

Teaching Critical Thinking in Graduate Medical Education: Lessons Learned in Diagnostic Radiology

Benjamin Morrissey and Marta E Heilbrun

Department of Radiology and Imaging Sciences, University of Utah Health Sciences, Salt Lake City, UT, USA

Journal of Medical Education and Curricular Development
Volume 4: 1–5
© The Author(s) 2017
Reprints and permissions:
sagepub.co.uk/journalsPermissions.nav
DOI: 10.1177/2382120517696498



ABSTRACT: The 2014 Institute of Medicine report, *Graduate Medical Education that Meets the Nation's Health Needs*, challenged the current graduate medical training process and encouraged new opportunities to redefine the fundamental skills and abilities of the physician workforce. This workforce should be skilled in critically evaluating the current systems to improve care delivery and health. To meet these goals, current challenges, motivations, and educational models at the medical school and graduate medical education levels related to formal training in nonclinical aspects of medicine, especially critical thinking, are reviewed. Our diagnostic radiology training program is presented as a “case study” to frame the review.

KEYWORDS: Critical thinking, graduate medical education, radiology, residency, flipped class room, value based

RECEIVED: September 26, 2016. **ACCEPTED:** February 7, 2017.

PEER REVIEW: Four peer reviewers contributed to the peer review report. Reviewers' reports totaled 1480 words, excluding any confidential comments to the academic editor.

TYPE: Perspective

FUNDING: The author(s) received no financial support for the research, authorship, and/or publication of this article.

DECLARATION OF CONFLICTING INTERESTS: The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

CORRESPONDING AUTHOR: Benjamin Morrissey, Department of Radiology and Imaging Sciences, University of Utah Health Sciences, 30 North 1900 East #1A071, Salt Lake City, UT 84132-2140, USA. Email: Ben.morrissey@hsc.utah.edu

Introduction

A 2014 Institute of Medicine (IOM) report, *Graduate Medical Education that Meets the Nation's Health Needs*, suggested that the current funding structure for training our US physician workforce lacks accountability.¹ The report describes the unique nature of public financing for graduate medical education (GME) via the Medicare program and therefore the unique accountability for serving the public good that such financing affords. The IOM suggests that significant changes to GME financing and governance could fundamentally improve physician training.

The first recommendation is the creation of “... a physician workforce better prepared to work in, help lead, and continually improve an evolving health care delivery system that can provide better individual care, better population health and lower cost.” The second is to encourage “... innovation in the structures, locations and designs of GME programs to better achieve Goal 1.”¹ Shifting resident training from an in-hospital-based structure to more diverse practice environments would help achieve these goals.² However, this training infrastructure does not yet exist and will be costly to build. In addition, although there are currently explicit Accreditation Council for Graduate Medical Education (ACGME) expectations that trainees participate in research and scholarly activity, these activities are uncommon in many residency programs.³

Motivation for Critical Thinking

The goal of this review is to propose a generalizable framework that GME training programs could use to meet the IOM report goals. We review current challenges, motivations, and educational models at the medical school and GME levels related to formal training in nonclinical aspects of medicine, especially critical thinking. To frame the review, we present our own training program as a “case study.”

Adding dedicated critical thinking training in residency programs' curriculum will address some of the IOM 2014 report goals. Critical thinking is, by definition, a mode of thinking in which the thinker analyzes his or her thought process, assesses it, and then reconstructs the thought process. The goal of critical thinking is to eliminate the tendency toward bias, prejudice, and otherwise uninformed conclusions.⁴ Given the complexity of medical systems and the need to respond correctly, it is important that physicians actively learn to recognize biases, prejudices, and incorrect thinking.

