Original Articles

Radiology Undergraduate and Resident Curricula: A Narrative Review of the Literature

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Abstract

Objective: The purpose of this study was to examine the literature regarding radiology curricula for both undergraduates and residents.

Methods: A review of the literature was performed using relevant key words. Articles were retrieved through December 2012 using PubMed, ScienceDirect, ERIC, Proquest, and ICL databases along with a manual review of references.

Results: Of the 4716 unique abstracts reviewed by the author, 142 were found to be relevant to the purpose of this study. Undergraduate radiology education, radiology curriculum, and radiology pedagogy vary widely between disciplines and between colleges within disciplines. Formal radiology education is not taught at all medical programs and little radiology training is incorporated into non-radiology residencies. This results in some medical graduates not being taught how to interpret basic radiology images and not learning contraindications and indications for ordering diagnostic imaging tests. There are no definitive studies examining how to incorporate radiology into the curriculum, how to teach radiology to either undergraduates or residents, or how to assess this clinical competency.

Conclusions: This review shows that radiology education is perceived to be important in undergraduate and residency programs. However, some programs do not include radiology training, thus graduates from those programs do not learn radiology essentials.

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Introduction

Radiology education is a complex mix of varying pedagogy, assessment, and administration—governed by beliefs about what should be taught, when it should be taught, and how to effectively teach the information. Opinions abound in the literature surrounding radiology education about what constitutes good education, usually presented with authors stating their opinion of what should be taught1–4 or how it should be taught.5,6 However, a dearth of literature exists examining how radiology is taught, learned, or evaluated. Nor is there much research comparing...
radiology programs with regard to any of the myriad of variables that exists within a given curriculum. What little literature exists demonstrates that undergraduate radiology education, radiology curriculum, and radiology pedagogy vary widely between disciplines and between colleges within disciplines. The paucity of literature addressing these issues was best summarized with the statement: “evidence-based radiology education and radiology education research are glaringly lacking”. 

Radiology educational curricula at both the undergraduate and graduate levels have been discussed in the literature since the early 1900s. Significant similarity is found in resident and undergraduate radiology training; they often have similar needs and utilize the same resources. However, no summary review has been completed to evaluate literature on Radiology educational curricula of undergraduate and graduate levels. A review is needed in order to provide a foundation of knowledge for informing future curricular research. Therefore, the purpose of this study was to examine the literature regarding radiology curricula for both undergraduates and residents in a variety of health professions educational programs.

Methods

Literature through December 2012 was searched using: PubMed, ScienceDirect, ERIC, Proquest, and ICL databases along with manual review of references. The comprehensive sampling strategy utilized the terms: radiology OR diagnostic imaging AND education OR teaching OR resident OR medical student OR chiropractic student OR curriculum OR medical education OR medical school OR medical students OR medical curriculum OR chiropractic education, OR chiropractic school OR chiropractic students OR chiropractic curriculum. Articles were limited to those in the English language and to humans.

Results

The resultant 4716 unique article abstracts and/or titles were reviewed by the author. All articles that appeared germane to undergraduate and resident radiology curriculum were obtained and reviewed by the author, which led to the inclusion of 142 articles in this paper.

Discussion

Undergraduate Radiology

Approximately 29% of American medical schools in 2000 had a required core radiology clerkship while 72% offer a radiology elective. This is a decrease from a similar study in 1994 that found 32% had required radiology clerkships. Internationally, hours spent in radiology training in undergraduate medical programs vary dramatically: a 1997 survey of 20 countries and 70 universities revealed hours dedicated to radiology ranged from 0 to 88 hours over medical undergraduate degree programs. However, 87% of 322 surveyed non-radiologist physicians believe that radiology education should be mandatory in medical school and a 2003 article found that physicians overwhelmingly support radiology electives in the curriculum.

Chiropractic education, unlike other healthcare programs, has long incorporated courses in radiology throughout its undergraduate curricula. Chiropractic curricula include courses on radiation physics, radiation protection, normal radiographic anatomy, bone pathology, and soft tissue pathology. On average, in chiropractic education in North America, 360 hours are dedicated to radiology education. Radiology classes generally begin in the first or second term of the program, and continue every term until students enter clinic in year four. In addition, portions of the National Board of Chiropractic Examiners (NBCE) exam are devoted specifically to radiology content.

