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Multi-institutional implementation and evaluation of a curriculum for the medical student clerkship in radiation oncology

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Abstract

Purpose/Objective(s)—Radiation oncology curriculum development is challenging due to limited numbers of trainees at any single institution. The goal of this project is to implement and evaluate a standardized medical student clerkship curriculum following the multi-institutional cooperative group research model.

Methods and Materials—During the 2013 academic year, a standardized curriculum was implemented at 11 academic medical centers consisting of three one-hour lectures and a hands-on radiation treatment planning workshop. Post-curriculum, students completed anonymous evaluations using Likert scales (1 = "not at all" to 5 = "extremely"; reported as median [interquartile range]) and free responses. Evaluations asked students to rate their pre/post-comfort with radiation oncology as a specialty, knowledge of radiotherapy planning methods, and ability to function as a radiation oncology resident. Non-parametric statistical tests were used in analysis.

Results—88 students at 11 academic medical centers completed the curriculum *de-novo* with 72.7% (64/88) survey response rate. 57/64 (89.1%) reported intent to pursue radiation oncology as their specialty. Median student ratings of the importance of curricular content were: Overview 4[4-5]; Radiation Biology/Physics 5[4-5]; Practical Aspects/Emergencies 5[4-5]; Planning Workshop 4[4-5]. Students reported the curriculum helped them to better understand radiation oncology as a specialty (5[4-5]), increased specialty decision comfort (4[3-5]), and would help the transition to radiation oncology residency (4[4-5]). Students rated their specialty decision comfort significantly higher after completing the curriculum (4[4-5] vs. 5[5-5], $p<0.001$).

Conclusions—A national standardized curriculum was successfully implemented at 11 academic medical centers, providing proof-of-principle that curriculum development can follow the multi-institutional cooperative group research model.

Introduction

Medical student core rotations in internal medicine, surgery, obstetrics/gynecology, pediatrics, family medicine, and psychiatry typically have a well-structured didactic curriculum to complement the clinical experience. These curricula are routinely reviewed and improved based on student feedback. However, curriculum development for undergraduate and graduate medical education in specialties and subspecialties, such as radiation oncology, is challenging due to limited numbers of trainees at any single institution. Stepwise models of curriculum development rely upon evaluation of targeted needs and feedback, which are hampered by restricted numbers of participants.(1) Medical

students applying for residency in radiation oncology complete a median of three clerkships at multiple institutions during their final year of medical school. However, the majority of these clerkships are reported to have no structured didactic curriculum for the rotating medical students.(2, 3) Based on these targeted needs assessments, a structured didactic pilot curriculum was developed for the radiation oncology clerkship and successfully implemented at two institutions in 2012.(4)

In order to overcome the challenge of limited numbers of trainees at the two pilot institutions, further evaluate the curriculum, and disseminate the curriculum to a wider audience, a multi-institutional collaborative group research model was adapted to educational curriculum development. The multi-institutional collaborative research model has been used successfully for many years to improve patient care for relatively uncommon diseases by pooling patients from multiple institutions around the country or the world to increase the total number of patients treated during a given timeframe.(5-7) We hypothesized that a similar model could be applied to subspecialty curriculum development to address the aforementioned clerkship educational gap by exposing a larger number of trainees to a novel curriculum. The Radiation Oncology Education Collaborative Study Group was therefore established with the goal of using curriculum development for the medical student clerkship as a test case for multi-institutional collaborative radiation oncology curriculum development. Thus, the initial two-institution pilot radiation oncology clerkship curriculum was expanded to eleven selected academic medical centers within the United States in 2013. Here we report the results of the expanded curriculum.