A workforce that is capable of leading and improving health care delivery systems will be skilled in critically evaluating the current systems. This will require learning how to ask answerable questions and how to perform background analyses. This background analysis can then be used to discover ways to innovate and improve. They can then assess the benefits these innovations have on direct patient care, population health, and cost of care delivery. This skill set can be achieved through formal and sustained training in critical thinking throughout the process of becoming a practicing physician. Rather than requiring all learning to take place in the direct care of patients, this opens opportunities to invest in nonclinical skills training, including research and quality improvement, during residency.

Current Initiatives and New Efforts

To boost the critical thinking skills of our trainees, we are implementing a trifold strategy that could be modeled by other training programs. The goal is to produce the workforce of the future—physicians who have the skills to innovate and improve health. This strategy shifts the focus from self-reliance, self-preservation, and passivity to team building and collaboration.



Our training program devotes a minimum of 8 hours per week to protected education for trainees. Although much clinical medicine is learned during direct interaction with patients, formal and protected classroom-based instruction is of value.⁵ Classroom teaching provides an avenue for in-depth exploration of topics outside the pressure of clinical decision making. Group teaching and discussion promote peer learning. In addition, critical and uncommon diseases are introduced during didactic teaching that are not reliably encountered during training. Although the IOM idea of moving all education into the clinical spaces where health care is delivered^{1,2} is appealing, classroom-based and clinical-based teaching are complementary.⁵ Trainees value time dedicated to the consolidation of clinical and theoretical knowledge.⁵ Didactic lectures and defined educational programming remain important in realizing a more capable physician workforce.

We are transitioning from a traditional didactic lecture model to the flipped classroom model. In the flipped classroom, didactic materials are provided to the learners prior to the scheduled lecture time. The face-to-face time is used to fill in knowledge gaps and further solidify understanding of the key concepts.⁶ This puts the onus on the resident to review and learn the material independently as there will be limited time in which the resident is a passive recipient of knowledge. Group time is used to foster active discussions in which trainees articulate their thought processes. In addition, the faculty, because the conference is not scripted, are often presented with opportunities to model critical thinking techniques. This mode of learning creates an environment that is conducive to discovering knowledge gaps, biases, prejudices, and other limitations of understanding that might lead to incorrect or uninformed clinical decisions.

There are many intersections between ACGME⁷-mandated general competencies for trainees and critical thinking. In radiology specifically, most of the activities of noninterpretive skills mandated by ACGME⁸ build the skill sets that are the foundation of critical thinking. For example, in the domain of Systems Based Practice, competence in Quality Improvement is mandated. In Quality Improvement projects, the trainees look at the processes and systems that interfere with optimized care delivery and work to fix them. These projects often focus on scenarios that the trainees believe negatively affect their ability to deliver optimized patient care. These interventions are explicitly designed to address quality of care and often implicitly address underlying contributors to physician burnout. The problem solving that is embodied in the Plan-Do-Study-Act model of Quality Improvement encourages reflection and progressive problem solving.^{1,9,10} This gives trainees an opportunity to understand that some errors may be unavoidable, that physicians are independent drivers of health, and that the system can improve. Knowing how to develop, implement, and evaluate quality improvement projects is a way one can add value to a health care organization and improve patient care.¹¹

These quality improvement activities are intrinsically aligned with the IOM report recommendations.

However, quality improvement projects are a relatively new concept. The lack of departmental support or resources for such projects could be a hindrance at some institutions. In addition, some programs may not have mentors who are comfortable in guiding residents through these projects as they themselves are new to these concepts.³ However, proving the “value” and impact on patient outcomes of health care interventions is a required skill set in the new payment models of health care and training. This means trainees must learn these tools to become the workforce that is envisioned by the IOM report.¹

The second domain in ACGME Systems Based Practice is Health Care Economics.⁸ Understanding economic concepts are essential to making informed recommendations and understanding potential barriers to change. Neither residents nor practicing physicians have a firm understanding of cost or the business aspect of medicine.¹² There are external resources available to teach these concepts, including the American College of Radiology via offerings in their Radiology Leadership Institute.¹³ Some residency programs have dedicated business curricula. By teaching practice management, malpractice, informational technology, and personal finance, we believe that trainees will be positioned to incorporate these factors into their decision making when in practice. A lack of understanding of the economics of health care can produce the types of knowledge gaps, biases, and prejudices that limit a physician's ability to make informed decisions.

