Preclinical Medical Student Training in Radiology: The Effect of Early Exposure

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OBJECTIVE. The purpose of this study was to determine whether an integrated radiology curriculum in the first year of medical school changes medical students' attitudes toward radiology or affects their knowledge of radiologic principles.

SUBJECTS AND METHODS. The first-year medical curriculum of a medical school was revised between the 2003 and 2004 academic years to introduce more didactic radiology teaching. Dedicated radiology lectures were introduced, and radiology consult sessions became integral to problem-based learning sessions. A survey was administered between the first and second years of training to assess first-year medical students' attitudes toward radiology and their knowledge of basic radiologic principles. Students who had undertaken the revised curriculum (class of 2008) were compared with students who had undertaken the traditional curriculum (class of 2007). Survey responses were compared with Mann-Whitney rank sum tests.

RESULTS. Students exposed to the new curriculum stated that they were more familiar with radiology as a specialty and believed that radiology had greater importance to the overall practice of medicine. They stated that they were more likely to select radiology as a clinical elective, and more of them were considering radiology as a career option. The students who had been exposed to radiology performed better on the test of basic radiologic knowledge. All results were statistically significant.

CONCLUSION. Exposing students to radiology in the first year of medical school improves their impression of radiology as a specialty and increases their interest in radiology as a career. Follow-up surveys will determine whether this effect persists through the clinical years of training and improves the overall impression of radiology within the medical community.

Keywords: medical student education, patient-based learning, radiology education

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In most traditional medical school curricula, radiology is not formally introduced to students until their clinical rotations [1, 2]. Even then, radiology is often not part of the core curriculum. It may be relegated to incidental exposure during medical or surgical rotations, or it may be included only as an optional elective after the core clinical clerkships have been completed. Few documented curricula formally incorporate radiology teaching into the first year of medical training, and this exposure tends to be limited to short sessions [3]. To our knowledge, investigators [4, 5] who have pursued a more thorough curriculum in radiology have not attempted to assess changes in medical student attitudes toward radiology.

The role of academic radiologists in early medical student education has received greater focus in recent years [6]. The advent of problem-based learning (PBL) in particular has provided radiologists with an opportunity to interact with students in the preclinical years [7, 8]. This exposure to the field of radiology, however, is within the context of medical and surgical problems rather than radiology as a distinct specialty.

It is likely that greater exposure to radiology for all medical students, not only those interested in radiology as a career, is advantageous to the specialty [9]. The attitude of other physicians toward radiology may be prejudiced by a lack of exposure to radiologists during the formative years of medical school [10]. Thus radiology teaching may have benefits beyond increasing the likelihood of students choosing radiology as a career.

Previous work on radiology in the medical student curriculum has focused on objectives for the clinical years of training or on the utility of radiology in PBL modules [11, 12]. To our knowledge, no studies have quantitatively measured the effect of preclinical radiology teaching in both didactic lectures and PBL modules. The purpose of this study was to quantify changes in medical student attitudes

toward radiology after introduction of an integrated radiology curriculum in the preclinical years of medical school.

Subjects and Methods

Changes in Medical School Curriculum

The curriculum for the first-year students at the University of Pittsburgh School of Medicine includes basic science courses such as medical anatomy, microbiology, genetics, and immunology. These courses are interspersed with patient care courses such as ethics, medical interviewing, and medical decision making and with pathophysiology courses such as neuroscience. These courses traditionally have been taught without input from radiologists. Although radiographs occasionally have been used to emphasize anatomic relations or to visualize pathologic conditions, lectures have not been dedicated to radiology, and radiologists have not been available to confirm correct evaluation of the images.