Methods and Materials

Initial development of the curriculum has been previously described.(4) In brief, Kern et al.'s six step approach to medical education curriculum development as outlined in Table 1 was used to develop a curriculum for the radiation oncology clerkship.(1) Prior to developing the curriculum, a targeted needs assessment was completed to characterize the medical student's perception of the radiation oncology clerkship experience and to determine what educational content to include in the curriculum.(2) A structured didactic pilot curriculum was designed to teach medical students the fundamentals of clinical radiation oncology as previously described.(4) The curriculum consisted of three one-hour lectures on 1) an overview of radiation oncology including a history of the specialty, types of treatments, and basic clinic flow, 2) fundamentals of radiation biology and radiation physics, and 3) practical aspects of radiation treatment simulation and planning/radiation emergencies. Goals of each lecture are previously described.(4) The lectures were designed to be delivered by a senior resident or faculty member. Ideally, one session was conducted per week with all students present. The lecture format was open and students were encouraged to ask questions. In addition to the three lectures, a one-hour hands-on radiation treatment workshop was developed to teach students the fundamentals of radiation treatment planning in an interactive manner.(4) Due to resource constraints, one institution instituted a modified version of this component of the curriculum that required students to outline the radiation target, but did not include the planning component. This component of the curriculum is available for download through MedEdPORTAL at https://www.mededportal.org/publication/9297.(8) The other curriculum components (i.e. lectures)

were disseminated to each participating site via Dropbox (Dropbox Inc., San Francisco, CA) and are being prepared for submission to MedEdPORTAL.org for public dissemination.

Nine additional academic medical centers were recruited to implement the revised curriculum in 2013, thus establishing the Radiation Oncology Education Collaborative Study Group. Participating academic medical centers included the University of Chicago, Massachusetts General Hospital, Brigham and Women's Hospital/Dana-Farber Cancer Institute, U.T. MD Anderson Cancer Center, Weill-Cornell Medical College, Yale School of Medicine, University of California, San Francisco, Oregon Health & Science University, Medical College of Wisconsin, New York University, and University of Wisconsin. Individual institutions were permitted to modify the lectures for institutional treatment or practice preferences, but all participating institutions kept the core curriculum format the same (three lectures, one planning session).

At one of the participating institutions, video recordings of the lectures were developed. Students at this institution were provided with web links to watch these lectures during their rotation. This institution continued to provide the hands-on treatment planning session in-person.

Upon completion of the clerkship, students were invited with a single e-mail invitation to complete an anonymous evaluation of the curriculum using Likert scales to rate curriculum components (1 = not at all, 2 = somewhat, 3 = moderately, 4 = quite, 5 = extremely). Students were asked to identify the rotation site where the curriculum took place. Student evaluations were collected remotely through an anonymous, internet-based survey. The survey was developed from input by site coordinators from all participating institutions (senior residents and attending physicians). Additionally, institutional site coordinators (senior residents or junior faculty) completed an evaluation of the clerkship curriculum at the end of 2013. Evaluations were collected and managed using Research Electronic Data Capture (REDCap). These electronic data capture tools are hosted at the University of Chicago.(9) REDCap is a secure, web-based application designed to support data capture for research studies, providing: 1) an intuitive interface for validated data entry; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for importing data from external sources.

Wilcoxon signed rank-sum was used to compare responses. Likert score responses are reported as median (interquartile range). All participating institutions were required to obtain IRB exemption.

Results

Ninety-four students at 11 academic medical centers completed the curriculum during the 2013 calendar year. Six of these students completed the curriculum at two institutions, leaving 88 students completing the curriculum for the first time. 64/88 first-time students submitted completed evaluations (72.7% response rate). 57/64 (89.1%) reported an intent to pursue radiation oncology as their specialty upon completion of the clerkship. Subsequent

analyses were performed on the evaluations from the students reporting intent to pursue radiation oncology as a specialty (see Figure 1 for a consort diagram).

Fifty students were in their fourth year of medical school, and 7 students were in their third year. Twenty-two students had completed no prior radiation oncology rotations, 21 had completed one prior rotation, 12 had completed two prior rotations, and 2 had completed three prior rotations. The number of students completing the curriculum *de novo* at each institution and completing evaluations is reported in Table 2 in de-identified form.

Student ratings of curricular content were between “quite” and “extremely” useful for the three lectures (Figure 2). The median Likert score for the overview/introductory lecture was 4 [interquartile range 4-5], for the radiation biology and physics lecture it was 5 [4-5], and for the practical aspects of patient set-up/emergencies it was 5 [4-5].

