



Brief Communication for the Education Corner

Impact of Early Radiology Research Experiences on Medical Student Perceptions of Radiology and Research

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ABSTRACT

Rationale and objectives: To promote opportunities for medical students to gain early exposure to radiology and research, our institution has initiated programs which fund summer radiology research projects for rising second-year medical students. This study assesses the impact of these faculty-mentored summer research experiences on medical student perceptions of radiology and research, in terms of both knowledge and interest.

Materials and methods: A voluntary, anonymous survey was administered to students both before and after the summer research period. Both the pre-program survey and post-program survey included 7-point Likert-scale questions (1 = strongly disagree; 7 = strongly agree) to evaluate students' perceptions about research and students' perceptions about radiology as a specialty. Faculty mentors were sent an analogous post-program survey that included an evaluation of their student's research skills.

Results: The surveys were completed by 9 of 11 students and 10 of 11 mentors. Students' perceived knowledge of radiology as a specialty improved ($P = 0.02$) between the pre-program survey and post-program survey. Similarly, there was an increase in students' perceived knowledge of research skills ($P = 0.02$) between the pre-program survey and post-program survey, with student ratings of research skills consistent with those of mentors. High student interest in both radiology and research was maintained over the course of the program.

Conclusion: Our pilot study suggests that summer research experiences can improve knowledge of radiology and research among medical students. Continued evaluation of this annual program will allow us to enhance the benefit to medical students and thereby bolster interest in academic radiology.

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Introduction

Early exposure to radiology in medical school has the potential to positively impact medical students' knowledge and perceptions of the radiology specialty.^{1,2} Medical students are often introduced to radiology via didactic lectures and problem-based learning sessions during the preclinical curriculum, most commonly in the anatomy course.¹⁻⁴ However, opportunities for more extensive, immersive experiences in radiology are still needed during the preclinical years. This is particularly crucial since the majority of radiology education does not occur until fourth-year electives at most U.S. medical schools,^{3,5,6} and studies suggest that student perceptions about radiology have already solidified prior to these electives.^{7,8} Preclinical opportunities in radiology could provide substantial benefit to students and help in their specialty decision-making process.

One way to expose medical students to radiology is via funded, faculty-mentored research opportunities. The benefits of medical

student research experiences are well-recognized and multifactorial.⁹⁻¹² For students, research provides the opportunity to learn fundamental skills of scientific inquiry and analysis, learn more about radiology as a field, establish mentors and contacts, and strengthen their residency applications. For faculty, mentoring students in research can substantially bolster academic productivity and bring about a sense of satisfaction in contributing to the intellectual growth of a trainee. In the long term, promoting radiology research to medical students can serve as a bottom-up approach to enhance rigorous academic research in radiology departments, as radiology is considered to be a specialty ripe with opportunities for innovation and investigation.¹³⁻¹⁵

We initiated a program at our institution that funds radiology research projects for medical students during the summer between their first and second years of medical school. This new research program in diagnostic radiology supplemented an existing program in interventional radiology. While a few formal programs exist for radiology research during the preclinical years at other institutions,^{10,16,17} a comprehensive analysis of the impact of these programs would be valuable. Therefore, we assessed the impact of faculty-mentored summer research experiences on medical student perceptions of radiology and research.

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Materials and Methods

Eleven rising second-year medical students, 7 with projects in diagnostic radiology and 4 with projects in interventional radiology, were selected for the 6-week research program during the summer of 2017. All received a weekly stipend from the Department of Radiology, with the exception of 2 students who had external summer research funding. The selection and mentor matching process included submission of a statement of interest and curriculum vitae from students, a meeting where faculty members presented available research projects to students, the distribution of a booklet with over 20 available summer projects, and pre-program one-on-one discussions between faculty members and selected students. Students carried out independent research under the guidance of their faculty mentors, with the goal of completing a research project and sharing their work with the community via an abstract or publication.

An anonymous, voluntary survey was administered to the students 1 week prior to the start of the research period, and the same survey was administered 1 week following the end of the research period. The student surveys consisted of 7-point Likert-scale questions (1 = strongly disagree; 2 = disagree; 3 = somewhat disagree; 4 = neutral; 5 = somewhat agree; 6 = agree; and 7 = strongly agree) to evaluate students' perceptions in 4 categories: (i) perceived knowledge of radiology as a specialty, (ii) interest in radiology, (iii) perceived knowledge of research skills, and (iv) interest in research. The survey also contained additional questions to assess students' general perceptions of the field of radiology and the value of research in radiology. Faculty mentors were sent an analogous post-program survey that included an evaluation of their student's research skills and questions to assess their own perceptions of radiology. Survey respondents were allowed to select "Not Applicable" to any question that did not apply to them or that they were not comfortable answering.

