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Permalink

<https://escholarship.org/uc/item/8465h649>

Journal

Journal of the American College of Radiology : JACR, 11(1)

ISSN

1546-1440

Authors

Naeger, David M
Wilcox, Chad
Phelps, Andrew
et al.

Publication Date

2014

DOI

10.1016/j.jacr.2013.03.026

Peer reviewed

Residents Teaching Medical Students: How Do They Compare With Attending Educators?

David M. Naeger, MD, Chad Wilcox, MA, Andrew Phelps, MD,
Karen G. Ordovas, MD, Emily M. Webb, MD

Purpose: Educating medical students is a core mission of academic radiology departments. In some programs, residents participate in student teaching. The aim of this study was to retrospectively compare medical student evaluations of radiology resident lectures with lecture evaluations of radiology faculty members.

Methods: Numeric evaluations for lectures given by faculty members, fellows, and residents were collected over a 1-year period as part of routine course evaluations for a fourth-year medical student radiology elective. Faculty member, fellow, and resident lecture scores were compared, overall using analysis of variance and pairwise using Student's *t* test. A predefined low *P*-value threshold was used for the *t* tests to account for the multiple comparisons. To account for the inherent clustering of the data due to repeat lecturers, the data were reanalyzed on a "per lecturer" basis.

Results: Three hundred seven individual lecture scores were collected. There was no statistical difference between the lecture scores received by attending faculty members (mean, 9.10 on a scale of 10) and residents (mean, 8.99) (*P* = .08). Fellows, however, scored statistically significantly lower (mean, 8.45) than attending faculty members and residents (*P* < .001 for both comparisons). The per lecturer analysis yielded similar results.

Conclusions: Lectures delivered by residents received similar evaluations as lectures delivered by faculty members. Given that teaching can be an educational experience for residents, involving radiology residents in medical student teaching may benefit students and residents alike.

Key Words: Residents, medical students, teaching, evaluations

J Am Coll Radiol 2014;11:63-67. Copyright © 2014 American College of Radiology

INTRODUCTION

Medical student education is vital to the specialty of radiology. Some medical students will choose radiology as a career after exposure to preclinical and clinical radiology content in courses and clerkships. Students who choose other specialties, on the other hand, become the referring clinicians with whom we interact on a daily basis [1-4]. Teaching the important role radiologists play in patient care is crucial, particularly in an era when the value of radiology must be more visibly demonstrated [2,5].

Although radiology education in medical school is important, there are many barriers to developing and maintaining quality radiology clerkships. Faculty time is under constant pressure, and although some academic physicians still strive to achieve the "triple threat" ideal, clinical practice and grant-funding research frequently take precedence over teaching. Financial considerations seem to be the main contributor to this trend [6]. Although less faculty time is generally available, the demand for high-quality instruction remains [7,8].

Radiology residents have slowly become more integral to the education of students at many institutions. The phrase "resident as teacher" has become commonplace in the literature. The possible explanations include residents' eagerness to teach and share their excitement for their new profession. Additionally, residents' participation in teaching can be educationally beneficial to residents. As has been reviewed in the literature [9-12], teaching skills are valuable in the practice of medicine, but not all residents graduate with these skills. Teaching is useful not only for residents entering academic positions but also general

Department of Radiology and Biomedical Imaging, University of California, San Francisco, San Francisco, California.

Corresponding author and reprints: David M. Naeger, MD, University of California, San Francisco, Department of Radiology and Biomedical Imaging, 505 Parnassus Avenue, M-391, Box 0628, San Francisco, CA 94143-0628; e-mail: david.naeger@ucsf.edu.

This study was supported by the University of California, San Francisco, Department of Radiology and Biomedical Imaging and the University of California, San Francisco, Haile T. Debas Academy of Medical Educators Rotating Minagi Chair Award.

practitioners, who will be participating in multidisciplinary tumor boards and conferences and will be interacting with clinical colleagues. Teaching skills are specifically detailed in the ACGME's description of the core competency "practice-based learning and improvement." As such, teaching residents to teach is not only desirable but is also required [13]. The degree to which residency programs have implemented formal "resident as teacher" curricula has been variable, ranging from a few hours over the course of the residency to a dedicated residency clinical educator track [14,15].

Little has been published about students' perceptions of radiology resident educators compared with attending radiologists [16], although there has been some work in nonradiology fields [17-20]. A wealth of research has shown that formal resident-as-teacher programs can be beneficial to both residents and students [11,12,21-25]. Radiology residents in our program teach in the fourth-year medical student radiology elective clerkship. Extensive feedback data are available, which we used to compare students' evaluations of resident educators with those of faculty members. Given our generally positive experience with residents as teachers, we hypothesized that residents would be evaluated as similar to attending radiologists in their lecture scores.

