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IBPRO – a novel short-duration teaching course in advanced physics and biology underlying cancer radiotherapy

Michael C. Joiner[*], **Monica W. Tracey**[†], **Sara E. Kacin**[‡], and **Jay W. Burmeister**[*]

[*]School of Medicine, at Wayne State University, Detroit, Michigan, 48201

[†]College of Education, at Wayne State University, Detroit, Michigan, 48201

[‡]Office for Teaching and Learning, at Wayne State University, Detroit, Michigan, 48201

Abstract

This article provides a summary and status report of the ongoing advanced education program IBPRO – Integrated course in Biology and Physics of Radiation Oncology. IBPRO is a five-year program funded by NCI. It addresses the recognized deficiency in the number of mentors available who have the required knowledge and skill to provide the teaching and training that is required for future radiation oncologists and researchers in radiation sciences. Each year, IBPRO brings together 50 attendees typically at assistant professor level and upwards, who are already qualified/certified radiation oncologists, medical physicists or biologists. These attendees receive keynote lectures and activities based on active learning strategies, merging together the clinical, biological and physics underpinnings of radiation oncology, at the forefront of the field. This experience is aimed at increasing collaborations, raising the level and amount of basic and applied research undertaken in radiation oncology, and enabling attendees to confidently become involved in the future teaching and training of researchers and radiation oncologists.

Background

Cancer therapy using ionizing radiation, termed Radiation Oncology or commonly radiation therapy or radiotherapy, has long been an important weapon in the arsenal against cancer, with nearly two thirds of all cancer patients receiving radiation therapy as a part of their treatment. Future growth in the number of older adults is leading inevitably to a corresponding increase in overall cancer incidence. Radiation Oncology has a long scientific history that has continually strengthened its role as a very successful clinical modality, and is therefore certain to remain an essential component of cancer therapy especially in a curative setting (1–4).

This requires securing future capacity to deliver advanced radiation biology and physics education and training to oncologists and researchers. In contrast, over the past 20 years there has been decreasing activity in radiation research and so the number of professors with the required knowledge and practical experience to effectively teach the physical and biological effects of ionizing radiation as applied to cancer treatment at doctoral level and beyond, has been declining steadily (5–8). This problem has been exacerbated during the last decade by decreasing funding which has further reduced the rate of new investigators taking up radiation research. Importing more teachers is not an option as this “training gap”

is not restricted to the USA. A conference in 2011 organized by the International Atomic Energy Agency highlighted the global shortage of radiotherapy professionals and researchers and the need for a long-term strategy to produce trainers, educators and new researchers (9). Additionally, the expansion of cancer services required in China, India, Africa and South America over the next 20 years is expected to exceed the global capacity to provide the biology and physics education needed in this development and therefore further worsen the situation.

In the USA the decline in the number of skilled and knowledgeable radiation teachers has been highlighted many times (*e.g.* 5–8, 10, 11). Yet, there is still no nationally sustained response to this developing crisis within cancer therapy and research. This contrasts with growing international advanced teaching and training activity in radiation sciences, for example in Europe which has evolved a highly-regarded centrally-sponsored radiation oncology education program which in 2016 comprised 39 live courses, covering advanced and basic topics. This program has also been extending to Russia, China, SE Asia, the Middle-East and Latin America (12–14).

It is therefore essential that the USA now cultivate the ability to educate to an advanced, state-of-the-art level, the professionals responsible for delivery and advancement of radiation therapy. Better imaging, engineering and computing have increased the effectiveness in delivering high-precision radiotherapy. Both the physics and biology of radiotherapy have been advancing in parallel. The physics has enabled greater precision allowing higher doses per fraction, in turn enabling biological factors to be introduced into treatment planning. Despite the overall contraction of the radiobiology research effort, improved biotechnology has enabled greater understanding of the mechanisms for radiation and pharmaceutical effects on cells and tissues which is allowing the new technology to be used with the greatest effect and safety. The role of the physical and biological sciences in Radiation Oncology is perhaps more significant than in any other medical discipline, underscoring the need for collaborative, interdisciplinary education. What is therefore required now is an *integrated approach* to educating future oncologists, physicists, biologists and researchers, which highlights and builds on this close interaction among all the disciplines in radiation oncology, and so strengthens the ability to supply this much-needed education into the future.