The planning workshop was rated as “quite” useful with a median Likert score of 4 [4-5] (Figure 2). The planning workshop improved student comfort with radiation treatment planning (pre-session 2 [1-3] vs. post-session 3 [3-4], $p<0.001$), and using a planning workstation (pre-session 2 [1-3] vs. post-session 4 [3-4], $p<0.001$), and enriched their understanding of a simple radiation treatment plan for the common clinical scenario of a vertebral metastasis (pre-session 2 [1-3] vs. post-session 4 [3-4], $p<0.001$).

Overall, students reported the curriculum was “quite” to “extremely” useful to help understand radiation oncology as a specialty (5 [4-5]), to increase specialty decision comfort (4 [3-5]), and to help the transition to radiation oncology residency (4 [4-5]). Students rated their comfort with their specialty decision significantly higher after completing the curriculum (pre-curriculum 4 [4-5] vs. post-curriculum 5 [5-5], $p<0.001$).

Subset analysis was performed. One academic medical center provided lectures in a recorded format, which mitigated the perceived impact of the curriculum. These 9 students reported a lower score for the overall usefulness of the curriculum (4 [4-4] vs. 5 [4-5], $p=0.009$). However, individual lecture content was rated equivalently between the institutions providing live lectures and the institution with recorded lectures (data not shown).

Lectures were administered by residents at 7/11 participating academic medical centers. Site coordinators found resident participation to be an “extremely” useful experience to develop teaching skills (5 [3-5]). Prior to implementation of the multi-institutional curriculum, 4/11 sites reported having no structured curriculum for rotating medical students, only 2/11 sites reported having weekly lectures specifically for medical students, and only one site had a requirement for students to spend time in dosimetry to learn about treatment planning. Similar to the medical student responses, site directors reported a perceived increase in the students’ comfort level with pursuing radiation oncology before and after the curriculum, although this was not statistically significant (4 [3-5] vs. 5 [4-5], $p=0.122$).

Students who repeated the curriculum at a second participating institution (n=6), continued to report that the curriculum was quite to extremely useful (4.5 [4-5]). Analysis was also performed on students who had completed prior rotations versus those students for whom

this was their first rotation and no difference was found in the perceived usefulness of the curriculum components or the overall curriculum (data not shown). Lastly, students who were not planning to pursue radiation oncology (n=7) rated the curriculum “quite useful” (4 [4-5]).

Discussion

Using the collaborative group model that has led to numerous advances in the standard of care for patient care, a structured didactic curriculum for the radiation oncology medical student clerkship was implemented and evaluated at 11 academic medical centers. A total of 94 students participated in the curriculum in 2013 allowing both wide dissemination and significant amounts feedback. The curriculum and each individual component were rated highly by the students.

The primary goal of this curriculum was to validate the initial findings from the pilot bi-institutional curriculum from 2012(4) and to further disseminate the curriculum. This would be similar to a phase 2 clinical trial being validated in a phase 3 setting, without double-blind randomization. Although conducting a randomization may better demonstrate the utility of a curriculum, it may not be ethical to withhold an educational intervention from a learner. Some medical educators have overcome this problem by using a crossover design, (10, 11) but that was not practical for this particular project. With these limitations in mind, we proceeded to validate the pilot curriculum by prospectively expanding the curriculum as a single-arm study at a multi-institutional level. The expanded curriculum confirmed the initial findings that students found the components of the curriculum useful and worthwhile. Students reported the curriculum increased comfort with their specialty decision, clinical radiation oncology skills, and would ease their transition to becoming a radiation oncology resident. These findings were also echoed by the site directors’ survey results.

There are other reports of radiation oncology curricula both for all medical students (12-15) and specifically students pursuing radiation oncology.(16) Our report represents the first curriculum designed for students considering a career in radiation oncology to be successfully expanded to multiple institutions.

