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Assessment of Radiology Training During Radiation Oncology Residency

Shanna A. Matalon[1,2] · Stephanie A. Howard[2,3] · Matthew J. Abrams[2,4]

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Abstract
A strong foundation in diagnostic imaging is essential to the practice of radiation oncology. This study evaluated radiology training in radiation oncology residency. An online survey was distributed to current radiation oncology residents in the USA by e-mail in 2017. Responses were summarized using frequency and percentages and compared with chi-square test and Spearman's rank correlation when appropriate. One hundred five residents completed the survey. Although most residents felt that a strong knowledge base in diagnostic radiology was moderately or extremely important (87%, $n = 90/104$), the majority were only somewhat confident in their radiology skills (61%, $n = 63/104$) and were only somewhat, minimally, or not at all satisfied with their training (79%, $n = 81/103$). Although there was an association between increasing post-graduate training and confidence level ($p = 0.01062$, $\rho = 0.24959$), the majority of graduating residents feel only somewhat confident in radiology skills (63%, $n = 12/19$). Residents were most commonly exposed to radiology via multidisciplinary conferences (96%, $n = 100/104$), though only 15% ($n = 16/104$) of residents ranked these as the most beneficial component of their radiology training and 13% ($n = 13/101$) of residents felt these were the least beneficial. Most residents (60%, $n = 63/105$) believe there is a need for dedicated radiology training during residency, preferring monthly formal didactics (68%, $n = 71/105$) co-taught by a radiologist and radiation oncologist (58%, $n = 61/105$). Radiation oncology residents feel their radiology training is suboptimal, suggesting a need for more guidance and standardization of radiology curriculum. A preferred option may be monthly didactics co-taught by radiologists and radiation oncologists; however, future studies should assess the effectiveness of this model.

Keywords Radiation oncology · Radiology · Residency education · Residency curriculum

Introduction

A strong foundation in diagnostic imaging and radiologic anatomy is essential for the daily practice of a radiation oncologist, including applications such as ordering proper staging and follow-up imaging, evaluation of simulation scans, and treatment planning and verification.

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✉ Matthew J. Abrams
mabrams2@bidmc.harvard.edu

[1] Department of Radiology, Brigham and Women's Hospital, Boston, MA, USA

[2] Harvard Medical School, Boston, MA, USA

[3] Department of Imaging, Dana-Farber Cancer Institute, Boston, MA, USA

[4] Department of Radiation Oncology, Beth Israel Deaconess Medical Center, 330 Brookline Avenue, Boston, MA 02215, USA

According to the Accreditation Council for Graduate Medical Education (ACGME), radiation oncology residents in the United States (U.S.) should be provided diagnostic imaging training by either a 1-month rotation in diagnostic imaging or attendance at regularly scheduled multidisciplinary conferences [1]. Despite the importance of radiology training, there is no standardized curriculum, no expected competencies, and no data to suggest which method is superior [2].

Past studies have evaluated the importance of a diagnostic radiology curriculum in medical school training and surgical residency [3, 4]; however, there is a dearth of information on its importance in radiation oncology residency.

The purpose of this study was to determine how radiation oncology programs currently train residents in diagnostic radiology and reports residents' satisfaction with this training.

Methods

An anonymous, IRB-exempt, 28-item online survey was created and tested on a focus group consisting of seven radiation

oncology residents for feedback on survey questions and answer choices. After testing, the survey was sent via e-mail to all radiation oncology program directors throughout the USA to be distributed to their current residents in March, 2017. A reminder e-mail was sent 2 weeks following the initial e-mail and the survey was closed after 1 month. Informed consent was implied by voluntary completion of the survey. Respondents were offered the chance to win a $50 Visa gift card upon completion of the survey.

Survey data was collected and stored using REDCap (Research Electronic Data Capture), hosted by our institution's HealthCare Research Computing Enterprise Research Infrastructure and Services (ERIS) group [5]. Associations between categorical responses were analyzed using chi-square test and between ordinal responses using Spearman's rank correlation coefficient where appropriate. Qualitative open-ended comments at the end of the survey were reviewed by the authors (SAM and MJA) and categorized to identify common themes. All statistical analyses were performed using the Statistical Package of Social Sciences Version 22.0 (SPSS, Inc. Chicago, IL), with a 2-sided P value $\leq .05$ deemed statistically significant.