METHODS

The Clerkship

The data for this study were obtained from our main senior (fourth-year) medical student radiology elective clerkship. The elective is offered for 6 sessions a year and is taken by a total of approximately 100 students per year. Each session includes approximately 50 hours of lecture. In addition, the elective involves assignments (an essay, a slideshow presentation, and the creation of an online module), self-study activities (the review of approximately 4 online faculty-created modules), and multiple hours of nonlecture activities, such as tours, hands-on sessions, and small-group sessions. Evaluations from the nonlecture sessions were not included in this study.

Lectures in the course had historically been given exclusively by attending faculty members. In recent years, however, the role of fellows and residents has increased. This trend has not been driven by the course director or teacher needs but rather by resident interest and a desire of the residency program to encourage the development of teaching skills.

Attending faculty members who teach in the course either volunteered or were identified and recruited by the course director on the basis of their experience and expertise. A core group of faculty members representing each subfield has been maintained through the years. The residents involved in the course all volunteered and were usually more senior residents (most recently, 16 of 22 [73%] participating residents were in postgraduate year 4 or 5); resident teachers were not selected on the basis of

their academic achievements or residency performance. Fellows participated in lecturing much less frequently than attending faculty members and residents; the fellows who taught were almost exclusively from one section (abdominal imaging). This section's leadership elected to develop standardized lectures covering core topics and assigned teaching to both fellows and attending radiologists on the basis of clinical site assignment rather than by requesting volunteers.

Over the 2011-2012 academic year, 31 attending faculty members, 12 fellows, and 22 residents lectured. Lecturers were generally asked to give a minimum of 6 hours of instruction per year, although some delivered fewer and some delivered more.

Lectures and Lecture Evaluations

The lectures given in the course covered the core topics of radiology listed in the curriculum proposed by the Alliance of Medical Student Educators in Radiology National Medical Student Curriculum in Radiology [26]. No differences were intentionally introduced between the topics covered by faculty members and those covered by residents (or fellows). Lectures were all 1 hour in length, and all used PowerPoint (Microsoft Corporation, Redmond, Washington) or similar presentation software. Example lecture titles include "Pelvic Ultrasound" (resident), "Neuroradiology: Strokes and Bleeds" (resident), and "Pediatric Non-Accidental Trauma" (attending radiologist). The lectures given by fellows were premade (ie, "canned lectures"), whereas all resident and nearly all attending faculty member lectures were created or modified by the lecturers.

Every lecture in the course was evaluated as part of our regular course improvement efforts. The submission of evaluations and feedback was linked to the online attendance record and therefore was treated as mandatory. Although attendance was tracked, the actual evaluations were anonymous. Evaluations were intended for the purposes of course improvement and consisted of 2 additional components: a request for an overall numeric score, and a request for free-text comments. The overall numeric score, which was used for the purposes of this study, was obtained by listing the lecture (eg, "Lecture 1: Lecturer Name – Lecture Topic – Time") followed below by 10 radio buttons labeled 1 to 10 and a legend: "Rating: 1 = poor, 10 = excellent." Given students' practiced familiarity with evaluations, additional instructions were not provided. The written comments, which were not included in this study, were requested by listing the lecture, followed by "Please provide comments on this lecture." Evaluations were collected at the end of the day with few exceptions, thereby generally resulting in an evaluation delay of between 0 and 7 hours.

Numeric data for this study were collected retrospectively from the online evaluation system covering 12 months of scores (6 course offerings). The collection of these data for analysis and publication was confirmed by our institutional review board to be an "exempt category"

of research. The data collected did not include individual student evaluations but rather the average combined score given after each individual lecture.

Resident Coaching and Mentorship

All residents participating in medical student teaching were mentored by the elective's course director. Lecture feedback was reviewed together, and ways to improve were discussed. Often the lecture slides were reviewed, and sometimes the course director would directly observe a resident's teaching and provide feedback. For particularly skilled residents, the time spent mentoring over the course of the year was often approximately 30 min; for residents who faced more challenges in teaching, mentoring could constitute up to approximately 2 hours of direct communication over the course of the year. The written lecture feedback was also provided to fellows and attending faculty members, but they were not directly mentored regarding their teaching.

