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COMMENTARY

Improving Research in Radiation Oncology through Interdisciplinary Collaboration

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The contribution of radiation oncology to the future of cancer treatment depends significantly on our continued clinical progress and future research advancements. Such progress relies on multidisciplinary collaboration among radiation oncologists, medical physicists and radiobiologists. Cultivating collaborative educational and research opportunities among these three disciplines and further investing in the infrastructure used to train both clinicians and researchers will therefore help us improve the future of cancer care. This article evaluates the success of a short-term educational environment to foster multidisciplinary collaboration. The NIH-funded educational course developed at Wayne State University, called "Integration of Biology and Physics into Radiation Oncology" (IBPRO), was designed to facilitate the engagement of radiation oncologists, medical physicists and radiobiologists in activities that enhance collaborative investigation. Having now been delivered to nearly 200 participants over the past four years, the relative success of IBPRO in fostering productive interdisciplinary collaboration and producing tangible research outcomes can be evaluated. The 140 IBPRO participants from the first three years were surveyed to quantify the effectiveness of the course. In total, 62 respondents reported developing 23 institutional protocols, submitting more than 25 research grants (nine of which have been funded thus far), and publishing more than 30 research manuscripts attributable to participation in IBPRO. Nearly one-half (45%) of respondents reported generating at least one of these research metrics attributable to participation in IBPRO and these participants reported an average of over four such quantitative research metrics per respondent. This represents a very substantial contribution to radiation oncology research by a relatively small number of researchers within a relatively short time. Nearly one-half of respondents reported ongoing collaborative working relationships generated by IBPRO. In addition, approximately one-half of respondents stated that specific information presented at IBPRO changed the way they practice, and over 80% of respondents practicing in a clinical setting stated that, since participation in IBPRO, they have approached clinical dilemmas more collaboratively. We believe that educational opportunities such as IBPRO can have a significant impact on interdisciplinary collaborative research. In addition, such interventions have the ability to effect significant clinical change. Both of these should have a positive impact on future advancements in radiation oncology and affect the future contribution of radiation oncology to the treatment of cancer. **© 2018 by Radiation Research Society**

INTRODUCTION

Advancements in the science of radiation oncology depend significantly on the collaborative efforts of the radiation oncologist, biologist and physicist. The effectiveness of such collaborative efforts depends upon the extent to which practitioners in each discipline understand the principles, capabilities, limitations and needs of the others. Few medical specialties enjoy a multidisciplinary approach as essential as that of radiation oncology. For evidence of this, one need look no further than the emphasis on physics and biology within the radiation oncology education infrastructure and certification examinations (*1–3*). Interdisciplinary collaboration between scientists and clinicians makes the work of both more effective. Indeed, the contribution of radiation oncology to the future of cancer research and treatment depends heavily on how we prepare clinicians and scientists to work together (*4, 5*).

If the capacity of multidisciplinary practitioners to ''speak the same language'' is critical to our success, we must cultivate and enhance this capacity. Residency training programs in radiation oncology explicitly include components in radiation oncology physics and radiobiology. However, no such standardized reciprocity exists in the training of medical physicists or radiobiologists. While

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basic radiobiology is a core component of medical physics education, clinical radiation oncology is not, and even radiation oncology physics residency training programs do not currently require foundational education in clinical radiation oncology (*6*). Training for radiobiologists is not standardized and thus does not have standardized educational requirements for either clinical radiation oncology or medical physics.

While the current supply of radiation oncologists and radiation oncology physicists is sufficient to meet clinical demand (*7, 8*), there is a strong need to further invest in our research infrastructure if we are to contribute significantly to future improvements in cancer care. As suggested in a recently published editorial, "'. . .more of the same' is unlikely to successfully defeat this disease in a reasonable timeline" (*5*). Fortunately, radiation oncology currently enjoys an abundance of research-oriented trainees who can become the next generation of clinician-scientists. In fact, more trainees with a Ph.D. in addition to their medical degree are matching into radiation oncology residency positions than into any other medical specialty (*9*). In addition, we are currently producing significantly more medical physics graduates than we can expect to be absorbed into clinical practice (*8*). In stark contrast, radiobiologists are becoming scarce, both in the clinical setting and in research institutions (*2, 10, 11*). Therefore, a strong need exists to produce more radiobiologists and/or train physicists and physicians to be fluent and productive in this research area. This need happens to correspond to the current availability of significant intellectual resources in both radiation oncology and medical physics.