Practice-based learning and improvement is an additional ACGME general competency.⁷ An introduction to the tools and process of evidence-based radiology provides a forum for teaching and promoting practice-based learning. Evidence-based medicine training is now required in every medical school's curriculum in the United States.¹⁴ The goal is to provide all physicians with a basic understanding of statistics, how studies are conducted, and how to evaluate studies.¹⁴ It is important to understand key concepts such as diagnostic accuracy, sensitivity, and specificity. The application of these concepts to make recommendations for patient care is even more important and elusive.¹⁵ Medical school provides an introduction to these topics, and many residency programs try to expand on this foundation and tailor it to their specialty through formal lectures or journal clubs.

Incorporating evidence-based medicine practices into clinical activities leads to better retention of concepts and, in theory, better patient care.¹⁴ The criticality of understanding and using evidence-based medicine in practice is enforced by the coverage of this content in physician basic licensing examinations as well as specialty board licensing examinations. For example, the American Board of Radiology has emphasized noninterpretive skills, including critical thinking, in their certification examinations.¹⁶

A third means to improve resident critical thinking is to provide dedicated academic time. This includes dedicated block research time to work with faculty on completing research projects with the intention of presentation at national meetings and publication. Through participation in scholarly activity and by prioritizing that as valued time, the trainees learn to advocate for the importance of nonclinical activities in practice. To succeed when provided with this protected time, a trainee must be effective when gathering and evaluating existing evidence. To design studies that may further contribute to existent knowledge, identify new opportunities, and/or validate current behaviors, a trainee has to question current truths. The goal of this time is to give trainees the chance to solidify a base skill set in evidence-based medicine, upon which he or she will build.¹⁷ By creating space outside of the clinical realm to process existing information, trainees are encouraged to take the time necessary to explore new information and break down biases.

Discussion

Improving critical thinking training in residency is necessary to meet the IOM goals as well as to meet the medical care needs of our patients. There are many current threats to clinical care that the physician workforce needs to be prepared to address. In medicine, and especially in Radiology, volumes have been increasing steadily since 2008.^{18,19} With the unsustainable costs associated with medical care in the United States, there has been increased scrutiny of the contribution of imaging to overuse of health care services in the United States.^{20,21} For example, among Medicare recipients, there was 85% cumulative growth in imaging from 2000 to 2009.²² Over the 1996–2010 period, the number of computed tomographic examinations has tripled and the number of magnetic resonance imaging scans has quadrupled among members of integrated health care systems, whereas the number of radiographic examinations has remained relatively stable.²²

At our institution, we have seen a steady growth of more than 10% in volume each year in radiology as well as multiple other specialties. This increasing volume creates tension between resident education, quality of care, and efficiency. The demand to meet the increasing work leads to less time for teaching of residents. This also means less time to incorporate the patient's history and current clinical status into making diagnoses. To meet the increasing volume pressures, the radiologist truncates the time spent in examining and interpreting each study. When interpreting a study, the radiologist needs to incorporate information from multiple resources, including the electronic medical record, the images themselves, the limitations of the modality, and other patient factors. To reach the correct diagnosis, the radiologist must access his or her prior experience, training, and ability to think critically about the factors that might make a particular patient unique.