All data were collected via REDCap (Vanderbilt University, TN), an online database application.¹⁸ When relevant, category-averaged responses were obtained by averaging responses from questions with common themes. Means and standard deviations were computed for each response. Wilcoxon signed-rank tests were used to determine significance of differences between the students' pre-program and post-program survey responses, and Mann-Whitney

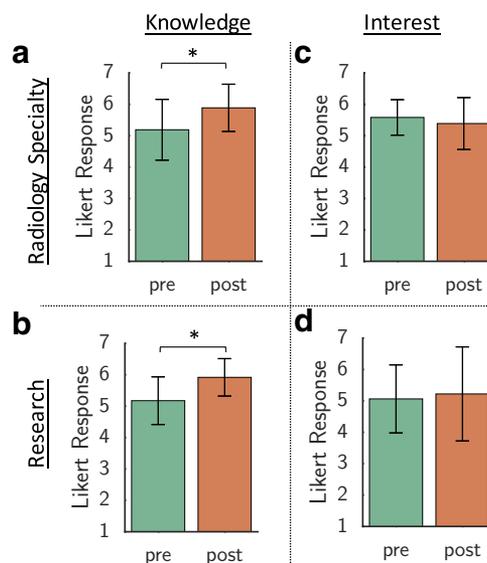


FIG 1. Pre-program and post-program student responses for (a) perceived radiology specialty knowledge, (b) perceived research knowledge, (c) radiology specialty interest, and (d) research interest. Likert scale: (1) Strongly disagree, (2) disagree, (3) somewhat disagree, (4) neither agree nor disagree, (5) somewhat agree, (6) agree, (7) strongly agree. * $P < 0.05$, Wilcoxon signed-rank test.

U tests were used to determine significance of differences between student and mentor responses. All statistical tests were performed at $\alpha = 0.05$, without correction for multiple comparisons. This study was exempted by our institutional review board.

Results

The response rate was high for both students and mentors, with 9 of 11 (82%) students and 10 of 11 (91%) mentors completing the surveys. Students' perceived knowledge of radiology as a specialty improved ($P = 0.02$) between the pre-program survey (5.2 ± 1.0) and post-program survey (5.9 ± 0.8) (Fig 1a), as measured by the category-averaged responses. While perceived knowledge of radiology as

TABLE 1
Survey responses related to radiology specialty knowledge and interest, and research interest

	Pre-program mean (SD)	Post-program mean (SD)	Wilcoxon P
Average of radiology specialty knowledge survey responses[†]	5.2 (1.0)	5.9 (0.8)	0.02*
I am familiar with the role of a radiologist in patient care	5.7 (1.2)	6.0 (0.7)	0.2
I am familiar with the daily life of a radiologist	5.4 (1.2)	6.2 (0.8)	0.04*
I am familiar with the role of a radiologist in interacting with other healthcare providers	5.6 (1.3)	6.1 (0.7)	0.1
I am familiar with the specialty of radiology as a whole, more so than I know about other medical specialties	5.3 (1.2)	6.2 (0.8)	0.04*
I am familiar with the various subspecialties that exist within radiology	4.7 (1.6)	5.7 (0.8)	0.1
I am familiar with the training pathway to become a radiologist (eg, residency, fellowship, years of training)	5.0 (1.2)	5.9 (1.0)	0.02*
I am familiar with the research landscape within radiology	4.7 (0.8)	5.1 (1.2)	0.4
Average of radiology specialty interest survey responses[†]	5.6 (0.6)	5.4 (0.8)	0.7
I am interested in learning more about radiology	6.0 (0.7)	5.6 (1.2)	0.5
I enjoy interacting with radiologists	6.1 (0.7)	6.2 (0.6)	0.6
I am planning to pursue radiology as a career	4.4 (0.8)	4.4 (1.3)	1.0
I am planning to take a radiology elective in my third or fourth year of medical school	5.8 (0.8)	5.3 (1.2)	0.4
Average of research interest survey responses[†]	5.1 (1.1)	5.2 (1.5)	0.6
I enjoy research	5.4 (0.8)	5.2 (1.5)	0.7
I plan to pursue a career in an academic setting	4.9 (1.6)	5.2 (1.8)	0.3
I am interested in carrying out research in my future career	5.3 (1.4)	5.4 (1.7)	0.7
I am likely to continue to do some form of research in medical school after this summer	5.7 (1.6)	5.9 (1.4)	0.6
I am likely to continue to do radiology-related research in medical school after this summer	4.8 (1.0)	5.3 (1.7)	0.2
I want to do a scholarly project or year out project in radiology research	4.4 (0.7)	4.6 (1.2)	0.7
I want to go into a residency program which offers dedicated time for research	4.9 (1.5)	4.9 (1.9)	1.0

Note: These questions had 7-point Likert-type item responses: (1) strongly disagree; (2) disagree; (3) somewhat disagree; (4) neutral; (5) somewhat agree; (6) agree; and (7) strongly agree.