Between the 2003 and 2004 academic years, changes were made in two courses (medical anatomy and neuroscience) to provide greater exposure to radiology. Medical anatomy is a 12-week course and is the first course taught to medical students. In medical anatomy, a 1-hour radiology lecture focusing on radiologic techniques and radiologic anatomy was added in the first week of the 7-week course. In addition, a 45-minute radiology consult session focusing on relevant anatomy and appropriate use of imaging was added to each of the four PBL modules [7, 12]. The PBL modules were supplemented with complete cross-sectional patient examinations presented with the same PACS interface used in the clinical setting [13]. Neuroscience is an 8-week course beginning in February of the first academic year. In the neuroscience course, three half-hour radiology lectures focusing on radiologic neuroanatomy and frequently encountered pathologic conditions were given in the first week of the course. In addition, a 1-hour radiology consult session to review pertinent case-based imaging findings was provided with each of the three PBL modules. In both courses, the radiology consult sessions consisted primarily of student-directed discussions interspersed with brief didactic monologues. All of these lectures and consult sessions were taught by the same academic radiologist.

The class of 2007, which was in its first year of medical school in academic year 2003, had 146 students (74 women, 72 men) and was exposed to the traditional curriculum. The class of 2008, which was in its first year of medical school in academic year 2004, had 149 students (76 women, 73 men) and was exposed to the new curriculum. Thus the class of 2007, who received no formal radiology instruction in the first year, served as a control group, and the class of 2008 was the experimental group.

Medical Student Survey

A survey was developed to measure medical students' attitudes toward and knowledge of radiology. Six multiple-choice questions were focused on attitudes toward radiology, and five multiple-choice questions were used to test knowledge of basic radiologic principles (Appendix 1). The latter questions were designed to measure conceptual knowledge of the practice of radiology, as would be expected of a referring clinician, rather than knowledge that would be expected of a radiologist. The knowledge questions varied in difficulty from questions that any medical student would be expected to answer to questions that might be difficult for experienced clinicians. Administration of the survey was approved by the medical school curriculum committee after review by the steering committee.

The survey was administered online to each group of students in the summer between their first and second years of medical school. The online system was structured such that respondents could not return to previous questions once they had answered them. This precaution prevented respondents from using knowledge gained in later questions to assist with earlier questions. Every question had to be answered for a survey to be considered complete. Incomplete surveys were discarded. Participation in the survey was voluntary, and Web access to the survey was provided within the medical school.

To invite participants, a bulk e-mail was sent to the entire medical student class. One week later, a second bulk e-mail was sent as a reminder. One week after that, personalized e-mails were sent to every student who had not yet responded to the survey. One week after that, a second personalized e-mail was sent, warning that the survey was closing soon. One week after that (4 weeks after the initial e-mail), the survey was closed. This procedure was followed for both the class of 2007 and the class of 2008. There was no response threshold for closing the survey.

Statistical Analysis

In the section on attitudes toward radiology, the answers to each question constituted an ordered, categoric data set. The distribution among the five ordered categories was not necessarily expected to be parametric, so nonparametric statistical tests were selected. The Mann-Whitney rank sum test was applied to each of the attitude questions to compare the class of 2007 with the class of 2008. For the knowledge section of the survey, the percentage of correct answers was calculated for each respondent, and a Mann-Whitney rank sum test was used to compare the scores for the two groups. Thresholds for p value were set at 0.05. To determine whether response rates were different between the two classes, a 95% CI for differences of percentages was calculated.

Results

Survey response rates were not statistically different between the two groups. The response rate was 81% (118/146) for the class of 2007 and 88% (131/149) for the class of 2008. For each of the six survey questions regarding medical student opinions toward radiology, statistically significant improvement in attitude was found in the group that had been exposed to the new curriculum. As expected, students in the experimental group answered they were more familiar with radiology as a specialty and that they had been exposed to more radiology in their first year of medical school. These students were also more interested in radiology as a field, were planning to take more elective rotations in radiology, and were more likely to consider radiology as a career. Specifically, the percentage of students who answered that radiology was intrinsically interesting increased from 42% to 73%. The percentage of students considering a clinical radiology elective increased from 67% to 84%. The percentage of students who answered that they might consider radiology as a career increased from 38% to 54%. Students in the experimental group answered that radiology has a substantial influence on other areas of medicine. These results are summarized in Figure 1.

The responses to the five knowledge questions are summarized in Figure 2. The class of 2007 had an average score of 3.21 (64%), whereas the class of 2008 had an average score of 3.79 (76%). This difference was statistically significant.