Increasing volume can also be a factor in the raise of physician burnout. This is a significant issue that will negatively

affect the ability of health systems and will force trainees to adapt to new models of care delivery.^{23,24} A provider workforce that actually improves health care delivery will have to have the bandwidth to take on further risk, given the uncertainty inherent in developing something new. Radiology, despite being a profession that is often cited as a good choice for work and life balance, most recently was ranked as having the fifth highest rate of burnout (61.4%) among all surveyed specialists.²⁴ The metrics of success in these future training systems will need to improve the health and satisfaction of caregivers, in addition to the quality of care delivered. If interventions merely help physicians cope with stress but do not address the root causes of physician burnout, the overall improvements may be limited.²³

Building Evidence

Radiology has long been criticized for the lack of high-quality evidence to inform the practice and recommendations that a radiologist makes when diagnosing a particular condition and patient. A 2006 article by Blackmore and Medina³² argues that what is described as truth in radiology relies heavily on a paternalistic approach that is associated with traditional eminence-based medicine. In an eminence-based mode, experts provide guidance on the basis of their own experience and judgment. The accurate synthesis of evidence is required to provide high-quality and cost-appropriate care. The randomized control trial (RCT) is considered the epitome of high-quality evidence for medical decisions. There is a relative paucity of radiology RCTs in the medical literature. A recent review of RCTs over the past 20 years revealed only 358 radiology trials, of which most were characterized by relatively poor methodologic quality.²⁶ If the evidence that predicated the training of the diagnostic radiologist is weak, then the decisions a radiologist makes are inherently uninformed. This is a problem that the specialty as a whole must realize. The incorporation of systematic critical thinking into specialty training will help radiologists recognize the strength or weakness of the evidence that informs decisions. The goal of critical thinking is to eliminate the tendency toward bias, prejudice, and otherwise uninformed conclusions.⁴

Adding Value

Health care in the United States is in transition from a fee for service (volume-based) system to an outcome (value-based) system.^{27–29} Increasingly, both government and private payers are indexing payment to quality and other outcome metrics. Research is necessary to support this move and define these metrics. A challenge for radiologists is a lack of discrete and quantitative measures of the radiologists' work that links patient outcomes to imaging and the interpretation of the imaging.^{10,30,31} Thus, current recommendations emphasize the development of performance measurement tools that promote the use of evidence-based criteria in radiology.^{30,32–34}

In addition to this, radiologists are trying to find ways to add value to the increasing team-based approach to medicine. Many residency programs, including radiology residency programs, now seek not only to involve but also to have residents function in multidisciplinary committees.^{12,35} We are trying to incorporate this mind-set into our program by giving senior residents the responsibility to prepare and present patients in these committees. The goal is to better understand the complexity of the multidisciplinary medical team and demonstrate how the radiologist effects and optimizes decision making regarding patient care. Through these means, the trainees are encouraged to both question current practice and discover the means to improve care.

The evolution, explosion, and significance of medical imaging in today's practice of medicine have made the process of both teaching and learning clinical and nonclinical radiologic skills a formidable task to accomplish during 4 years of Diagnostic Radiology residency.^{36,37} Faculty and future practitioners may have only their experience to inform decisions. There is no guarantee that such experience is insulated from bias, prejudice, or basic incorrect thinking. Even the guidelines developed by radiology societies, to which a practicing radiologist may refer to support a recommendation for the appropriate use of imaging tests, are often dependent on the experience of an expert committee over evidence.³²

Conclusions

Training programs can transition from a traditional hospital-based structured teaching method to a more diverse practice environment by thinking broadly about their current efforts that encourage critical thinking and active learning. Realizing the long-term benefits imagined in the IOM report will require substantive, dedicated, and continuous training. Many of the changes in our program represent initial steps needed to begin this process. To fully realize the IOM report goals, residency training must teach trainees to critically appraise and synthesize information rather than focus on fact memorization. Physicians with a critical thinking skill set are positioned to adapt to and to help shape ever-changing models of health care delivery. Although the specifics in each medical specialty may be different, the theme of producing physicians that solve clinical problems is a universal goal.

