

Radiology Education in the Era of Population-based Medicine in the United States

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Over the past several decades, the practice of radiology has undergone substantial change primarily related to advances in imaging technology, changes in the infrastructure of healthcare delivery, and evolution of reimbursement systems. Yet to a large extent, the educational system has not substantially changed. In this perspective, we discuss the need for radiology education to adapt and address these essential systems-based skills (business, quality, informatics, leadership, population-based medicine, and interprofessional teamwork) to ensure that future radiology graduates will thrive in this evolving healthcare environment.

Key Words: Medical education; radiology education; population-based medicine; non-interpretive skills; resident education; graduate medical education; quality, inter-professional, practice management; research methodology; imaging appropriateness; business; leadership; patient-centered care.

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Over the past several decades, the practice of radiology in the United States has undergone substantial change primarily related to advances in imaging technology, changes in the infrastructure of health delivery, and evolution of reimbursement systems (1–3). It is estimated that inappropriate use of high-tech imaging (such as computed tomography, magnetic resonance, and positron emission tomography) accounts for approximately \$26.5 billion of the \$700 billion wasteful spending in the US healthcare system each year (4). The recent introduction of accountable care organizations (ACOs) and the associated bundled payments for populations of patients in place of the traditional fee-for-service model in the United States is changing the focus from individual subspecialty care to team-based interprofessional care (5). An ACO is defined as a healthcare organization of interprofessional healthcare providers who work collaboratively together to provide coordinated care for a defined population of patients (6). One of the main goals of an ACO is to reduce overall healthcare costs within a defined patient population with reimbursement directly tied to meeting target quality goals and cost measures (6,7). Although radiologists can add value by overseeing the content and implementation

of decision-support systems and by continuing to provide consultative services to ensure appropriate imaging based on evidence-based guidelines (8), we believe that there is a great need to develop and implement innovative educational approaches to best prepare future practitioners in this era. These initiatives should create transformative leaders who can readily respond to the ever-changing healthcare landscape. However, presently, in our experience, the training of radiologists in the United States continues to occur somewhat in isolation from other disciplines, as the traditional boundaries of medical and surgical specialties seem to remain in place. This classical model entails training within the specialty according to specific requirements and guidelines without considering how the specialty interacts with specialties outside of radiology in real-life practice. Although residencies often now involve trainees in multidisciplinary conferences, there is a need to increase these experiences as practicing radiologists more often function as part of multidisciplinary teams and are routinely responsible for teaching each others' learners. This model of education is also of particular relevance given the focus on patient- and family-centered care in our own institutions; in health care, we (the authors) believe that we must work together as an effective and excellent team for the improved benefit of patients and their families. We are aware that some medical schools are now calling to integrate systems science into the medical school curriculum; however, in reality, it seems only natural to extend this tri-pillar approach (basic science, clinical science, and systems science) from undergraduate medical education into graduate medical education (GME), including diagnostic radiology (DR) residencies and radiology fellowships because mastery of informatics, leadership, population-based medicine,

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patient-centered care, quality improvement, and teamwork appears to be self-evident essential skills in these newer delivery models (9,10). This tri-pillar approach could possibly be achieved through curricular design and reform, emphasis at the level of departmental and programmatic leadership, provision of certificate and degree-yielding subprograms, funding and time to attend relevant classes in undergraduate and graduate schools, mentorship, and related projects and committees.

In addition, in our opinion, to a large extent, the advent of picture archive communication systems and digital imaging in the United States has marginalized most radiologists from the bedside and resulted in radiologists having what can at times be minimal contact with patients and referring providers. The main exceptions would be breast imaging and interventional radiology where daily patient interaction is the norm and radiologists work closely with other specialties to provide the highest quality of care to patients. The Radiological Society of North America (RSNA) campaign to revitalize patient-centered radiology aligns well with the desire of many of us to bring all radiologists back to the forefront of healthcare delivery (11). That being said, for radiologists to be poised as leaders in providing the highest quality of care to patients, it is critical that the next generation of radiologists be trained with the essential value-added skills to succeed in this new era of population-based medicine. This next generation must possess the necessary management skills so that radiologists are at the table adding value to all decisions regarding imaging, whether it concerns an individual patient or is at the national policy level. So, then, how should radiology education change to meet the demands of our evolving healthcare delivery system?

For many DR residency programs, recent restructuring of board certification by the American Board of Radiology has created the reality of a “3:1” or “3:2” program—3 years of core training in diagnostic interpretation and intervention (core residents) and 1–2 years of advanced training (advanced residents, occasionally with fellowship included in a “3:2” program), sometimes focused in one or more subspecialty areas. Many DR residents also continue to complete 1–2 years of subspecialty fellowship training before their first job after training. Within this framework, there is great opportunity for educators to develop curricula to address the growing need for radiologists to have strong skills not only in image interpretation but also in business, healthcare management, interprofessional collaboration, leadership, and quality, many of which are now recognized as key Accreditation Council for Graduate Medical Education (ACGME) non-interpretive DR milestones (12) (Table 1). Residency training should, we believe, educate all graduates with essential value-added skills so that they can function as leaders in the varied and evolving healthcare system, whether that training takes place at a university or in a community-based healthcare delivery system. In this era of ACOs, we feel that there needs to be a shift toward educating radiologists to be part of a system of population-based care that is coordinated across settings, specialties, and time, such as that which apparently already exists

TABLE 1. Key Curricular Components

- **Imaging appropriateness**
 - Interactive case-based conferences integrating ACR Appropriateness Criteria (<http://www.acr.org/Quality-Safety/AppropriatenessCriteria>)
 - Relative costs (in terms of ionizing radiation, money, and time) of various imaging modalities
 - **Clinical decision-making**
 - Evidence-based medicine
 - Case-based didactic sessions
 - Multidisciplinary conferences and tumor boards
 - Interprofessional simulated experiences
 - Consultant rotations in advanced years
- **Practice management**
 - Working within systems
 - Healthcare economics
 - Financial accounting
 - Leadership
 - Healthcare delivery models
- **Quality**
 - Educational sessions focused on this topic
 - Focused reading and online resources
 - Interdisciplinary quality improvement projects
 - Departmental, institutional, and national committees
- **Research methodologies**
 - Comparative effectiveness
 - Technology assessment
 - Basic statistics
 - Epidemiology
 - Interdisciplinary projects in health services research
- **Team-based interprofessional experiences**
 - How to work effectively in teams
 - Simulation with interprofessional teams
 - Active participation in multidisciplinary conferences and tumor boards
 - Consultant rotations in advanced years of training

at Kaiser Permanente (13). However, many program directors, especially those in charge of smaller training programs, face substantial challenges in tailoring their programs to address population-based care. As such, this further emphasizes the need to develop national open-source resources (such as curricula, teaching strategies, and assessment tools) that all programs can use to ensure that these topics remain a priority.

Given a need to train valued members of a multidisciplinary team, it seems critical that radiology residency and fellowship programs place greater emphasis on developing these systems-based skills (Table 2). With this goal in mind, one option would be for the first 3 years of residency training to focus first on the development of basic interpretative and interventional skills in all radiological subspecialties and then provide the trainee opportunities to “drill down” in one to three specific clinical areas during the final year of training. In addition to image interpretation, the teaching sessions during the first 3 years should include focused didactic sessions covering key non-interpretive topics, including relative costs and

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