Much of the undergraduate medical radiology education literature centers on the importance of radiology education and, in particular, a formal radiology curriculum, what it should entail, when it should be taught, and how it should be incorporated, whether in the form of an integrated curriculum, an independent curriculum, or some combination of the two. Radiology curricula is problematic because not enough hours exist in undergraduate medical programs to adequately accommodate all courses that stakeholders wish to include in the curriculum. Additionally, stakeholders often have disparate goals, even when agreeing on curricular content. Complicating factors are numerous and include poor remuneration for clerkship coordinators and other academic radiologists, changing demands due to health care reform, faculty members’ time constraints, and the fact that radiology instruction in problem-based learning curricula is often performed by non-radiologists. These issues have been in the literature for decades, cross into the chiropractic
undergraduate literature, and continue to worsen. The wealth of knowledge undergraduate students must assimilate during their four-year tenure continues to increase with the ever-expanding body of medical knowledge. Some articles suggest that new medical graduates exhibit a minimal level of radiology knowledge with approximately half of graduates not knowing the risks of common investigations or how to select the appropriate clinical investigation. This could possibly result in a potential risk to patients in clinical practice.

Lack of proper radiological knowledge and skill is not a new concern. Bloomfield (1977) argued that a comprehensive radiology-teaching program was needed in the undergraduate medical curriculum in order for all physicians to adequately interpret images when a radiologist is not immediately available and to know what imaging modality to order. Interacting with radiologists is something all practitioners will do throughout their practice lives. Bloomfield presents his experiences as the sole developer and instructor of a radiology educational program at a medical school in Tasmania and suggests that a similar program needs to be incorporated into all medical colleges. He believes that radiology should be “the key subject in the medical curriculum” (p. 981). Bloomfield (1978) develops this argument by explaining how he structured the courses to be in the form of tutorials and not lecture format. He found that students respond favorably to this teaching style and that evaluations ensured students grasped the information. In the 1980s, the University of Adelaide Medical School in Australia incorporated a six-week clinical skills training program that included nine hours in radiology: this inclusion was greatly supported by web technology and preliminary evaluations have found that the students learned well with this approach but administration and implementation of the clerkship has been problematic. An earlier attempt at integrating radiology into another course was undertaken in the 1960s through the use of cinefluorography in a medical pharmacology course.

A recent curricular change at Wake Forest University School of Medicine has resulted in a radiology clerkship supported by web technology and preliminary evaluations have found that the students learned well with this approach but administration and implementation of the clerkship has been problematic. An earlier attempt at integrating radiology into another course was undertaken in the 1960s through the use of cinefluorography in a medical pharmacology course.

The American Association of Dental Schools published curricular guidelines for oral radiology in 1980 that specify not only what needs to be taught, but also how to teach it, specifying that the students must have didactic and demonstration-type teaching, in addition to taking and interpreting radiographs. These guidelines also specify the qualifications required of the individuals teaching these courses.

Several articles describe ways to alter a medical curriculum to integrate radiology in a variety of courses and times during students’ training. For instance, integration of radiology lectures into third-year student internal medicine clerkships has been attempted and was found to be just as favorably received by students as independent radiology lectures. However, while the study evaluated compensation for the instructors for the two different courses, it did not assess the courses’ effectiveness by comparing their outcomes. Therefore, it is unclear from the article whether, academically, this is a worthwhile curricular revision.

Another form of curricular integration, studied at Emory University College of Medicine and the University of Iowa College Of Medicine, is the merging of radiology and anatomy courses, including using digital radiographic images alongside the cadaver in digital anatomy teaching suites. This was shown to be effective at both institutions and is dependent on neither the instructor nor the institution. Similar curricular reform has been implemented at the University of Maryland School of Medicine, with radiology education integrated into the second- and third-year core clinical clerkships. Other colleges are incorporating radiology into the basic anatomy classes at the start of the students’ program. A recent curricular change at Wake Forest University School of Medicine has resulted in a radiology clerkship supported by web technology and preliminary evaluations have found that the students learned well with this approach but administration and implementation of the clerkship has been problematic. An earlier attempt at integrating radiology into another course was undertaken in the 1960s through the use of cinefluorography in a medical pharmacology course.

