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Authors

Straus, Christopher M

Webb, Emily M

Kondo, Kimi L

et al.

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Medical Student Radiology Education: Summary and Recommendations From a National Survey of Medical School and Radiology Department Leadership

Christopher M. Straus, MD^a, Emily M. Webb, MD^b, Kimi L. Kondo, DO^c,
Andrew W. Phillips, MD, MEd^d, David M. Naeger, MD^b, Caroline W. Carrico, MD^e,
William Herring, MD^f, Janet A. Neutze, MD^g, G. Rebecca Haines, MSM^h, Gerald D. Dodd III, MD^c

The ACR Task Force on Medical Student Education in Radiology, in partnership with the Alliance of Medical Student Educators in Radiology, investigated the current status of how and to what extent medical imaging was being taught in medical schools. The task force executed a 3-part survey of medical school deans, radiology department chairs, and intern physicians. The results provided an updated understanding of the status of radiology education in medical schools in the United States. This summary includes recommendations about how individual radiology departments and ACR members can assist in advancing the specialty of diagnostic radiology through medical student education.

Key Words: Radiology education, medical imaging education, radiology clerkship, appropriateness criteria, medical student

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INTRODUCTION

Imaging is central to the practice of modern medicine. It can be used to detect disease, direct clinical management, guide procedures, and deliver therapies. Yet radiology is frequently underrepresented in the formal curricula of medical schools and taught by nonradiologists with educational materials that do not include the latest technological advances or reflect the current role of radiologists in the patient care continuum. More specifically, several recent surveys confirm that only 10% to 25% of US

medical school graduates are required to take radiology as a clinical rotation [1,2].

The ACR and the Alliance of Medical Student Educators in Radiology (AMSER) conducted a survey of the US medical school system to assess the current status of radiology education. Responses were elicited from medical school deans, radiology department chairs, and intern physicians. Selected results of the survey and recommendations to enhance the quality of radiology education in our medical schools are reported here.

ACR AND AMSER SURVEY METHODOLOGY

Members of the ACR and AMSER created a detailed survey that was sent electronically to all US members of the Society of Chairs of Academic Radiology Departments (n = 124), US allopathic medical school deans (n = 138), and members of the American Medical Student Association who graduated from medical school in 2011 and 2012 (n = 4,596). The survey was conducted from November 1 to December 18, 2012. The response rate was 46% for the survey of chairs (57 of 124), 24% for the survey of deans (33 of 138), and 1.4% for the survey of interns (66 of 4,596). Because of the low response rate for the survey of interns, these data were not included in the analysis. The survey data collected from the deans and chairs,

^aDepartment of Radiology, University of Chicago, Chicago, Illinois.

^bDepartment of Radiology and Biomedical Imaging, University of California, San Francisco, San Francisco, California.

^cDepartment of Radiology, University of Colorado School of Medicine, Aurora, Colorado.

^dStanford/Kaiser Emergency Medicine Residency Programs, Palo Alto, California.

^eDepartment of Radiology, Duke University Medical Center, Durham, North Carolina.

^fDepartment of Radiology, Albert Einstein Medical Center, Philadelphia, Pennsylvania.

^gDepartment of Radiology, Penn State Hershey Medical Center, Hershey, Pennsylvania.

^hAmerican College of Radiology, Reston, Virginia.

Corresponding author and reprints: G. Rebecca Haines, MSM, American College of Radiology, 1891 Preston White Drive, Reston, VA 20191; e-mail: bhaines@acr.org.

however, reflect a balanced representation of US allopathic medical schools: $\chi^2(1) = 1.015$ ($P = .314$) and $\chi^2(1) = 3.274$ ($P = .351$) for class size and geography, respectively ($[1 - \beta] > .8$ for both).

For the data analysis of open-ended survey questions, one researcher (KLL) read all the responses and identified recurrent themes that captured the breadth of the respondents' views. This provided a thematic framework that was used by two researchers (CMS and KLL) who independently coded the comments.

SELECTED SURVEY RESULTS

The ACR-AMSER task force selected the following survey results to initiate discussion and support specific and actionable recommendations for implementation in today's medical education environment. Full survey results are provided online.

Who Is Teaching Radiology and Imaging to Medical Students?

Radiologists often advocate that it is essential for medical students to learn medical imaging from imaging-trained experts; however, survey responses suggest that nonradiologists commonly teach imaging in both preclinical and clinical settings. The exact percentage could not be calculated from the present survey.