Results

One hundred and five current US radiation oncology residents completed the online survey. Based upon the number of residency positions in recent years, we propose an estimated response rate of approximately 15% (105/680). Table 1 summarizes the respondents' demographic and program characteristics. All survey questions were optional and any denominator less than 105 indicates that at least one respondent chose to skip that question.

While the majority of residents believe a strong knowledge base in diagnostic radiology and image interpretation was moderately or extremely important (87%, $n = 90/104$), most residents were only somewhat confident in their overall radiology skills as it pertains to their daily practice (61%, $n = 63/104$). Residents were most comfortable in interpreting PET/CT and CT images, and least comfortable interpreting mammographic and x-ray images. Table 2 summarizes the results for Likert-scale survey questions. Although there is an association between increasing confidence level and increasing year of post-graduate training ($p = 0.01062$, $\rho = 0.24959$) (Fig. 1), the majority of graduating residents (PGY-5) reported feeling only somewhat confident with their radiology skills as it pertains to their daily practice (63%, $n = 12/19$).

Residents were exposed to radiology through a variety of means (Fig. 2). Radiology rotation during medical school was felt to be the least beneficial (60%, $n = 47/78$), followed by independent study (26%, $n = 20/77$), mandatory radiology rotation during radiation oncology residency (18%, $n = 2/11$), and multidisciplinary conferences (13%, $n = 13/100$).

Table 1 Respondent characteristics. $n = 105$

Characteristic	Answer options	No. (%) of responses
Post-graduate year (PGY)	PGY-2	41 (39)
	PGY-3	23 (22)
	PGY-4	22 (21)
	PGY-5	19 (18)
Age	< 25	0 (0)
	25–29	41 (39)
	30–34	53 (50)
	35–40	9 (9)
	> 40	2 (2)
Sex	Male	74 (70)
	Female	31 (30)
Number of residents in program	< 6	10 (10)
	6–10	55 (52)
	11–15	24 (23)
	> 15	16 (15)
Residency location	Northeast US	38 (36)
	Southeast US	21 (20)
	Midwest US	26 (25)
	Northwest US	7 (7)
	Southwest US	13 (12)

All survey questions were optional and any denominator less than 105 indicates that at least one respondent chose to skip that question

Informal teaching by a radiation oncology attending was considered the most beneficial (36%, $n = 32/90$), followed by radiology didactics as part of radiation oncology curriculum (27%, $n = 11/41$) and informal consultation by a diagnostic radiologist (22%, $n = 17/79$).

Most residents believe there is a need for dedicated diagnostic radiology training during radiation oncology residency ($n = 63/105$, 60%). Formal didactic sessions ($n = 59/105$, 56%) were preferred over mandatory 1-month rotation in diagnostic radiology ($n = 20/105$, 19%) and required regularly scheduled multidisciplinary conferences ($n = 26/105$, 25%). Regarding preferences for frequency and delivery of radiology didactic training, most preferred monthly didactics ($n = 71/105$, 68%), co-taught by a radiation oncologist and a diagnostic radiologist ($n = 61/105$, 58%).

Twenty-four percent ($n = 25/105$) of residents provided an optional open-ended comment at the completion of the survey. Over one quarter of the comments (29%, $n = 7/24$) supported more radiology training in general: one resident wrote "Any formal training would be extremely helpful. In July, I had never felt more overwhelmed in my life" and another wrote "I feel very strongly that residents should be provided with a thorough didactic background in radiology early in their first year of radiation oncology residency". The next most common theme was the potential inadequacies of a diagnostic radiology rotation as it pertains to radiation oncology

Table 2 Response to Likert-scale questions

Survey question "On a scale of 1–5…"	Not at all (1)	Minimally (2)	Somewhat (3)	Moderately (4)	Extremely (5)	Median ± interquartile range
…how comfortable do you feel interpreting x-ray images, as it pertains to your daily practice?	3 (3%)	34 (33%)	40 (39%)	23 (22%)	4 (4%)	3 ± 1
…how comfortable do you feel interpreting CT images, as it pertains to your daily practice?	1 (1%)	4 (4%)	22 (21%)	58 (56%)	19 (18%)	4 ± 1
…how comfortable do you feel interpreting MRI images, as it pertains to your daily practice?	4 (4%)	23 (22%)	36 (35%)	38 (37%)	3 (3%)	3 ± 2
…how comfortable do you feel interpreting PET/CT images, as it pertains to your daily practice?	0 (0%)	3 (3%)	21 (20%)	56 (54%)	24 (23%)	4 ± 0
…how comfortable do you feel interpreting mammographic images, as it pertains to your daily practice?	23 (22%)	52 (50%)	25 (24%)	4 (4%)	0 (0%)	2 ± 1
…how comfortable do you feel interpreting bone scan images, as it pertains to your daily practice?	2 (2%)	31 (30%)	39 (38%)	26 (25%)	6 (6%)	3 ± 1
…overall, how confident are you in your diagnostic radiology skills?	4 (4%)	13 (13%)	63 (61%)	23 (22%)	1 (1%)	3 ± 0