[†]Overall value for this category was obtained by averaging responses to all questions in category.

* $P < 0.05$.

TABLE 2
Survey responses related to knowledge of research skills

	Student pre-program mean (SD)	Student post-program mean (SD)	Wilcoxon P (student pre- to post-program difference)	Mentor mean (SD)	Mann-Whitney P (mentor-student difference)
Average of research skills survey responses[†]	5.2 (0.8)	5.9 (0.6)	0.02*	6.2 (0.6)	0.2
Knowledge of the field of research related to my project	4.8 (0.9)	5.9 (1.0)	0.02*	5.7 (1.1)	0.4
Understanding of the potential clinical impact of my research project	5.9 (0.9)	6.2 (0.6)	0.3	6.1 (0.8)	0.4
Searching for and reviewing relevant literature	5.4 (1.3)	6.1 (0.9)	0.1	6.6 (0.5)	0.1
Understanding of the scientific method	5.8 (0.9)	6.4 (0.5)	0.06	6.4 (0.5)	0.4
Using the research-specific tools I'll need for my project (experimental techniques, software, etc.)	4.8 (1.1)	6.1 (0.6)	0.03*	6.3 (1.2)	0.1
Data collection	5.2 (1.4)	6.1 (1.0)	0.1	6.7 (0.5)	0.1
Laboratory records and data management	5.1 (1.3)	6.0 (0.8)	0.1	6.7 (0.5)	0.05
Statistical analysis techniques	4.4 (1.9)	5.2 (1.9)	0.02*	6.0 (0.8)	0.4
Scientific writing skills	4.4 (1.3)	5.0 (1.2)	0.2	5.8 (0.9)	0.1
Oral communication of research	4.9 (1.1)	5.5 (1.2)	0.07	6.4 (0.9)	0.2
Interacting with others on a research team	6.0 (0.8)	6.1 (0.9)	0.8	6.5 (0.5)	0.2
Dealing with obstacles during the course of a research project	5.3 (0.9)	6.2 (0.8)	0.01*	6.2 (1.1)	0.4

Note: These questions had 7-point Likert-type item responses: (1) strongly disagree; (2) disagree; (3) somewhat disagree; (4) neutral; (5) somewhat agree; (6) agree; and (7) strongly agree; with the following question prompt: "I feel that I have expertise in the following areas..."

[†]Overall value for this category was obtained by averaging responses to all questions in category.
*P < 0.05.

a specialty across all relevant survey questions demonstrated a trend toward improvement, the increase was statistically significant for perceived familiarity with the daily life of a radiologist, with the specialty of radiology as a whole, and with the training pathway for radiology (Table 1). Similarly, there was an increase in students' perceived knowledge of research skills (P = 0.02) between the pre-program survey (5.2 ± 0.8) and post-program survey (5.9 ± 0.6) (Fig 1b). There was no significant difference (P = 0.2) between student post-program survey responses (5.9 ± 0.6) and mentor responses (6.3 ± 0.6) to analogous survey questions regarding students' knowledge of research skills. Students' perceived knowledge of research skills demonstrated a trend toward improvement across all relevant survey questions, with statistically significant improvements in students' perceived expertise in the following areas: knowledge of the field of research related to their project, using project-specific tools, statistical analysis techniques, and dealing with obstacles during the course of a research project (Table 2). Initial student interest was

fairly high for both radiology (5.6 ± 0.6) (Fig 1c, Table 1) and research (5.1 ± 1.1) (Fig 1d, Table 1), and was maintained over the course of the program, with no statistically significant change over time.

As assessed by 4 survey questions (Table 3), we found that student perceptions about the value of research in radiology was high at the start of the summer (5.91 ± 0.76), did not change significantly over time, and was not significantly different from faculty mentors' perceptions (5.5 ± 1.2, P = 0.2). Additionally, we found that students' responses to the following questions were positive, did not change significantly over time, and were consistent with mentor responses: "Radiologists are friendly people," "The job of a radiologist is intellectually stimulating," and "Radiologists treat patients." Interestingly, we found that there was a significant increase in the degree to which students believed that the job of a radiologist is "fast-paced" between pre-program (5.3 ± 1.1) and post-program (6.0 ± 0.7) surveys (P = 0.03), with faculty members thinking that the job is even more fast-paced (6.7 ± 0.5) than students did in the post-program (6.0 ± 0.7) survey (P = 0.02; Table 4).