On a 5-point, Likert-type scale, 58% of chairs and 53% of deans reported that more or much more radiologist involvement is needed with medical imaging education. However, chairs reported a significantly greater need than deans for more imaging instruction by radiologists ($t[81] = -2.277$, $P = .025$, $r = 0.25$ for comparison of means on the 5-point, Likert-type scale). Furthermore, majorities of both chairs and deans indicated that more radiologists need to be available to teach. Only 57% of chairs agreed or strongly agreed that clinical expectations prevent radiology faculty members' involvement in student education, suggesting that there are other significant obstacles in addition to the availability of professional time.

Most radiology departments have only a select few radiologists engaged in medical student teaching, substantiated by a mean chairs' estimate of $14 \pm 4\%$ (median, 10%) of their departments' total faculty full-time equivalents dedicated to medical student education. There was no significant difference in the percentage of full-time equivalents devoted to medical student education between large and small medical schools (defined as a class size of ≥ 150 or < 150 students, respectively) ($t[46] = -0.606$, $P = .548$) or between faculty size ($r = -0.105$, $P = .479$).

Alternatives to Radiologists Teaching Imaging

Deans were significantly more likely than chairs to indicate that nonradiologists could adequately teach medical imaging to medical students ($\chi^2[1] = 50.606$; $P < .001$; odds ratio, 153.06). Seventy-five percent (24 of 32) of deans believed that nonradiologists can adequately teach basic imaging skills, supported by comments shown in Table 1a (available online). Some deans qualified their

statements, citing specific circumstances such as orthopedists' teaching skeletal imaging (Table 1a).

Conversely, 98% of chairs (51 of 52) reported that nonradiologists could not adequately teach medical students medical imaging. Fifty-eight percent (29 of 50 comments) cited limited expertise, inadequate training, and a lack of comprehensive knowledge (Table 1b, available online). Sixteen percent of chairs (8 of 50 comments) cited inaccurate knowledge and the propagation of misconceptions as reasons that nonradiologists cannot adequately teach medical imaging (Table 1b).

How, When, and What Medical Imaging Is Being Taught Today?

The majority of imaging education occurs in clinical rotations, primarily during year 4 and primarily in the form of electives (Tables 2 and 3, available online). Most schools do not offer or require imaging courses during years 1 through 3 (Table 3). Imaging is often incorporated into existing required preclinical courses, most notably during anatomy (Table 4, available online).

During year 3, when many students take their required clerkships, formal medical imaging instruction commonly occurs within core clinical rotations, such as internal medicine, surgery, and or obstetrics and gynecology (Tables 5 and 6, available online). If radiologists are involved, survey results showed that nearly all use traditional methods such as lectures and textbooks, with only half reporting the use of online or interactive digital resources.

How Should Radiology Be Taught and What Should Be Taught?

Both chairs (77% [39 of 51]) and deans (59% [19 of 32]) reported that we need more or much more medical imaging instruction across all 4 years of medical school. No dean or chair respondents reported needing less vertical integration. Sixty-three percent of chairs (33 of 52) agreed or strongly agreed that radiology should be a required medical school course, with a trend toward more chairs (39% [18 of 46]) than deans (20% [6 of 30]) supporting the statement ($\chi^2[1] = 3.076$, $P = .079$).

Chairs and deans were also asked the open-ended survey question "In the next ten years, what changes would you like to see (if any) to how medical imaging is taught to students?" Vertical curricular integration was the most common answer, cited by 44.1% (15 of 34) and 25.6% (22 of 86) of deans and chairs, respectively. Responses such as "Integrated into all four years with teaching by radiologists" and "Increased presence of radiologists teaching in the medical school curriculum" demonstrate not only a desire for increased imaging instruction but that imaging be taught by radiologists, which was the second most desired change by both chairs and deans (Tables 7a and 7b, available online). Although students place great value on image interpretation skills in their imaging education [3], this was not a theme identified by chairs or deans. The third most desired change was greater emphasis on utilization and ACR Appropriateness Criteria® education (Table 7b).

Identified Barriers in Medical Imaging Education

When asked what hinders implementation, the chairs cited radiology faculty time availability, followed by a lack of available time in the curriculum and resistance from other departments (Tables 8a and 8b, available online). “Departmental faculty interest in medical student teaching is low” was specifically cited.

Deans similarly identified cost and a lack of availability of radiology faculty members as hindering factors; however, these were less commonly cited compared with logistics or the “lack of coordination between clerkship directors and radiologists” (Table 8b).