It was therefore a principal hypothesis that to maximize the effectiveness of this education, it should be planned in a coordinated way and best delivered simultaneously and jointly to groups comprising clinicians, physicists and biologists. Each of these three sub-specialties would then better understand and appreciate the current issues related to the other two sub-specialties, improve the required cross disciplinary collaboration, and promote and reinvigorate effective research and future development of Radiation Oncology.

This innovative program was named IBPRO – Integrated course in Biology and Physics of Radiation Oncology. Prior to undertaking this educational program reported here, it was first ascertained that no other federally-supported activities existed in radiation oncology education that were aimed nationally. The teaching together of advanced radiobiology and medical physics which was proposed, integrating keynote lectures, workshops and hands-on

examples of practical application to the planning and execution of research in clinical radiotherapy, was funded by the US National Cancer Institute (NCI) as a research project for a period of 5 years. This report reviews the most important experiences of the first 3 years.

Approach and experience

Early in the IBPRO project, it was recognized that it would be challenging to bring together and teach together the usually disparate disciplines of Biology and Physics and to give course attendees new insights and skills which would make them more effective within the field of Radiation Oncology. Therefore the IBPRO leadership and development comprised both experts in educational design from the University's College of Education and Office for Teaching and Learning, and experts in the course content itself from the School of Medicine.

State-of-the art educational design, planning, monitoring and evaluation of all aspects of the Program, was used in order to continually enhance its effectiveness and impact and demonstrate success. This strategy has promoted interaction among attendees and brought together the physics and biology so that attendees in these disciplines are learning from each other not just from the faculty delivering lectures. This Faculty comprise both the leadership developing the physics and biology content of IBPRO and also typically 13 additional visiting faculty who hold clinical and/or research positions and already teach at US or Canadian institutions. To the authors' knowledge, never before IBPRO had such a pool of teaching faculty been assembled having the depth and breadth of experience not only in researching biology and physics applied to radiation oncology and its interaction with other therapies, but recognized experience in teaching these subjects. All faculty are encouraged to stay for the whole duration of IBPRO in addition to their lecture(s). There has been mixed success with achieving this due to their seniority, but attendees report favorably on being able to talk with such experienced faculty before or after their lecture.

IBPRO always takes place at Wayne State University in midtown Detroit, Michigan. This location is conveniently central within the USA and travel in and out is easy. Applicants register for IBPRO via the permanent course website which additionally supplies them with helpful information about Detroit. Accommodation is at a single local hotel which over 90% of course attendees elect to use. The visiting teaching faculty stay at the same hotel, so attendees can meet with them for discussion in the evenings, which has been a successful strategy. Everyone is provided bus transportation for the short journey between this hotel and the conference facility on the medical school campus, which allows further interaction among attendees and faculty.

The attendees sought for IBPRO are advanced: already professionally experienced and most are clinical board-certified faculty in academic radiation oncology departments, others being full-time cancer research faculty. The goal of IBPRO is not to teach at a basic or training level. Rather, it is to examine the forefront of the field of Radiation Oncology, exploring the clinical, medical-physics and radiobiology dimensions of this field simultaneously with the constant aim of attendees experiencing cross-disciplinary viewpoints, developing collaborations, and putting together future ideas and proposals for new research and development, teaching, and clinical trials. The number of attendees at each course is

therefore limited to 50. This has been successful, giving a very low attendee to faculty ratio that allows full implementation of active learning strategies, which promote attendee interaction, discussion, and problem solving in groups. Examples of such active learning strategies are online small group case studies, followed by large group discussions on how to treat particular cancer cases, debates on topical controversies in radiation therapy, hands on treatment planning, and development of proposals for clinical trials of novel radiotherapy approaches. These activities are interspersed with the keynote lectures. This program is facilitated by a single-room conference facility which in addition to widescreen lecture presentation, can be configured to simultaneously handle eight break-out groups of attendees, each with its own individual AV setup. Each of these break-out groups (up to 7 attendees) is selected to contain a balanced mix of experience and discipline, and with attendees from different institutions to encourage development of new collaborations.

IBPRO is a short-duration course and is held over 5.5–6 days once per year, at the beginning of May. This timing guarantees good weather and hence easy travel in and out for attendees. It also facilitates having some activities, like discussion groups and lunch meetings, taking place outside. The first course (2014), began Sunday at 8AM and finished Friday at 5PM. Following feedback from attendees, the second course (2015) began Sunday at 8AM and finished Friday at 1PM to allow attendees to return home Friday afternoon, noting that IBPRO attendees come from all over the USA. Following further feedback on difficulties that attendees experienced taking time away from the clinic, the third course began Friday at 8AM and finished Wednesday at 1PM. This timing has now minimized possible conflict with clinical duties of attendees.