Graduate medical education residency training should embrace the goal of developing lifelong learning skills in trainees so that independent practicing physicians will be able to question current practices, synthesize information, recognize study design flaws, including statistical biases, and develop meaningful solutions and processes for their practice. This ability to question biases, expose uncertainty, and innovate is necessary to improve the health of our patients, our communities, and our profession. Residency provides the perfect place for young physicians to hone these skills, but for this to happen critical thinking must be an explicit focus of resident education.

Author Contributions

Both authors contributed equally to drafting, revising and approving the final version of the manuscript.

REFERENCES

- Eden J, Berwick D, Wilensky G. *IOM (Institute of Medicine): Graduate Medical Education That Meets the Nation's Health Needs*. Washington, DC: The Institute of Medicine; 2014.
- Kirch DG. IOM's vision of GME will not meet real-world patient needs. <https://www.aamc.org/newsroom/newsreleases/381882/07292014.html>. Updated 2014. Accessed August 23, 2016.
- Yu JP, Kansagra AP, Thaker A, Colucci A, Sherry SJ, Subramaniam RM. Building for tomorrow today: opportunities and directions in radiology resident research. *Acad Radiol*. 2015;22:50–57.
- Scriven M, Paul R. Defining critical thinking. National Council for Excellence in Critical Thinking Instruction. <http://www.criticalthinking.org/pages/our-concept-and-definition-of-critical-thinking/411>. Updated 2015. Accessed August 20, 2016.
- Chen LY, McDonald JA, Pratt DD, Wisener KM, Jarvis-Selinger S. Residents' views of the role of classroom-based learning in graduate medical education through the lens of academic half days. *Acad Med*. 2015;90:532–538.
- Hurtubise LC, Turner TL, Ledford CH, Mahan JD. Getting started with on-line faculty development. *J Grad Med Educ*. 2015;7:671–672.
- Accreditation Council for GME (ACGME). Common program requirements, 2016:23. http://www.acgme.org/acgmeweb/Portals/0/PFAssets/ProgramResources/Common_Program_Requirements_07012011%5B1%5D.pdf. Accessed November 1, 2016.
- Accreditation Council for GME (ACGME). ACGME program requirements for graduate medical education in diagnostic radiology, 2016:34. https://www.acgme.org/Portals/0/PFAssets/ProgramRequirements/420_diagnostic_radiology_2016.pdf. Accessed November 1, 2016.
- Flanagan MR, Foster CC, Schleyer A, et al. Aligning institutional priorities: engaging house staff in a quality improvement and safety initiative to fulfill clinical learning environment review objectives and electronic medical record meaningful use requirements. *Am J Surg*. 2016;211:390–397.
- Johnson CD, Swensen SJ, Applegate KE, et al. Quality improvement in radiology: white paper report of the Sun Valley Group meeting. *J Am Coll Radiol*. 2006;3:544–549.
- Lee VS, Kawamoto K, Hess R, et al. Implementation of a value-driven outcomes program to identify high variability in clinical costs and outcomes and association with reduced cost and improved quality. *JAMA*. 2016;316:1061–1072.
- Slanetz PJ, Mullins ME. Radiology education in the era of population-based medicine in the United States. *Acad Radiol*. 2016;23:894–897.
- Prober AS, Ledermann E, Norbash A, Mehan WA Jr, Bedi HS. Fulfilling the health care economics milestones: adopting an online curriculum for radiology residency programs. *J Am Coll Radiol*. 2015;12:314–317.
- West CP, Jaeger TM, McDonald FS. Extended evaluation of a longitudinal medical school evidence-based medicine curriculum. *J Gen Intern Med*. 2011;26:611–615.
- Cronin P, Rawson JV, Heilbrun ME, et al. How to critically appraise the clinical literature. *Acad Radiol*. 2014;21:1117–1128.
- American Board of Radiology (ABR). *Core exam quality and safety syllabus*. 1st ed. 2013. https://www.theabr.org/sites/all/themes/abr-media/pdf/CORE_Exam_Study_Guide_FINAL%28V1%29.pdf.
- Heilbrun ME, Rawson JV, Shah M. Using health services research to meet ACGME resident research requirements. *Acad Radiol*. 2013;20:1077–1082.
- Chokshi FH, Hughes DR, Wang JM, Mullins ME, Hawkins CM, Duszak R Jr. Diagnostic radiology resident and fellow workloads: a 12-year longitudinal trend analysis using national Medicare aggregate claims data. *J Am Coll Radiol*. 2015;12:664–669.
- Moreno CC, Hemingway J, Johnson AC, Hughes DR, Mittal PK, Duszak R Jr. Changing abdominal imaging utilization patterns: perspectives from Medicare beneficiaries over two decades. *J Am Coll Radiol*. 2016;13:894–903.
- Armao D, Semelka RC, Elias J Jr. Radiology's ethical responsibility for health-care reform: tempering the overutilization of medical imaging and trimming down a heavyweight. *J Magn Reson Imaging*. 2012;35:512–517.
- Korenstein D, Falk R, Howell EA, Bishop T, Keyhani S. Overuse of health care services in the United States: an understudied problem. *Arch Intern Med*. 2012;172:171–178.
- Smith-Bindman R, Miglioretti DL, Johnson E, et al. Use of diagnostic imaging studies and associated radiation exposure for patients enrolled in large integrated health care systems, 1996–2010. *JAMA*. 2012;307:2400–2409.
- Montgomery A. The inevitability of physician burnout: implications for interventions. *Burnout Res*. 2014;1:50–56.