TABLE 3
Survey responses related to perceived value of research in radiology

	Student pre-program mean (SD)	Student post-program mean (SD)	Wilcoxon p (student pre- to post-program difference)	Mentor mean (SD)	Mann-Whitney p (mentor-student difference)
Average of radiology research perspective survey responses[†]	5.9 (0.4)	5.9 (0.8)	1	5.5 (1.2)	0.2
It is feasible to devote time for research investigations as a radiologist	6.0 (0.8)	5.8 (1.1)	0.7	5.7 (2.0)	0.2
Most radiologists are involved in research projects	5.6 (0.7)	5.6 (0.8)	1	4.6 (1.7)	0.1
Research is valued by radiologists	6.1 (0.3)	6.2 (0.8)	0.7	5.1 (1.7)	0.06
Research is an important part of radiology	6.0 (0.5)	6.1 (0.7)	0.7	6.5 (0.9)	0.09

Note: These questions had 7-point Likert-type item responses: 1. strongly disagree; 2. disagree; 3. Somewhat disagree; 4. neutral; 5. Somewhat agree; 6. agree; 7. strongly agree.
[†]Overall value for this category was obtained by averaging responses to all questions in category* p < 0.05

TABLE 4
Survey responses related to perceptions of radiologists

	Student pre-program mean (SD)	Student post-program mean (SD)	Wilcoxon p (student pre-to post-program difference)	Mentor mean (SD)	Mann-Whitney p (mentor-student difference)
Radiologists are friendly people	6.3 (0.7)	6.6 (0.7)	0.4	6.1 (0.7)	0.1
The job of a radiologist is intellectually stimulating	6.1 (0.9)	6.3 (0.8)	0.4	6.9 (0.3)	0.06
The job of a radiologist is fast-paced	5.3 (1.0)	6.0 (0.7)	0.03*	6.7 (0.5)	0.02*
Radiologists treat patients	5.9 (0.9)	6.4 (0.5)	0.06	6.6 (0.7)	0.3

Note: These questions had 7-point Likert-type item responses: 1. strongly disagree; 2. disagree; 3. Somewhat disagree; 4. neutral; 5. Somewhat agree; 6. agree; 7. strongly agree.
* p < 0.05

Discussion and Conclusion

In our pilot study, we instituted a formalized, faculty-mentored summer radiology research program for rising second-year medical students, and used survey-based analyses to assess its impact. We found that medical students participating in the program expressed high interest in both radiology and research. These students significantly increased their knowledge of research and the radiology specialty between the start and end of the summer program. Students' post-program perceived knowledge of research skills was consistent with evaluations from their faculty mentors, suggesting that the students' self-evaluation was an accurate assessment of their capabilities. Finally, we assessed perceptions relating to radiology across a range of dimensions and found that perceptions were mostly consistent between students and mentors. The notable exception was that while student agreed with the statement that "the job of a radiologist is fast-paced" more strongly by the end of the summer, mentors endorsed the statement even more strongly than students, perhaps because this aspect of radiology is likely to only be fully understood via experience rather than observation.

By offering research opportunities to medical students during their preclinical curriculum, radiology departments have the ability to engage with students early in their training, help them make a more informed decision about the field as a potential career, and arm them with the tools to become strong candidates for residency programs. This early exposure is particularly crucial due to recent evidence of waning student interest in radiology residency programs.^{19,20} This also may serve as one avenue for ultimately increasing the number and strength of academic clinician-investigators in radiology. Promoting a culture of mentorship within radiology can serve as a feed-forward loop that contributes to the growth and success of each new generation of academic radiologists.

We recognize that the students participating in the program are a self-selected group of people who likely have very positive opinions of both research and radiology. This could help explain our finding that there was no change in interest in radiology or research between the start and end of the summer, because the initial interest was fairly high. We hope to carry out these analyses every year for each new cohort of students and mentors, so that we can assess the robustness of our current findings over a larger group of participants. Follow-up studies will be carried out on this cohort to assess both short-term and long-term impact of the summer research experience on student attitudes. In the short term, we would like to assess the students' success in publishing abstracts and papers based on their summer research, and their decision to continue their research projects into their second year and beyond. In the long term, we are interested in the impact of early radiology research on students' ultimate specialty choice and their future pursuit of research endeavors. We believe it is noteworthy that significant changes in students' perceived knowledge were observed in our study over the relatively short time frame of 6

weeks; further studies can evaluate if these changes are sustained or magnified over a longer period of time. For example, students' perceived competence in scientific writing and oral communication of research may significantly improve as students begin to prepare for presentation at conferences or submission to journals.

Our program can serve as a valuable model for increasing exposure of medical students to radiology and research. Continued optimization of research programs, using data and analyses such as those described here, will allow radiology departments to best serve the needs of medical students and promote interest in academic radiology.

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