By expanding the number of students who completed the curriculum, interesting subset analyses became possible that were not possible in the pilot study. For example, the finding that medical students who received lectures in a recorded format consistently rated the usefulness of the lectures lower than their counterparts at other institutions suggests that students may prefer to have a live lecture format to allow for interactive discussions. It is important to note that the institution that delivered lectures in the recorded format did so due to coordination issues, and still received an average rating of “quite” useful for each lecture. Additionally, this study demonstrates that even students not planning to pursue radiation oncology as a career rated the curriculum equivalently useful as students actively pursuing radiation oncology.

Prior to curriculum implementation, the study group considered including a pre- and post-curriculum assessment of students’ objective knowledge. However, students completing the

curriculum are frequently auditioning for a residency position during the clerkship. Objectively assessing a student's knowledge would put additional pressure on the student and potentially blunt any educational impact of the curriculum by inhibiting a sense of a comfortable and safe learning environment in which students felt they could ask questions without being evaluated. Hence, as a surrogate the students subjectively rated their own knowledge level using "comfort" with various components of the radiation oncology specialty. A positive effect of a structured curriculum on objective test scores has been previously demonstrated in a single institutional study.(17) The decision was therefore made to not include an objective performance assessment.

Social desirability bias is a potential weakness of this study. Students may rate the curriculum highly due to the perception that the evaluation reviewers (i.e. faculty at each institution) would want to see positive feedback. This was minimized by collecting anonymized evaluations, not including a performance evaluation, and encouraging the students to provide honest feedback to drive further curricular improvements. The 73% evaluation response rate, although reasonable for a survey study, was lower than desired. This was in part due to the method of requesting evaluations. Students were sent a single e-mail by their site coordinator asking them to complete an anonymous evaluation. This required relying on the coordinator to send the e-mail in a timely fashion and the student to respond to the single e-mail. In future study iterations, we may collect student e-mails in a central pool to facilitate reminder e-mails. However, the results of the curriculum evaluation remain valid given the 72% response rate.

Future directions include expansion to additional institutions, continued development and improvement of the curriculum, and development of a complementary "resident as a teacher" component to be incorporated into subsequent iterations of the curriculum. Academic medical centers that included residents as teachers rated the curriculum as an "extremely" useful experience for the participating residents. The Accreditation Council for Graduate Medical Education (ACGME) includes "participation in education of … students, residents, and other health professionals" as a component of the Practice-based Learning and Improvement core competency.(18) Future iterations of this curriculum will include training and evaluating resident teachers. With the imminent implementation of the ACGME Next Accreditation System,(19) novel methods to both develop and evaluate residents' core competencies are needed. Indeed, the radiation oncology level 4 milestone (i.e. competent to graduate residency) for Practice-Based Learning and Improvement is, "Participates in the education of patients and their families, students, residents, and other health professionals in all situations."(20)

Curriculum development using the collaborative study group model can be applied to numerous areas of medical education. Within radiation oncology, applicants to residency rate "perceived quality of didactics" within the top five factors of importance when ranking programs.(21) We plan to use the multi-institutional collaborative study group model to develop novel resident didactics. Beyond radiation oncology, this collaborative paradigm may be suitably applied to other similarly structured specialties (radiology, ophthalmology, dermatology, surgical subspecialties, etc.). Finally, collaborative international curriculum

development could broadly help to disseminate best-practices in medical education both out of, and into, the United States.

Conclusions

A national standardized curriculum for the radiation oncology medical student clerkship was successfully piloted at 11 academic medical centers during the 2013 calendar year, providing proof-of-principle that didactic curriculum development can follow the multi-institutional cooperative group model. Subsequent to participation in the curriculum, the students felt more comfortable with their specialty decision and better prepared to begin radiation oncology residency. Further curriculum development for trainees, including both medical students and residents, can be pursued using this model.