A small subsection of this area of literature deals with the debate of what should be taught to undergraduates. For instance, 1 article proposes a specific set of educational objectives for medical student radiology training to prepare qualified future junior medical staff in a general practice setting. Other articles propose general curricular content for medical student instruction. The authors posit radiation protection or suggest components of an overall radiology curriculum for medical students, such as cardiothoracic radiology, sonographic diagnosis, or the use of PACS for case presentation.

Radiology Residencies

Articles have been published discussing the need for a well-defined, quality curriculum for radiology residencies. Arguments supporting a national curriculum for radiology abound, with editorials, political articles, and letters addressing the topic. Some discuss the definition of curriculum, arguing it is more than a simple list of subjects. Others borrow heavily from educational literature presenting concepts such as: goals and objectives, the dynamic nature of curricular content, methods of instruction, faculty training, infrastructure
needs, and methods of evaluating both faculty and students. The authors explain that it is imperative that radiology education adopt these educational models to adequately educate future radiologists.

Many articles propose curricula in specific areas of radiology, including cardiothoracic, musculoskeletal, mammography, or pediatric radiology. Proposals for new topic areas include imaging informatics and electronic imaging technology specialists. There are arguments about the degree to which specialization should occur and topics that should or should not be included in the curriculum. Articles of this nature can be found dating back to the 1960s. Some authors demand that a standardized national curriculum for radiology residencies be defined; that the institutions be required to follow the guidelines and that the radiology board exams test from the curriculum.

Authors also describe radiology education in its current manifestation, how it was developed, or how it was historically taught in their area of the world. Many European medical schools offer master’s degrees in conjunction with their residency programs. This is also a trend in the chiropractic radiology residency programs with master’s programs currently offered at National University of Health Sciences and New York Chiropractic College. The University of Glamorgan Welsh Institute of Chiropractic and Life University are currently developing similar master’s programs.

A subsection of curriculum discussion focuses upon non-interpretive skills that radiologists will need during their professional lives, such as job search and contracting skills, business savvy, professional standards, ethics, accreditation programs, critical thinking skills, interpersonal skills, communication skills, research skills, teaching skills, and medical organizational politics. One article describes a collaborative effort undertaken by the American College of Radiology and the Association of Program Directors in Radiology to meet this curricular need within residency programs. This effort entailed designing a set of videotapes to teach residents these skills. This study found that significant resident learning occurred as a result of viewing the videotapes. Feedback from residents and residency directors was very positive. Additional skills requiring mastery by radiology residents include effective communication and an understanding of guidelines for making the most appropriate imaging or treatment decision for a specific clinical condition. Accordingly, the Accreditation Council for Graduate Medical Education mandates that radiology residency programs teach residents communication skills.

Discussions exist of the importance of radiology training for residents in other medical specialties such as orthopedics, pediatrics, internal medicine, family practice, and emergency medicine. One article, examining the use of the morning report to provide radiological education to pediatric residents, found that during 388 case presentations over a 10-month period, 559 radiological studies were shown. However, the morning reports were generally done by non-radiologists which resulted in questions participants could not adequately answer. Common unanswered questions included radiological study indications and techniques and the radiological appearance of diseases. The article concluded it was important for radiologists to take part in morning reports to enhance primary care residents’ education. Several schools are integrating radiology resident training with emergency medicine residents and other specialties, and some are requiring a clinical year in addition to the 4 years of radiology residency.

**Limitations**

This study was limited to articles available in the English language and therefore is not comprehensive of all literature world-wide. The search did not include the grey-literature or other potentially relevant sources. It is possible that the search terms did not identify all relevant articles.

**Conclusions**

This literature review identified that the only similarity found in literature relating to radiology curricula is that radiology education is perceived to be important in both undergraduate and residency medical education programs. However, formal radiology education is not taught at all undergraduate medical programs and, in most undergraduate programs, it is only offered as an elective. Similarly, little radiology training is incorporated into non-radiology residencies. This insufficient amount of radiology education has resulted in about one-half of new medical graduates not learning the contraindications and indications for ordering diagnostic imaging tests, and not given the opportunity to learn how to read and interpret basic radiology images in the event that a radiologist is unavailable. The remaining literature on radiology education curricula consists of debates and suggestions for curricular content, descriptions of existing programs, and proposals for methods incorporating radiology into
various programs and other related ideas. No agreement exists in these areas, and it does not appear that there will be in the near future.

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