24. Shanafelt TD, Hasan O, Dyrbye LN, et al. Changes in burnout and satisfaction with work-life balance in physicians and the general US working population between 2011 and 2014. *Mayo Clin Proc.* 2015;90:1600–1613.
25. Wood BP. What's the evidence? *Radiology.* 1999;213:635–637.
26. Hong SJ, Yoon DY, Cho YK, et al. Characteristics and quality of radiologic randomized controlled trials: a bibliometric analysis between 1995 and 2014. *AJR Am J Roentgenol.* 2016;206:917–923.
27. Allen B Jr, Levin DC, Brant-Zawadzki M, Lexa FJ, Duszak R Jr. ACR white paper: strategies for radiologists in the era of health care reform and accountable care organizations: a report from the ACR Future Trends Committee. *J Am Coll Radiol.* 2011;8:309–317.
28. Lee CI, Basu PA. The radiologist's guide to health services and policy research training. *AJR Am J Roentgenol.* 2011;197:W978–W979.
29. Lee CI, Forman HP. Radiology health services research: from imperative to legislative mandate. *AJR Am J Roentgenol.* 2011;196:1111–1114.
30. Patti JA, Berlin JW, Blumberg AL, et al. ACR white paper: the value added that radiologists provide to the health care enterprise. *J Am Coll Radiol.* 2008;5:1041–1053.
31. Baker LC, Atlas SW, Afendulis CC. Expanded use of imaging technology and the challenge of measuring value. *Health Aff (Millwood).* 2008;27:1467–1478.
32. Blackmore C, Medina J. Evidence-based radiology and the ACR appropriateness criteria®. *J Am Coll Radiol.* 2006;3:505–509.
33. Hollingworth W, Jarvik JG. Technology assessment in radiology: putting the evidence in evidence-based radiology. *Radiology.* 2007;244:31–38.
34. Van Moore A Jr. Radiology and the health care reform debate. *J Am Coll Radiol.* 2006;3:569–570.
35. Slanetz PJ, Kelly AM. Transforming radiological education through collaboration and innovation. *Acad Radiol.* 2016;23:777–778.
36. Looking back on the millennium in medicine. *N Engl J Med.* 2000;342:42–49.
37. Van Beek EJ, Malone DE. Evidence-based practice in radiology education: why and how should we teach it? *Radiology.* 2007;243:633–640.