residency training (21%, $n = 5/24$). For example, one resident wrote "A diagnostic radiology rotation would be most useful for radiation oncology residents only if oncologic patients are presented. This model weakens when most of the time on this rotation is spent viewing non-oncologic cases." while another simply stated "Diagnostic rotations during residency are low yield, unless you can guarantee an oncologic case load".

Discussion

To our knowledge, this is the first study to examine the current state of radiology training during radiation oncology residency. Despite the fact that the daily practice of radiation oncology is closely intertwined with diagnostic imaging and radiologic anatomy, these survey results suggest that radiology training during radiation oncology residency in the U.S. may be suboptimal. On average, residents are only somewhat satisfied with their radiology training and feel only somewhat comfortable in their radiology skills as it pertains to their daily practice.

Although this survey shows an association with increasing year of post-graduate training and increasing comfort level in diagnostic radiology, only 33% of graduating PGY-5s (who are about to enter the workforce) were moderately comfortable in their knowledge base, suggesting there is substantial room for improvement.

This survey demonstrates that most residents believe a formal radiology curriculum is necessary. The 2013–2015

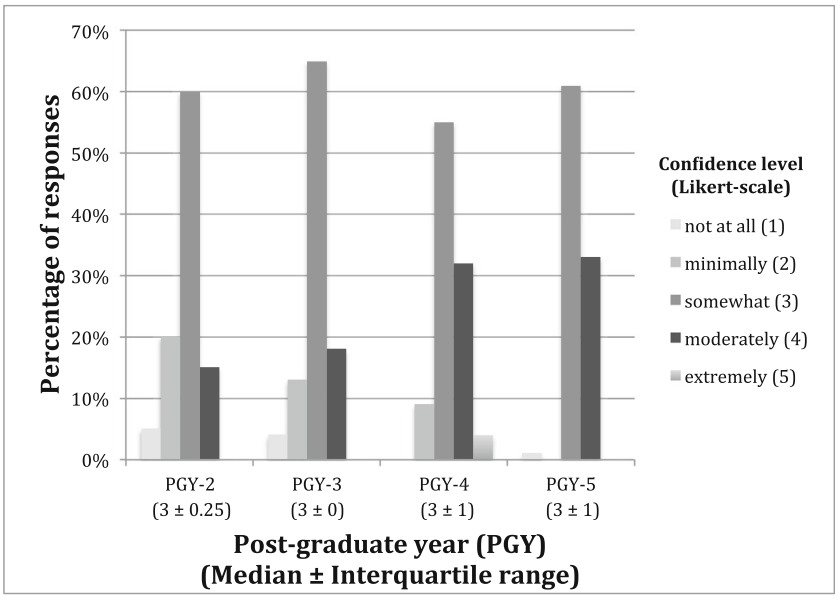

Fig. 1 Overall comfort level in diagnostic radiology skills by post-graduate year (PGY)

