiologists share with cardiologists and other clinicians complex tools using imaging guidance to target catheter-based therapy at sites inside the human body. With the building out of HIFU and new tools for catheter-based intervention, imaging has facilitated the birth of a new nonsurgical discipline of interventional medicine.

Similarly, the increasing integration of imaging into the surgical suite, and the creation of new tools using molecular probes, optical scanning, and intraoperative uses of ultrasound, MR, and other modalities, may result in a new discipline of surgical imaging. The operating room of the future will certainly contain a rich mix of imaging tools and require professional expertise in the surgical suite and be connected by broadband networking to help manage those tools [6]. Mastering the skills needed for radiologists to participate in the intimate dance of the surgical team may indeed require the focused concentration of fellowship training in surgical imaging.

Finally, the emergence of a toolbox of molecular probes for imaging active pathology inside the human body puts radiology and an important subdiscipline of laboratory medicine, molecular pathology, on convergent paths. Some of these probes may serve a dual purpose: targeting abnormal cells and then destroying them (so-called theranostics). We may be seeing here the emergence of yet a third new clinical discipline: "molecular diagnosis and therapy." Presently, only a relative handful of radiology trainees receive special preparation in molecular biology to provide the knowledge foundation for using these new tools.

All of these technological advances raise the potential for interdisciplinary conflict and economic competition among clinical disciplines for control over the technologies, which may not redound to the benefit of patients. Radiologists are unlikely to be able to replicate the organ-specific knowledge of anatomy, physiology, and molecular biology of subspecialists who train in organ-specific disciplines. At the same time, it is highly unlikely that trainees in organ-specific disciplines will be able to match the command of image management and interpretation imparted to those who train in radiology at the graduate level. Why should patients have to choose between modality competence and organ-specific expertise if collaboration could bring them both through team-based care?

The rise of subspecialty radiology presents the possibility that radiology, which has flourished in a generalist practice model for most of the past 40 years, may fragment into subspecialty disciplines or conceivably "calve" new disciplines. How radiologists respond to these technological disruptions of traditional practice modes will have great implications for future patient care and the future of the discipline.

One approach is to co-opt these modalities into traditional radiology practices or academic departments through the creation of new sections and the hiring of the relevant collaborating practitioners (cardiologists, neurosurgeons, molecular pathologists, etc). These new disciplines could be built out as "centers of excellence" inside radiology practices, both in the academic and community setting. At the same time, academic radiology departments must be prepared to create learning experiences at the postgraduate and fellowship level to equip young radiologists to participate in these emerging disciplines.

Another approach is for radiologists, in collaboration with hospital managements, to support the creation of new clinical centers that provide both capital and operating support of these emerging disciplines and that recruit the organ-specific and scientific expertise to utilize the new technologies, fully drawing their staffing from multiple clinical disciplines. Radiologists could provide space, equipment, and administrative support or some combination for the new disciplines, as well as the expertise to manage both imaging related workflows and payment. Radiology's role would be to catalyze and support the formation of the new discipline without directly controlling it, relying on hospital management for transitional administrative support.

A third and potentially more dangerous alternative is to let nature take its course, and to permit the spawning of additional turf conflicts with the disciplines of pathology and the neurosciences. The proliferation of these conflicts will weaken all the parties involved by diluting their political influence and creating the perception that economic concerns outweigh those of quality patient care in the eyes of policymakers. Given a choice, I believe patients will opt for centers that combine clinical, scientific, and modality-specific expertise in a single care experience, guided by multidisciplinary clinical protocols.

Inventing New Economic Models to Support Radiologic Practice

Health reform will unleash a flood of experimentation with new forms of Medicare payment as a departure from fee-for-service payment [7]. Fee-for-service payment based on incidents of care has been the engine of economic growth of radiology and imaging for more than two generations. So the uncertainty about future payment models reflects real concerns about the potential for undermining both radiologists' incomes and professional standing.