Discussion

The results of this study show that medical student attitudes toward radiology are significantly affected by early exposure to didactic teaching in radiology and by radiologist involvement with PBL modules. Students who have been exposed to more radiology in their first year of medical school are more interested in radiology and have a higher opinion of the specialty.

Recent applicants to radiology residencies have represented the top academic tier of medical students. Therefore some radiologists may question the need for increased participation in undergraduate medical education. Medical student interest in any specialty fluctuates, and current first-year medical students may begin their residencies at a time when interest in radiology has waned. Furthermore, early exposure to radiology may prompt medical students to pursue research

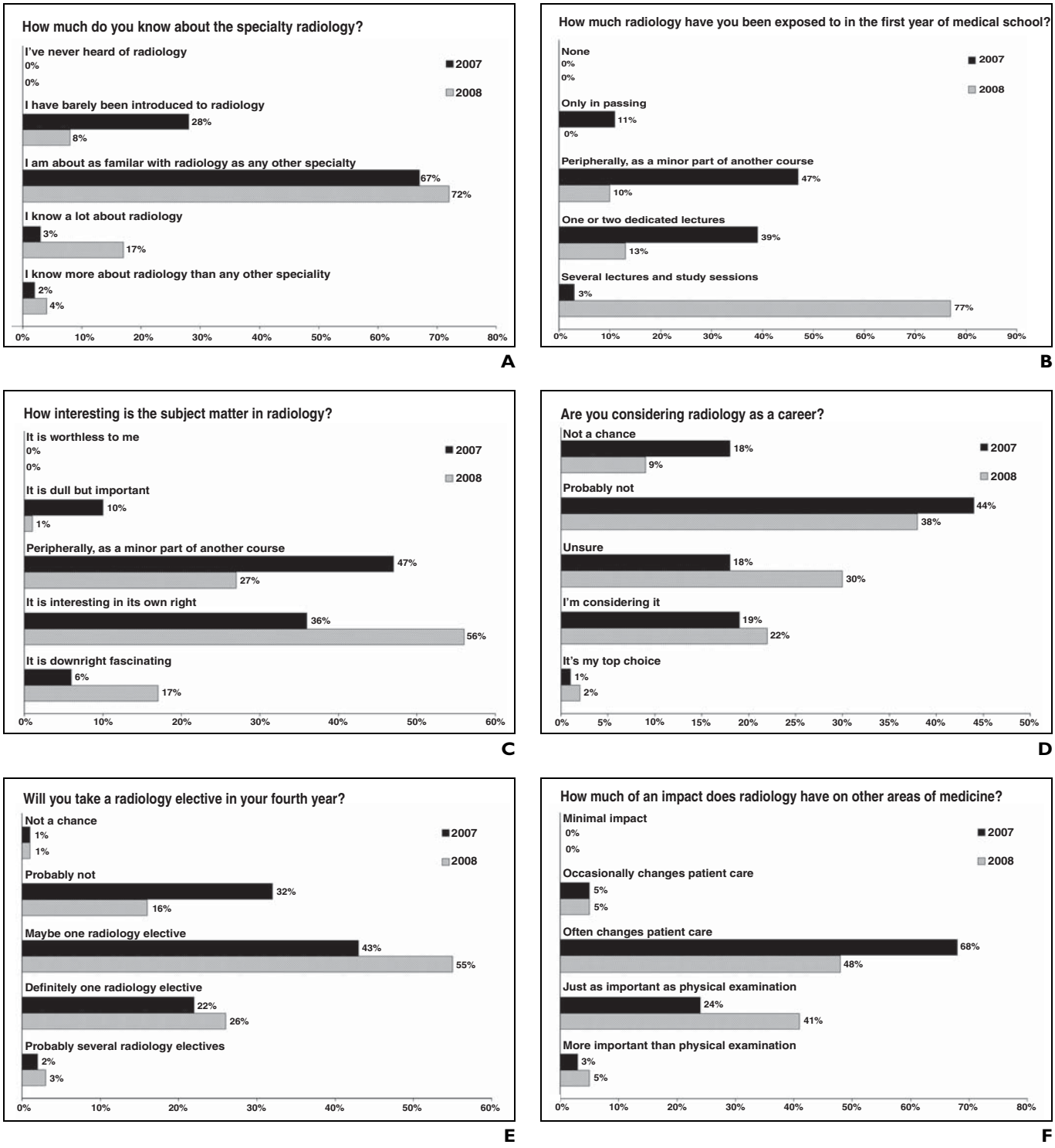

Fig. 1—Survey responses on attitude questions for class of 2007 (no formal radiology) and class of 2008 (new curriculum). Differences are statistically significant for every question.

within the field instead of arriving at a career decision late in training, after opportunities for in-depth research have passed.

Another advantage of early exposure is the opportunity to confirm career choice. Medical students who are aware of radiology earlier in their training may choose to observe radiologists in the reviewing room or angiography suite. These students would be less likely to

