

Introducing First-Year Medical Students to Radiology: Implementation and Impact

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Rationale and Objectives: The aims of our study were (1) to describe a new educational intervention for first-year medical students that gave a substantial, early exposure to radiology and (2) to examine how this early exposure was received by the students.

Materials and Methods: Our new curriculum incorporated a new 2-week course very early in the M1 year entitled Foundations of Diagnostics and Therapeutics. Among other topics, the course included a substantial introduction to radiology primarily through small-group seminars and online materials, administered using a flipped-classroom approach. The students were given pre- and postcourse surveys that assessed the degree to which they felt prepared to learn about radiology, as well as their interest in radiology. Results were analyzed using the Wilcoxon signed-rank test.

Results: Survey responses were obtained from 170 students before the course and 65 students afterward. Upon completing the course, students showed significantly increased academic interest in radiology ($P = .008$) and a heightened perception of the effect of radiology on patient care ($P = .04$), without a significant change in interest in pursuing radiology as a career. Students showed an overwhelmingly positive response to the course, although some noted that previous anatomy training would have been helpful. Eighty percent agreed or strongly agreed that the flipped-classroom structure was an effective educational model.

Conclusions: Our study demonstrated that students were very excited to gain exposure to radiology early in their medical school curriculum, and such exposure led to an improved perception of the field.

Key Words: Education; medical student education.

INTRODUCTION

Medical school curricula regularly undergo review and revision to stay current and relevant, a process necessitated by a growing body of scientific knowledge, evolving roles of medical providers, and expansion of technology within health-care delivery. The curriculum at the University of Michigan Medical School was recently revamped, enabling the inclusion of increased exposure to radiology, particularly in the first and second years of the 4-year program.

Traditionally, at most American medical schools, students do not receive significant exposure to radiology until their later clinical years, when they may enroll in an elective radiology rotation, as only a small number of schools have required medical imaging content taught by radiologists (1). However, previous research suggests that basic attitudes concerning radiology are created early in medical school and remain mostly

unchanged throughout despite a later radiology elective (2). Furthermore, despite the increasing use of imaging for patient care, completing a rotation in radiology is required in only about 25% of US medical schools (3). Nevertheless, a majority of students express the desire to learn how to interpret radiographs and cross-sectional imaging studies (4). As the growing importance of and the desire for medical student proficiency in diagnostic radiology are recognized, there is much interest in the development of effective models for earlier and more robust incorporation of radiology within the medical school curriculum. This can be challenging, however, as radiology is an interdisciplinary subject, sitting at the intersection of anatomy, physiology, and pathology, and preclinical medical students may not have the background in these other related disciplines to appreciate the role of imaging.

We designed and implemented an early medical school curriculum intervention that gives a broad overview of radiology, emphasizing medical imaging as a diagnostic resource that helps to answer critical clinical questions. In addition, the intervention incorporates curricular elements that have demonstrated particular effectiveness in medical education, including a flipped-classroom approach, small-group sessions, and interactive components.

The goal of our study was to examine how the early exposure to radiology in this new curriculum element was received by students. Specifically, we were interested in

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understanding whether the students felt prepared to study radiology this early in their medical career and to determine the students' level of interest in the material and in radiology as a career, as well as their perception of the importance of radiology to patient care. Secondly, we aimed to evaluate the students' receptivity to the flipped-classroom teaching model used for this course.

METHODS

An institutional review board-approved, prospective cohort study was conducted during September 2016 at the University of Michigan Medical School. All participants were first-year medical students enrolled in a newly introduced, 2-week course entitled "Foundations of Diagnostics and Therapeutics (FDT)." The course was administered in the second month of the students' first year and introduced core concepts in radiology, pathology, and pharmacology.

Course Design

The FDT course design included 20.5 class hours of pharmacology, 12.5 class hours of pathology, and 8 class hours of radiology. The course also included 4 class hours of live patient presentations emphasizing the interdisciplinary nature of the health-care experience. Interspersed throughout the 2 weeks were small-group seminars on topics including communicating effectively with patients, history taking, and physical examination skills, which were part of the longitudinal initiatives that run throughout the year. The stated objectives of the FDT course were twofold: (1) "Students will learn foundational knowledge and skills to support continued and effective learning of radiology, pathology, and pharmacology throughout the scientific trunk and in the clinical setting. (2) Students will learn to use the basic terminology of radiology, pathology, and pharmacology to communicate with healthcare colleagues."

Although the FDT course covered a variety of interdisciplinary clinical topics, our study focused only on the elements of the course that related to radiology. The objective of the radiology component of the course was that "students will learn to identify key radiologic findings on a variety of imaging studies and explain the diagnostic significance of these findings in various clinical presentations." The radiology component consisted of three main elements: (1) interactive seminar on chest radiography, (2) full-day introduction to various imaging techniques (called "Radiology Day"), and (3) imaging review at two multidisciplinary live patient presentations.

- (1) **Chest Radiography Seminar:** a 2-hour interactive seminar on chest radiography during week 1, utilizing a flipped-classroom model.

Prep work: Students were assigned approximately 2 hours of work, including online video lectures, quizzes, and interactive modules on chest radiographic anatomy and interpretation.

Class time: The 170 first-year medical students were divided into four classes with ~43 students in each class and one faculty leader. Each class was divided into seven teams with approximately six students per team. The faculty leader led the class through five unknown chest radiographic cases, as follows. A case scenario including one or more chest radiographs and a series of questions was presented to the entire class. Each team had 7 minutes to go through the case and attempt to answer the questions. Subsequently, the faculty leader took the entire class through the case, giving each team a chance to point out radiographic findings and to answer the questions. This was repeated four more times, with the session ending upon completion of all five cases. Students were given paper evaluation forms to fill out at the end of the session to assess the value of the interactive modules and videos, as well as the team-based learning format.

- (2) **Radiology Day:** four 90-minute, interactive case-based sessions during week 2. Each session focused on unique imaging modalities. A flipped-classroom approach was used.

Prep work: Interactive online modules from the Geisel School of Medicine at Dartmouth (http://www.dartmouth.edu/~anatomy/HAE/Radiology_Intro/rad_index.html) on the topics of radiography, computed tomography (CT), ultrasonography, magnetic resonance imaging, fluoroscopy and angiography, and nuclear medicine were used. Estimated time for completion of this prep work was approximately 90 minutes.

Class time: The 170 students were divided into eight groups with approximately 21 students in each group. All groups participated in each of the 90-minute interactive seminars throughout the day:

- A) Radiography, fluoroscopy, and angiography (case based)
- B) CT and magnetic resonance imaging (case based)
- C) Ultrasound and nuclear medicine (case based)
- D) Hands-on ultrasound

Eight rooms ran simultaneously, two for each topic. The student groups rotated from room to room throughout the day, and a single faculty or resident leader ran each room. The exception was that there were several additional resident helpers in the hands-on ultrasound rooms, so that the students could learn in smaller groups.

Each of the case-based seminars was taught using an interactive approach. The students sat at tables arranged in a U-shape so that everyone could see and interact optimally with each other and with the resident or the faculty leader. The leader presented patient cases one by one using PowerPoint and went around the room asking students questions; the students passed around a computer mouse so that they could point to items on the slides and take turns answering questions. Every few minutes, a question was posed that all the students answered using an audience response system. The approach was open, interactive, and encouraged questions. Students were

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