So how can we best bring these multidisciplinary groups together to create a collaborative educational environment to both stimulate interdisciplinary research collaboration and to address the decreasing capacity for radiobiology research? One possible solution is the creation of short-term educational environments to foster such stimulation and collaboration. An example is the educational course funded by the National Institutes of Health (NIH) developed at Wayne State University called "Integration of Biology and Physics into Radiation Oncology" (IBPRO) (*12*). This course was designed specifically with the intent of promoting the ability of radiation oncologists, medical physicists and radiobiologists to "speak the same language," appreciate the specialized skills and knowledge of the other disciplines and engage in activities that foster collaborative investigation. IBPRO has been delivered to nearly 200 participants over the past four years so its relative success in fostering productive interdisciplinary collaboration and producing tangible research outcomes should be measurable.

MATERIALS AND METHODS

IBPRO course participants from years 1–3 were surveyed to quantify the effectiveness of the course. Participants from year 4 were not included since collaborative activity and associated academic productivity would not have had time to mature. Even those participants who were surveyed had only 1–3 years to develop collaborative relationships and generate research productivity. Survey questions included the number of institutional protocols submitted, research grant applications submitted and funded, published manuscripts, research presentations, collaborative research projects and collaborative working relationships "that they would attribute, in whole or in part, to their participation in IBPRO." In addition, participants were asked whether participation in IBPRO resulted in changes in patterns of clinical practice, and whether they now approach clinical dilemmas more collaboratively ("never," "occasionally" or "often").

RESULTS

Of the 140 IBPRO participants surveyed, 62 (44%) responded, including 17, 19 and 26 responses from participants in years 1, 2 and 3, respectively. While anonymous completion of the survey was an option, 56/62 respondents identified themselves. The 56 identifiable respondents included 30 medical physicists (48%), 15 radiation oncologists (24%) and 11 radiation biologists (18%), percentages which are very similar to the overall attendee composition of 51% medical physicists, 28% radiation oncologists and 22% radiation biologists over these three years. The academic rank composition of identifiable respondents was 44% assistant professor, 26% associate professor, 16% professor and 5% trainee. Nearly one-half of respondents reported ongoing collaborative working relationships generated by IBPRO, and over one-third of respondents identified specific collaborative research projects that they would attribute, in whole or in part, to participation in the course. Research metrics from the responses are shown in Table 1. A total of 38 out of 62 (61%) of respondents reported at least one of these metrics attributable to participation in IBPRO. In total, these 62 respondents produced a total of 23 institutional protocols, submitted more than 25 research grants (9 of which have been funded thus far), and published more than 30 research manuscripts attributable to participation in IBPRO. Percentages of the survey metrics attributable to each subgroup are shown in Table 1, and aside from institutional protocols, these percentages are also similar to the overall attendee composition. Thus, one can conclude that the survey demographics are representative of the attendee demographics and that the research productivity generated by IBPRO is relatively uniformly attributable to all three subgroups in proportion to their attendance.

To evaluate the total quantitative research output generated, we will define "quantitative research metrics" to include institutional protocols developed, research grants submitted, manuscripts published and scientific presentations delivered. A total of 28 out of 62 (45%) of respondents reported generating at least one of these quantitative research metrics. These participants were extremely productive, producing an average of over 4.0 quantitative research metrics per respondent. Even averaged over all

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TABLE 1
Responses and Percentages for Post-Participation Survey Questions regarding Collaborative Research Output Attributed, in Whole or in Part, to Participation in IBPRO