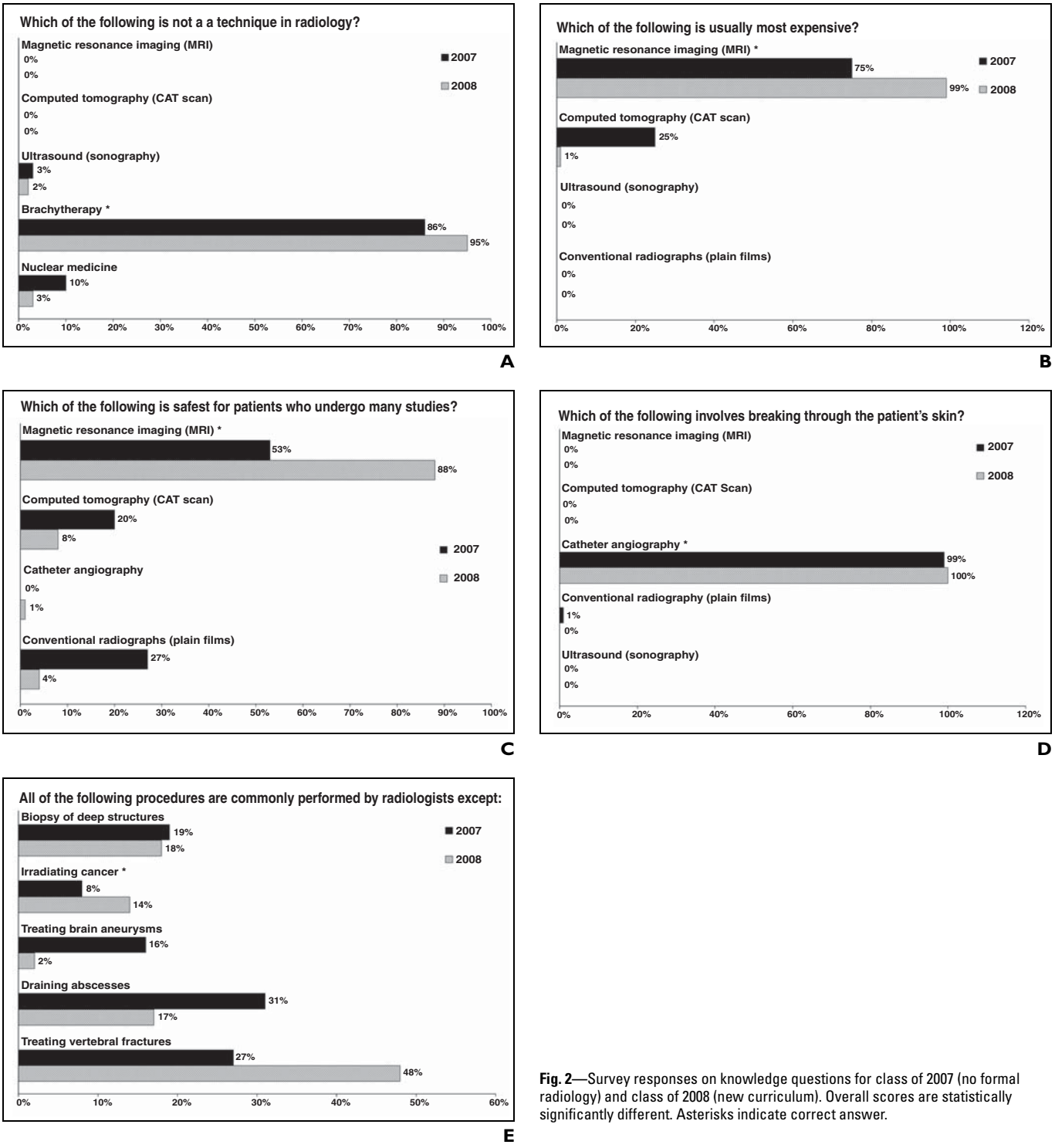

Fig. 2—Survey responses on knowledge questions for class of 2007 (no formal radiology) and class of 2008 (new curriculum). Overall scores are statistically significantly different. Asterisks indicate correct answer.

choose radiology careers for misunderstood or imagined reasons, such as a relaxed lifestyle or a lack of direct patient care.

Although academic radiologists may be primarily interested in persuading medical students of the benefits of a career in radiology, there are ancillary benefits to the specialty when students who are destined for other specialties have an improved understanding of radiology. One benefit is more appropriate use of diagnostic tests, which can improve the delivery of efficient patient care. Another potential benefit is improved relationships with referring clinicians. The stereotype of the radiologist with an undemand-

ing schedule and overly high reimbursement may be effectively controverted. It is unclear to what degree improved radiologist–clinician relationships may reduce political battles or turf wars with other specialties [10].

One of the questions in our survey addressed the perceived importance of radiology to other areas of medicine. Of the medical students exposed to radiology, 46% answered that imaging is as important as or more important than physical examination, compared with 27% in the control group. This difference suggests that the importance of radiology was clearer to students in the experimental group and may indicate more respect for radiology as a specialty, regardless of career interest.

Incorporation of radiology in the preclinical curriculum requires a substantial time commitment from academic radiologists. Several hours of preparatory time are needed for each hour of lecture or consult session presented. (Educational material can be reused over several years to improve the return on the time invested.) Furthermore, a radiologist ideally should be a member of the course design and PBL design committees for each course to which radiology is pertinent. Such time commitments detract from research and clinical commitments and from postgraduate teaching. Promotion committees often underestimate the importance of medical student teaching. The results of this study suggest, however, that radiologist commitment to medical student teaching may result in substantial benefits for the field of radiology and for medicine in general.