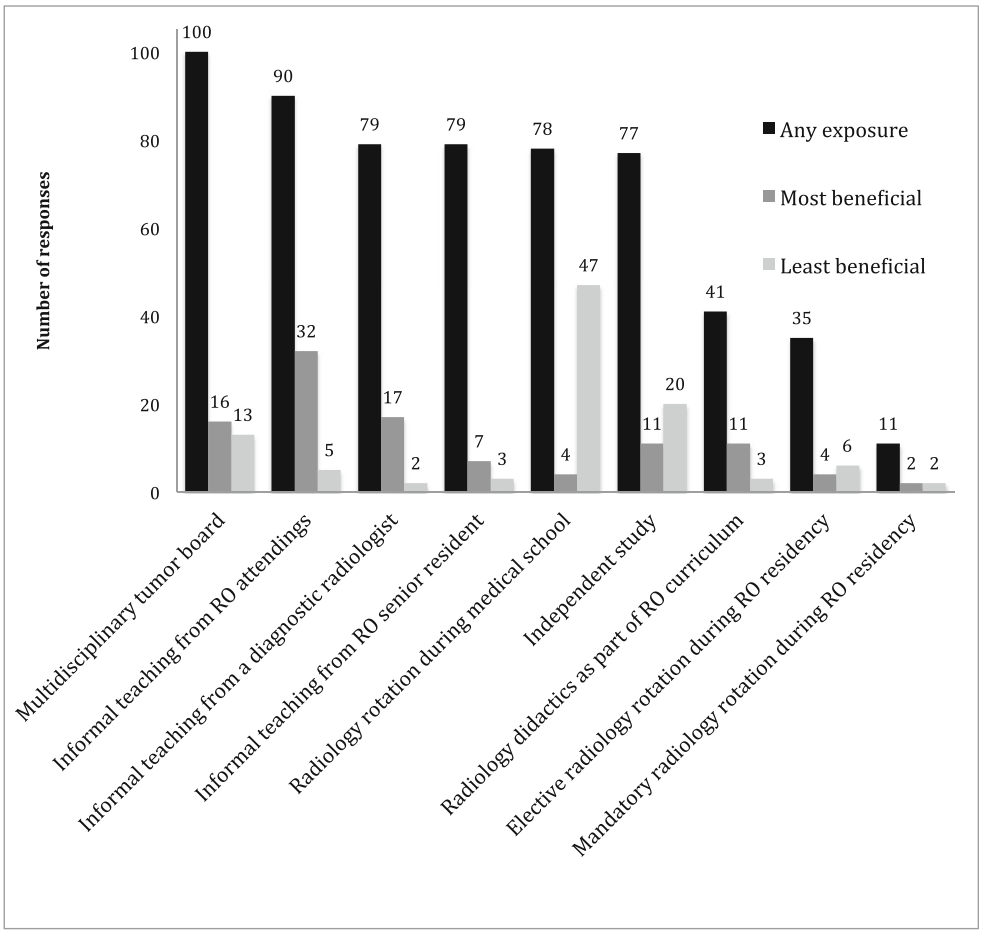

Fig. 2 Resident exposure to radiology during training. Response to 3 survey questions: (1) In which of the following ways have you been exposed to diagnostic radiology (select all that apply); (2) Of the following, which has been the *most* beneficial in your education of diagnostic radiology (select one); (3) Of the following, which has been the *least* beneficial in your education of diagnostic radiology (select one)

Association of Residents in Radiation Oncology (ARRO) Survey of Chief Residents in the USA found that fewer than 25% of programs provide adequate formal didactic courses in radiology anatomy [6]. Our survey demonstrates slightly higher percentage of residents reporting radiology didactics as part of their radiation oncology curriculum (39%); suggesting the importance of this topic may be already receiving increasing awareness. Previous studies have shown high levels of resident satisfaction with implementation of formal radiology and anatomy curriculum [7–9]; however, the standardization, incorporation, and impact of such a curriculum in the national radiation oncology group have yet to be examined.

Similar challenges in the physics curriculum were recognized after several studies demonstrated marked variability and inconsistency in physics education during radiation oncology residency [10, 11]. In response, the Radiation Physics Committee of the American Society for Radiation Oncology (ASTRO) created a committee to develop a core physics curriculum in late 2003 [10, 12]. According to the ARRO 2013–2015 survey, more than 80% of residents reported having adequate experience in physics [6].

One possible limitation of this study is that there may be a sampling bias with program directors acting as survey gatekeepers; for example, perhaps only programs with suboptimal radiology training responded. Additionally, there may be a response bias with more responses from larger programs. Finally, actual performance in interpreting imaging studies as it pertains to the daily practice of these radiation oncology residents was not measured, but could be elucidated in a future study.

Conclusion

In conclusion, this survey suggests that the current diagnostic radiology curriculum and training in radiation oncology residency may be insufficient. Using the successful revamping of the radiation oncology physics curriculum as a guide, development of a standardized curriculum in oncoradiology under the direction of a centralized committee may facilitate the transition by individual residency programs to a more effective training method. Future studies should be performed to validate these findings in a larger cohort of current radiation oncology residents. In addition, these studies should evaluate objective outcomes (e.g., inservice exam results in the radiology subcategory or focused assessments of radiology skills through periodic examinations throughout residency) to see if residents' perceived skills translate into objective

assessment, justifying the formation of a formalized oncoradiology curriculum.

Compliance with Ethical Standards

Conflicts of Interest The authors declare that they have no conflicts of interest.

IRB Exempted by the Partners Healthcare institutional review board (IRB).

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