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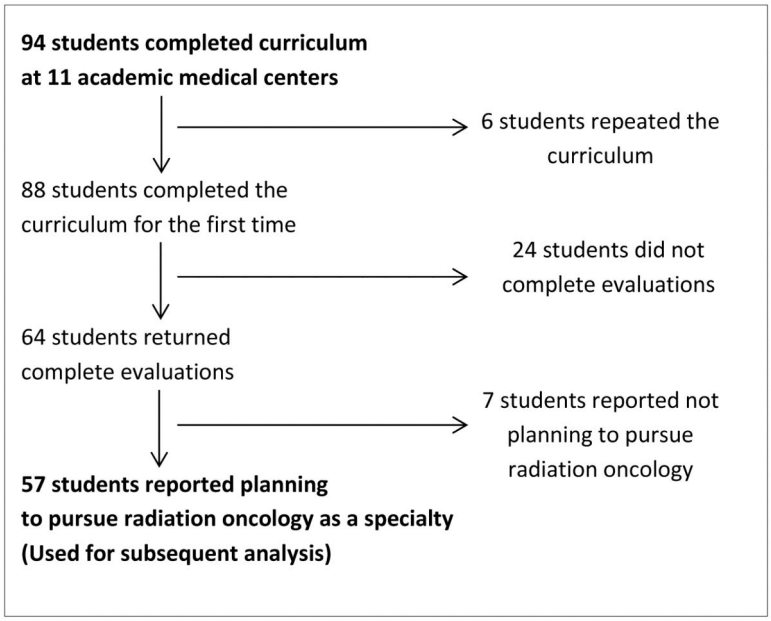

Figure 1.
Consort diagram of students completing curriculum and submitting evaluations.

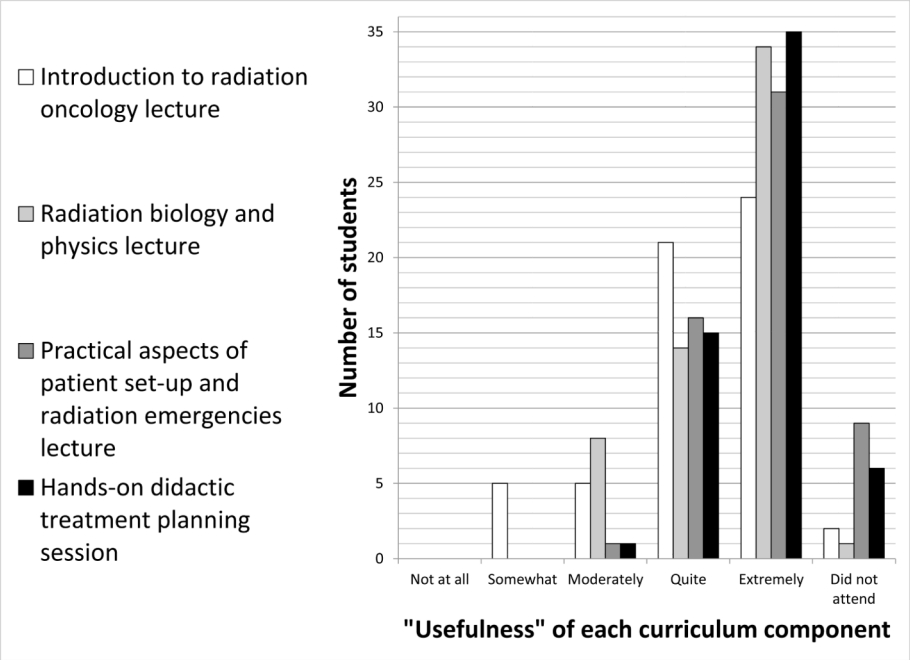

Figure 2.
Student ratings of the usefulness of each curriculum component.

Table 1

Kern et al.'s six step approach to medical education curriculum development.[1]

1. Problem identification and General needs assessment
2. Targeted needs assessment
3. Goals and Objectives
4. Educational strategies
5. Implementation
6. Evaluation and Feedback

Table 2

Number of students completing rotations at each institution versus and pursuing radiation oncology with completed curriculum evaluations at each institution.

Institution	Number of students completing the curriculum *de novo* at each institution	Number of students completing curriculum *de novo* and completing an evaluation
A	15	9
B	10	8
C	12	7
D	9	7
E	8	6
F	6	6
G	4	4
H	4	4
I	9	3
J	10	2
K	1	1
Total	**88**	**57**