Although didactic lectures require substantial time commitments for preparation and delivery, radiologists can become involved in PBL modules with less disruption to their schedules [12, 14]. In addition to moderating PBL sessions, radiologists can make themselves available to answer questions posed during the sessions. Radiologists' broad knowledge of surgical options and diagnostic pathways may be particularly appealing to medical students trying to obtain an overview of a particular disease process.

It may not be surprising that students who received didactic lectures about radiology were more knowledgeable about radiology. Nevertheless, we considered it important to document that first-year medical students have sufficient medical background to comprehend the clinical ramifications of the subject matter. It might be argued that radiology is best taught after students have had exposure to substantial clinical training so that the radiologic manifestations of disease can be better appreciated. Our results and those of others [4] suggest that medical students, even in their first year, are able to incorporate information about radiology that enriches their understanding of normal and pathologic anatomy and disease processes.

There were several limitations to this study. It is possible that there was an underlying trend toward more interest in radiology across the 2 years of the study regardless of the increased didactic exposure. However, given the current popularity of radiology residencies, the theory of regression to the mean suggests that students should be less interested in radiology over time not more interested, as in our results. It is also possible that the differences in this study were the result of idiosyncratic differences between two medical school classes. The magnitude of the differences between classes and the consistent statistical significance across all survey responses, however, suggest that the effect is the result of the intervention.