Research metric	Number generated				Number per respondent	Percentage generated by		
	0	1	2	3 or more		Medical physicists	Radiation oncologists	Radiation biologists
Institutional protocols	46 (74%)	10 (16%)	5 (8%)	1 (2%)	0.37	30%	39%	30%
Research grants submitted	47 (76%)	7 (11%)	5 (8%)	3 (5%)	0.42	42%	35%	19%
Research grants funded	56 (90%)	3 (5%)	3 (5%)	0 (0%)	0.15	67%	33%	0%
Research manuscripts	45 (73%)	7 (11%)	5 (8%)	5 (8%)	0.52	56%	31%	0%
Research presentations	47 (76%)	5 (8%)	2 (3%)	8 (13%)	0.56	64%	18%	15%
Collaborative research projects	40 (65%)	14 (23%)	3 (5%)	5 (8%)	0.53	43%	31%	17%
Collaborative relationships	35 (57%)	15 (24%)	5 (8%)	7 (11%)	0.74	48%	28%	15%

participants, both those who did and those who did not generate quantitative research metrics, this represents a very substantial contribution to radiation oncology research by a relatively small number of researchers within a relatively short time.

In addition, approximately one-half of respondents stated that specific information presented at IBPRO changed the way they practice, and over 80% of respondents practicing in a clinical setting stated that, since participation in IBPRO, they have approached clinical dilemmas more collaboratively. Specific comments from participants described a direct attribution of research productivity to IBPRO, including study design and hypotheses for clinical protocols and research grants, instigation for research publications and presentations, and initiation of long-term collaborations across multiple disciplines.

DISCUSSION

Based on the results from respondents to our survey, we have shown that implementation of the IBPRO course has resulted in the production of sustained collaborative activity among the multidisciplinary participants. Extrapolation of these survey data to all IBPRO participants is limited by the possibility of response bias, as participants producing the most significant collaborative research may be the most likely to respond. However, while the relative values for each metric may be lower if all participants had responded, the total absolute output would almost certainly be larger. Thus, the cumulative collaborative research productivity resulting from IBPRO is larger than that presented in Table 1. Moreover, both collaborative efforts and resulting output take time to mature and the time from IBPRO participation to survey completion was relatively short. At the time of survey, over 40% of the respondents had only 14 months to develop these collaborative results after participation in IBPRO. Thus, these data represent a very conservative estimate of the tangible outcomes associated with the course and we can expect both percentages and overall totals for these metrics to continue to increase for some time. Feedback from course attendees has been continually used to shape the evolution of the course and we anticipate that resulting changes will make future collaborative research output even more profound.

In a recently published review article addressing the role of radiation oncology in the era of precision medicine, six key research areas for advancing the field of precision radiotherapy were identified (*13*). One of these areas was ''promotion of multi-professional research groups, including experts in radiation oncology and imaging, medical physics, biology, information sciences and engineering, to advance innovative personalized approaches in radiation oncology.'' It appears that the IBPRO course very effectively fills this need as evidenced by the data presented here. Based on these results, we can anticipate that the future of radiation oncology research will be positively influenced by the implementation of this course and that it can potentially serve as a model for the creation of other initiatives designed to promote interdisciplinary collaboration. Such interventions will be critical to our profession as we forge the path for tomorrow's research and define the future contribution of radiation oncology to the treatment of cancer.

CONCLUSIONS

The implementation of the IBPRO course has resulted in the production of a considerable amount of sustained collaborative activity among the multidisciplinary participants. This collaborative activity and research productivity is relatively uniformly attributable to all three subgroups in attendance at IBPRO. Greater than 80% of clinically practicing survey respondents reported approaching clinical dilemmas more collaboratively after participating in IBPRO and over 60% of respondents reported at least one of the metrics shown in Table 1 attributable to their participation in the course. The data gathered from this pool of participants following only 1–3 years, since participation in the course, represents a very substantial contribution to radiation oncology research by a relatively small number of researchers within a relatively short time. We believe that collaborative educational opportunities such as IBPRO can

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have a significant impact on interdisciplinary collaborative research, which will result in a positive impact on the future contribution of radiation oncology to the treatment of cancer.

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