There was no significant difference between chairs’ (55% yes [29 of 53]) and deans’ (53% yes [17 of 32]) assessments of whether their medical schools provide financial support (salary, equipment, or other resources) to radiologists (or their departments) to teach medical imaging ($\chi^2[1] = 0.020, P = .887, [1 - \beta] = .79$). Similarly, there was no significant difference between chairs’ (35% yes [18 of 51]) and deans’ (28% yes [9 of 32]) assessments of whether their medical schools provide financial support to nonradiologists to teach medical imaging ($\chi^2[1] = 0.460, P = .497, [1 - \beta] = .78$). According to deans’ responses, there was no significant difference in medical schools’ providing support to radiologists or nonradiologists to teach medical imaging (Fisher’s exact test, $P = 1.00, [1 - \beta] = .67$). However, radiology chairs reported a weak trend toward more frequent radiologist financial support than nonradiologist support ($\chi^2[1] = 2.675, P = .201, [1 - \beta] = .86$).

Chairs were asked about faculty promotion and the level of support provided by other faculty members in the radiology department. Only 57% of chairs (30 of 53) reported that “Other faculty members in the Radiology Department strongly support medical student education.” And only 45% of chairs (23 of 52) reported that medical student teaching improves a radiologist’s chance for promotion. Deans placed significantly greater importance on teaching medical students for promotion compared with chairs (3.23 vs 2.73 on a 5-point, Likert-type scale ranging from 0 = not important to 5 = very important, $t[81] = -2.732, P = .008, r = 0.29$, demonstrating a moderate effect size).

What Can the ACR and AMSER Do at a National Level to Improve Medical Imaging Education?

Survey respondents were asked, “What can ACR or AMSER do at a national level to improve medical imaging education?” (Tables 9a and 9b, available online). The most commonly cited directive by chairs (26.9% [14 of 52]) was advocacy. Respondents strongly believe that both organizations need to advocate the improvement of medical imaging education and radiology as a curricular requirement, with both financial support and accountability.

The next two most common themes involved curricular resources and the development of a national standard

curriculum. Twenty-five percent of chairs (13 of 52) requested the development of readily available educational resources reflecting “a consensus of what all medical students should know including findings, utilization, and safety.”

In contrast, more than half of the deans (53.6% [15 of 28]) requested more curricular resources and cited the need to establish a national standard curriculum for medical imaging education (Table 9b). One dean wrote, “Provide one unified organization responsible for medical imaging education that works with medical schools and the AAMC [Association of American Medical Colleges] to set standards and competencies and increase visibility of this group.”

RECOMMENDATIONS

The combined ACR-AMSER committee proposes the following 6 recommendations and actionable interventions to help move medical student education in radiology away from entrenched and outdated traditions. The recommendations were crafted to be easy to adopt and to allow measurable improvement [4]. Each intervention can be attempted separately or in combination.

1. Radiologists need to acknowledge that expectations surrounding medical imaging education are expanding and are currently unmet.

The survey highlighted the importance and increased need for medical imaging education as a discrete component in medical school curricula. Without broader participation by radiology, the vacuum created will be filled by nonradiologists. For example, teaching anatomy to students using hands-on ultrasound usually requires small-group instruction and a substantial number of instructors or time. Clinically busy radiology departments sometimes consider this type of commitment overwhelming, resulting in skills defaulting to emergency or critical care physicians and surgeons [5,6].

Action Plan

- Implement and increase exposure to medical imaging education taught by radiologists at every available point in the medical school curriculum.
- Identify radiologists (including residents and fellows) interested in teaching imaging.

2. Radiologists must be identified by medical school leaders as the “go to” faculty members for teaching of medical imaging.

When radiology is not included in the formal medical school curriculum, radiologists have little input into how imaging content is introduced. Although students encounter radiology in reading rooms and on the wards, nonradiologists take the lead in instruction. Radiologist-led instruction is not only critical to the quality of student education, it is critical to students’ appreciation of the role of radiology in medical practice and the level of expertise involved in accurate image interpretation [7].

According to 2012 National Resident Matching Program data, fewer than 5% of graduating US medical school seniors pursue careers in radiology [8], with most medical students destined to become future referring physicians. How can students, later as practicing physicians, be expected to understand radiologists' role if radiologists are not identified as the experts in medical imaging during their training?

A student's appreciation for the value and complexity involved with image interpretation can be conveyed only by specialists demonstrating these skills. Non-radiology-led experiences prevent critical imprinting experienced earlier in training, thus reinforcing the incorrect stereotype that radiologists are not active in the care of patients, a stereotype often communicated to the general public by these same referring physicians.

Action Plan

- a. Lobby for fundamental medical imaging concepts to be taught by radiologists.
- b. Identify educational opportunities for medical students to directly observe radiologists' role in patient care, such as in interdisciplinary conferences.
- c. Consider the use of social media and points of student access that are outside formal medical school curricula.