Statistical Analysis

Each lecture score was treated as a separate data point, classified only by the status of the lecturer (attending radiologist, fellow, or resident). Scores were summarized with a mean and standard deviation. Overall differences between the groups was assessed with analysis of variance, with statistical significance defined as $P < .05$. Pairwise comparisons (3 in total) were performed using student's t tests. To maintain an overall type 2 error level of .05, Bonferroni's correction was applied to determine the P -value threshold for statistical significance. Therefore, .05 was divided by the number of comparisons, 3, to define $P < .0167$ as being statistically significant.

Although each hour lectured was by definition a unique event with regard to lecturer, topic, and group of students, there was inherent clustering of the data by lecturer. That is, the same lecturers giving the same lecture to a different group of students might score similarly. To address this, we reanalyzed the data per lecturer, by giving each lecturer a single average score, whether he or she lectured once or multiple times.

For the primary analysis comparing individual lecture scores, the comparison between the 2 largest groups (attending radiologists vs residents), we were powered to detect a difference of 0.2 points on a scale of 10 (assuming $\alpha = .0167$ [Bonferroni's correction, $.05/3$], $\beta = 0.80$, ratio of groups = 0.73, SD = 0.5). The comparisons with fellows, a smaller group, were powered to detect a difference of approximately 0.35 points on a scale of 10 (calculated using the smaller size group but otherwise using similar assumptions).

RESULTS

A total of 307 lectures over 6 course offerings were delivered and scored by students. Mean scores of 9.10 ± 0.60 , 8.45 ± 0.90 , and 8.99 ± 0.49 were calculated for faculty members, fellows, and residents, respectively (Fig. 1). Faculty members gave 162 lectures (53%), fellows 27

Fig 1. Mean (and SD) evaluation scores of lectures given by faculty members, fellows, and residents. Analysis of variance (ANOVA) and pairwise t -test P values are reported. Note that only the upper half of the 10-point scale is included on the graph.

lectures (9%), and residents 118 lectures (38%) over the 1-year period. There was an overall statistically significant difference in the scores assigned to the 3 groups as determined by analysis of variance ($P < .001$). Pairwise t tests revealed that the difference was driven mainly by statistically significantly lower scores of the fellow group compared with residents and faculty members ($P < .001$ for both comparisons). There was no statistically significant difference in scores between attending radiologists and residents ($P = .089$).

On average, each lecturer in the course gave 5.7 lectures over the course of the year (median, 3; interquartile range, 1–6). Some lecturers gave as few as 1 lecture, and the course director gave the most, at 25. Fellows gave the fewest number of lectures per individual (mean, 1.6; median, 1). To assess the effect of clustering of the data, the analysis above was rerun with each lecturer's average score as an individual data point (ie, each of the 31 faculty members, 12 fellows, and 22 residents received one average score, and the different groups were compared). The mean of each faculty member's average score was 8.91 ± 0.49 , 8.00 ± 0.71 for fellows, and 8.86 ± 0.59 for residents. The statistical tests yielded nearly identical results as above: an overall difference was again detected ($P < .001$, analysis of variance) with the differences by pairwise t tests being statistically significantly lower scores for fellows compared with faculty members and residents ($P < .001$ for both, respectively). Resident and faculty member scores did not significantly differ ($P = .74$).

DISCUSSION

We found that lectures delivered by radiology residents received evaluation scores that were not statistically sig-

nificantly different compared with scores from lectures delivered by faculty radiologists. The residents who participated were a volunteer subset from the overall residency, just as faculty members were a volunteer subset from the whole faculty. Although residents were comparable with faculty members in overall scores, it should be noted that each resident received mentorship and guidance in his or her teaching, and residents' participation was more heavily scrutinized. Resident self-improvement and mentoring sessions were informed by the numeric and qualitative evaluations generated by the medical students. Faculty members did not receive active mentorship in improving their lectures, but they did receive the monthly evaluation scores and comments. It is possible that the active resident mentorship was what allowed residents to garner results comparable with those of faculty members. We considered mentorship to be beneficial to the residents and their students, and per Liaison Committee on Medical Education guidelines, mentorship on some level is required [27].

Our data did reveal a difference in the performance of fellows who lectured in our clerkship. Fellows were the smallest group, and the nature of their participation differed. Unlike residents and attending faculty members, fellow lecturers were assigned by their section to give premade presentations, a format used only by one section in the department. As such, they tended to give fewer lectures and may have been less invested in their lecture performance and improvement. Fellows did not receive active mentorship, and with relatively few lectures given per lecturer, fellows had little opportunity to improve over time.