An individual teacher occasionally can produce a positive response from students that is then attributed to the subject matter rather than the teacher. This phenomenon is particularly true of a physician–professor teaching during the preclinical years, when medical students avidly seek clinical teaching amid their basic science courses. Because only one radiologist was involved in the medical student teaching in our study, the merits of this individual teacher may have confounded our results. Nevertheless, it is expected that among radiologists, the stronger teachers would be more likely to volunteer for medical student teaching, so our results may be reasonably generalized. In previous teaching of radiology to medical students in their second through fourth years, the radiologist–educator in our study had not received specific teaching awards and had not demonstrably affected student attitudes. Thus we attributed the changes in attitude at least in part to the placement of lectures in the first year of training.

Response bias is a potential limitation in the analysis of any survey responses. Students interested in radiology may be more likely to complete a survey on the subject. Because our response rate was very high (84% overall) and did not differ significantly between groups, response bias is not likely to have been a substantial confounder in this study.

The results of this study apply only to attitudes of medical students at the end of their first year of training. It is unclear whether these changes in attitude will persist throughout medical school, whether these students will be more likely to choose radiology as a career, or whether students who eventually choose clinical careers will have a higher opinion of their radiology colleagues. We intend to continue following this cohort of students and to specifically address these questions in future studies.

In conclusion, dedicated medical student teaching from an academic radiologist during the first year of medical school increases students' interest in and appreciation of the field of radiology. Further study is needed to determine whether these changes in attitude persist through the clinical years of training and are predictive of students' career choices.

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Appendix appears on next page

APPENDIX 1. Medical Student Survey

This survey was administered to medical students between their first and second years of training. In part II, an asterisk indicates the correct answer.

Part I: Opinions

1. How much do you know about the specialty radiology?
   a. I've never heard of radiology.
   b. I have barely been introduced to radiology.
   c. I am about as familiar with radiology as with any other specialty.
   d. I know a lot about radiology.
   e. I know more about radiology than any other specialty.

2. How much radiology have you been exposed to in the first year of medical school?
   a. None
   b. Only in passing
   c. Peripherally, as a minor part of another course
   d. One or two dedicated lectures
   e. Several lectures and study sessions

3. How interesting is the subject matter in radiology?
   a. It is worthless to me.
   b. It is dull but important.
   c. It is interesting only as it relates to other areas of medicine.
   d. It is interesting in its own right.
   e. It is downright fascinating.

4. Are you considering radiology as a career?
   a. Not a chance
   b. Probably not
   c. Unsure
   d. I'm considering it.
   e. It's my top choice.

5. Will you take a radiology elective in your fourth year?
   a. Not a chance
   b. Probably not
   c. Maybe one radiology elective
   d. Definitely one radiology elective
   e. Probably several radiology electives

6. How much of an impact does radiology have on other areas of medicine?
   a. Minimal impact
   b. Occasionally changes patient care
   c. Often changes patient care
   d. Just as important as physical examination
   e. More important than physical examination

Part II: Knowledge

1. Which of the following is not a technique in radiology?
   a. Magnetic resonance imaging (MRI)
   b. Computed tomography (CAT scan)
   c. Ultrasound (sonography)
   d. Brachytherapy*
   e. Nuclear medicine

2. Which of the following is usually most expensive?
   a. Magnetic resonance imaging (MRI)*
   b. Computed tomography (CAT scan)
   c. Ultrasound (sonography)
   d. Conventional radiography (plain films)

3. Which of the following is safest for patients who undergo many studies?
   a. Magnetic resonance imaging (MRI)*
   b. Computed tomography (CAT scan)
   c. Catheter angiography
   d. Conventional radiographs (plain films)

4. Which of the following involves breaking through the patient's skin?
   a. Magnetic resonance imaging (MRI)
   b. Computed tomography (CAT scan)
   c. Catheter angiography*
   d. Conventional radiography (plain films)
   e. Ultrasound (sonography)

5. All of the following procedures are commonly performed by radiologists except:
   a. Biopsy of deep structures
   b. Irradiating cancer*
   c. Treating brain aneurysms
   d. Draining abscesses
   e. Treating vertebral fractures