One major potential change, the accountable care organization, deputizes someone—a hospital and its "extended medical staff," an independent practice association, a multispecialty group, a hospital or physician organization—to bring down the rate of increase in Medicare costs in a defined population (of at least 5,000) [8]. Because imaging examinations have been, until very recently, one of the most rapidly growing of those costs, "community control" over imaging expense (and radiologic incomes) will be an element of strategy needed to achieve sharable savings gains.

Another potential change—bundled, episode-based payment—places not only inpatient imaging technical costs (already bundled into inpatient Medicare diagnosis-related groups) but radiology professional fees and the outpatient preadmission workup and potentially all follow-up imaging examinations up to 30 days after discharge, inside a fixed payment envelope adjusted only by the severity of the patient's illness. This would have the effect of pooling and politicizing the distribution of imaging dollars, making ultimate compensation for radiologists a clinical-administrative decision made, most likely, by the hospital that receives the bundled payment.

Of course, intelligent use of imaging is vital to ensure that appropriate care is rendered and that patients do not return to the hospital (where the expense of a readmission will rapidly exhaust the fixed payment). Radiologists must anticipate the demands for an economic justification for the strategic use of imaging to maintain even the current levels of unit payment and be prepared to conduct the analysis of the impact of imaging on episode costs.

In this new world, imaging must forge not only new economic rationales for imaging's role but also new payment schemes that encompass its services. Of particular relevance are the increasing number of instances in which diagnosis and therapy can take place in the same session. Presently, it is possible to use imaging to diagnose and intervene (by stenting or balloon dilation) in anomalies in arterial circulation (though many instances of interventional radiology are, in fact, scheduled and take place in a different session than the diagnostic event). Applications of HIFU might ultimately enable diagnosis and treatment in a single session. As dual-use "theranostic" molecular imaging agents become more widely prevalent, those tools might also require only a single session.

Single sessions that encompass both diagnosis and image-guided therapy could replace many interventions that are presently inpatient or that require general anesthesia, or multiple sessions, some of which are ambulatory. They fall into a hazy area between outpatient and inpatient: neither "scan" nor "hospitalization," more than a "visit." Many of these diagnostic and therapeutic interventions are legitimately bundled episodes. In reality, they are a new form of clinical care and should be paid on a severity-adjusted or risk-adjusted single-payment basis that recognizes the savings accruing to the care system from avoiding all that inpatient overhead and complexity.

Generous payment bundles that recognize the value of intelligent and rapid intervention in acute conditions could preserve radiologists' incomes and save the health system money. The relatively generous payment for "triple-rule-out" CT scans for chest pain provides a useful analog. Indeed, as the CT scan has become the pivotal event in diagnosis of virtually any serious and unobvious somatic pain, one can make a strong argument that the role of CT in emergency diagnosis merits a higher unit payment, or a larger piece of a bundled payment, than for an elective diagnosis.

Of course, as with coronary artery stenting (in which there has been huge variation in use and at least circumstantial evidence of overuse), there is the moral hazard of unnecessary intervention guided by the therapist (for additional income). Thus, these unified episodes of diagnosis or therapy must be framed by enforceable appropriateness criteria and peer review. Otherwise, increased utilization will, as for outpatient surgery, wipe out the potentially large unit cost savings from reduced hospitalization expenses.

CONCLUSIONS

Radiologists have been fortunate to have grown up with and extended some of the most powerful technological tools in the contemporary medical toolbox. Furthermore, they have, time and again, anticipated societal needs and an increasingly evidence-based clinical environment to create new knowledge frameworks to define their business. Nonincremental changes in payment policy, the changing structure of clinical practice, and further technological innovation require that radiologists plan yet a further wave of adaptation. Active experimentation, not only with emerging technologies, but emerging forms of care organization and payment, will be required for radiology to extend and strengthen its professional franchise in the coming decade. There are grounds for optimism that the profession's successful adaption will continue.

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