The factor(s) ultimately responsible for the lower fellow scores cannot be known, although we believe the scheduled (rather than volunteer) nature of their involvement may have been the largest contributor. There were no "assigned" lecturers among the residents and attending radiologists, so we are unable to evaluate the role of volunteerism in having higher scores. Presumably, fellows are between residents and attending faculty members in knowledge level and teaching experience and would score similarly if the nature of their recruitment were similar. Indeed, fellows, who are closer to the process of applying and interviewing for jobs, may have more of an incentive to have good reputations for being talented educators. Regardless, it is our belief that an all-voluntary teaching cadre results in higher learner (and teacher) satisfaction.

Little has been written in the radiology literature comparing resident teaching with faculty member teaching, although our findings do agree with the most similar study available. A 2003 study by Scheiner and Mainiero [16] compared evaluations and test scores from 2 groups of 20 students in a radiology clerkship. Each group received standardized lectures, either given by residents only or by faculty members only. No differences in evaluation scores or test scores were noted, although students did report that resident lecturers fostered "an environ-

ment in which students felt more comfortable asking questions," whereas attending radiologists had "a greater ability to answer student questions, as well as to ask more appropriate questions of students." The selection of resident and attending educators in this study was based on availability, although the exact degree to which the educators volunteered is unknown. Overall, the authors concluded that residents were effective teachers. Our study did not have a similar experimental design, or test score outcomes, although our study involved a more real-world situation in which lecturers developed their own lectures and were able to improve them through time. Such a setup more accurately reflects the real-life teaching experience in most departments. Additionally, our study included a larger number of lectures, lecturers, and student evaluations. Despite these differences, the drawn conclusion is similar, namely, that residents give noninferior radiology lectures compared to faculty members.

Outside of the radiology literature, a small number of studies have directly compared resident and attending faculty member teaching; most are in the context of teaching on the wards, and the results have been varied. Stern et al [18] suggested that faculty members produced a better teaching experience than residents as determined by student examination scores during a mandatory internal medicine clerkship. Donnelly and Woolliscroft [17], by contrast, found no difference in internal medicine clerkship teaching evaluations of junior residents, senior residents, fellows, and faculty members. Two studies focused on teaching during surgical clerkships found that residents scored higher in evaluations of teaching and mentorship than attending faculty members [19,20]. The degree to which educators volunteered in these settings is unknown, although it seems that many of the resident educators were those assigned to clinical service. This overall educational setting (the wards) and medical student rank (third year) differ from our study.

Although residents scored similarly in teaching evaluations in our study, is medical student education a good use of a resident's time? We consider teaching a useful skill, regardless of career path. Therefore, if residents are guided and actively engaged in teaching, the experience could be beneficial to residents and students alike [22]. We therefore encourage programs to use resident teaching but also provide formal mechanisms for residents to learn teaching skills. We do want to emphasize, however, that residents should not be used as the primary educators in medical student electives, particularly in the absence of supervision and feedback. The Liaison Committee on Medical Education's published materials [27] confirm that faculty members are ultimately to be responsible for the supervision of all medical student learning and that residents participating in medical student education should be properly prepared, supported, and evaluated.

Many radiology residencies have made the mastery of teaching skills a priority by offering workshops, teaching electives, or resident lecture series [10,28,29]. Some pro-

grams even offer dedicated teaching tracks within the residency program [15]. Although most residencies recognize the importance of teaching residents to teach, major barriers to this goal include faculty time limitations and lack of personnel trained in education methodology [10].

Our study had a number of limitations. The study design was retrospective, and it relied on students' perceptions of the educators. An outcome measuring actual learning would have brought additional rigor but was unavailable given that our end-of-the-elective test questions are generated by the lecturers themselves and therefore variably assess learning. Our results pertain to the experience at 1 institution with 1 cohort of teachers. Additionally, we evaluated lecturing in the setting of an elective, so our results may not be applicable to lecturing to large groups (≥ 100), teaching hands-on sessions, teaching in reading rooms, or instruction on the wards. Our data were also inherently clustered, with some lecturers giving multiple lectures; we accounted for this by rerunning the same analysis with all clustering removed (by using a single average score for each lecturer). This repeat analysis yielded identical results. Finally, residents benefited from focused teaching mentorship, whereas faculty members did not. Given the retrospective nature of the study, this could not be addressed; furthermore, medical school requirements dictated that resident supervision and mentorship occur.

TAKE-HOME POINTS

- Over a 1-year period, lectures given by residents received similar scores compared with lectures given by attending faculty members in the setting of a fourth-year medical student radiology elective.
- Residents received formal mentorship and sufficient feedback to allow improvement over time. The Liaison Committee on Medical Education requires that residents teach under the supervision of attending faculty members and that residents be properly prepared, supported, and evaluated.
- We believe that involving residents in medical student teaching may benefit residents and students.

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