3. Shift medical imaging education to logical early points in the medical school curriculum.

The survey indicates that the majority of radiology education currently takes place in the last 2 years of medical school. It is far easier, however, to teach someone who is uninitiated rather than to undo information already learned and considered "understood." Updated medical curricula now more commonly introduce radiology content in the first 2 years of coursework [9]. Students exposed to radiology in their preclinical curricula are less likely to hold negative stereotypes about the profession [10-12], and radiology in an integrated curriculum can be academically beneficial [13].

Action Plan

- a. Aggressively promote radiologists as integral to every anatomy course, to become the face of imaging at the beginning of the student educational experience.
- b. Identify additional preclinical courses in which imaging is utilized or could be integrated: pathology, neuroanatomy, research, or elective courses.
- c. Start a radiology interest group and invite junior students to participate.
- d. Increase the availability of digital imaging resources to this technically savvy population.

4. Radiologists must provide a uniform message and experience across institutions.

The majority of deans surveyed supported the development of a national imaging curriculum and standardized

educational resources integrated into the 4-year curriculum. Imaging taught by nonradiologists is often highly specific to a particular clinical situation. This is attractive to medical students who gravitate toward "imaging pearls," but these anecdotal teachings lack cohesion and are unlikely to use evidence-based information. Radiologists must demonstrate our value across a diverse curriculum with content emphasizing best-use practices, including education on image production techniques, patient safety, and patient outcomes, and identify ourselves as the consultants best able to navigate the nuances of appropriate examination selection [14,15].

Action Plan

- a. Implement integrated medical imaging training across all 4 years of the curriculum.
- b. Develop a nationally recognized and utilized core imaging curriculum with both didactic and digital interactive materials that all schools and students can access.
- c. Institute a required radiology-led medical imaging clerkship, preferably in the third year.
- d. Include education on imaging safety, quality, and appropriateness of utilization.
- e. Stress the extent of direct patient contact and procedures.

5. Promote the adoption of standardized measures of medical student competency in medical imaging.

Similar to the need for a standardized curriculum, this survey indicates the need for standardized assessment tools. Examinations are probably underused in radiology clerkships, which are often observational and sometimes lack a formal structure, especially with regard to assessment [16]. Examinations motivate mastery of material and ensure that students and other educators take programming seriously [17]. This uniform platform will give credibility to individual departments adopting this type of curricular expansion.

Action Plan

Support testing of students on basic principles and concepts, using nationally available resources such as ExamWeb.

6. Radiology chairs should make medical student education a top priority and a valued part of their departmental hierarchy.

This survey identified several barriers to the implementation of more comprehensive radiology education programming, most notably a lack of clinical faculty time and department cost. Individual radiology faculty members cannot alter their roles in the medical school curriculum and hierarchy without the support and encouragement of their chairs. Salary support, dedicated time to teach, rewarding teaching, and mentoring are all strategies to support change [18-20]. Departments must also place value on educational research to allow the

evaluation of curricular innovations. Without clear study of the effectiveness of new programming, the adoption and dissemination of needed changes will be hampered.

Action Plan

- a. Encourage department chairs to develop and support an education track for faculty promotion within their programs.
- b. Support faculty membership in professional organizations that promote educational material development and collaboration.

CONCLUSION

The importance of medical imaging to patient care has grown exponentially; however, the role of radiology in teaching has not changed in a correlative fashion [4]. Radiologists must play a more active role in the education of students who will be future referring physicians and potential radiologists. Furthermore, radiologists must rededicate themselves and reconstruct their idea of how medical students should be taught, just as radiologists need to be more visible to patients [21]. This effort will require increased resources, the development of dedicated faculty members, and an increased appreciation for those who choose to make this their career, but it is an absolute requirement if we are to enhance the fundamental relationship between radiologists and referring physicians.

The ACR can play a major role in improving these opportunities, by partnering with similarly focused professional organizations in the development and dissemination of targeted materials and online teaching resources. The development and expansion of ACR-backed programming would facilitate the integration of a new national paradigm in medical student education.

TAKE-HOME POINTS

- Both medical school deans and radiology department chairs describe an increasing need for more undergraduate medical imaging education.
- Medical school deans describe nonradiologists as adequately teaching medical student—level imaging, which is in direct opposition to radiology chairs, who state that radiologists, as imaging experts, should be teaching this material.
- A small percentage of programs have required medical imaging content taught by radiologists, and most use traditional methods of instruction with scattered self-generated materials.
- Both deans and chairs report the need for vertical integration and a standardized medical imaging curriculum across the 4-year program, with increased utilization of the ACR Appropriateness Criteria.
- Both deans and chairs agree that financial support for medical imaging instruction is required, yet deans do not differentiate between the need to support radiology versus nonradiology departments in this effort.

SUPPLEMENTARY DATA

Supplementary data can be found online at: <http://dx.doi.org/10.1016/j.jacr.2014.01.012>.

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