The website at ibpro.org is available year round for past attendees to access activities, exercises and keynote lectures given to them during their attendance. Potential new IBPRO attendees (applicants) visit the registration section which is made available in December for the Course given the following May. This registration gives applicants the opportunity to supply all relevant contact information and qualifications as well as explaining their sub-specialty (*e.g.* clinical, veterinary, physics, biology), interests (*e.g.* patient treatment, research, teaching) and experience/seniority (*e.g.* rank, number of years, national/international profile). As part of the NCI support grant, successful applicants are not charged any registration fee and are also allocated funds to support travel and accommodation to attend IBPRO. They are then obligated to attend the whole 6 days of the course, which is also a requirement for us to be able to give them AMA PRA Category 1 CME Credits. An optional form in the registration section allows applicants to present their personal details relating to gender and under-represented minority status. IBPRO has a maximum attendance of 50, and has been oversubscribed in all the first three years. Applicants are then selected to provide the best balance of attendance among academic discipline, age and experience, geographic location, and prioritizing women and under-represented minorities.

The content of IBPRO – activities and keynote lectures – changes each year to reflect what the leadership team has determined to be the most appropriate coverage of topical items in Radiation Oncology. Thus IBPRO is always aimed at the “cutting edge” of cancer treatment with ionizing radiation. Each of the first 5 days is associated with an underlying “Theme” so that throughout a day, that day’s activities and keynote lectures can all associate with that

Theme. On day 6, there is a summary of all the clinical-trial proposals that have been developed by the attendees during the previous 5 days, as well as a summary and discussion of the entire course content with the question “where do we go from here?” So, each year one or more of the five Themes may change to follow what is most topical and of interest that year. As an example, the Theme for Day 4 in IBRPO 2015 was “Radiomodification” and in IBPRO 2016 this was changed to “Immunotherapy” which better reflected a highly topical subject around which much new research is being conducted. Therefore the keynote lectures, and associated visiting faculty, were different in 2016 than 2015.

A further key component of the IBPRO program has been the identification and assistance and advice given to new teachers and researchers which will be required in the future. This aim to “teach-the-teachers” had never before been included as part of a nationally funded radiation oncology advanced training initiative. Also addressing this issue of the expected future shortage of specialist teachers and researchers, is the development of novel web-based enrichment and mentoring of course participants, which continues year round following the live courses.

Discussion

Bringing together Physics and Biology, and “teaching” them together, at an advanced level, should at first glance be at best very difficult and at worst, impossible. The glue that holds these apparently disparate disciplines together in this case and therefore does make this feasible, and valuable, is Clinical Radiotherapy. Successful application and further development and innovation in radiation oncology depends on an understanding of medical physics and radiobiology, *as applied to radiotherapy*. Thus the languages of medical physics and radiobiology have already a lot in common and so there is already substantial communication among these disciplines. The main goal of IBPRO is to increase the fluency of this interdisciplinary communication. An increase in the complimentary feedback received over the first three years of presenting IBPRO implies success in achieving this goal, though enough data have not yet been accumulated to demonstrate statistical significance.

There are 5 additional accomplishments and important points to note. First, the course website has been developed into a permanent presence which handles all course information, advertising, registration, description of activities and keynote lectures, post-course communication and discussion among attendees. Second, 13 very high quality, internationally known, visiting faculty have been successfully attracted each year and have been highly complimentary of IBPRO. Third, course attendees have been successfully provided with >40 American Medical Association Physicians Recognition Award Continuing Medical Education credits. Fourth, up to three attendees each year have been successfully identified specifically for additional training to improve their teaching skills at this interface between physics, biology and clinical radiotherapy. Fifth, IBPRO has always been oversubscribed and so not able to accommodate all applicants every year into the 50 attendee limit which was set in order to make the experience of attending as valuable as possible. Of considerable interest is that physicists outnumber biologists and clinicians in a ratio of approximately 2:1:1 and this has remained consistent over this first three years. This

could suggest that the population of radiobiologists, which has been decreasing over the past decade largely due to aging and retirement, could be increased again by interested medical physicists assimilating the biology required within a forum like IBPRO and then "crossing over", remembering that many of the most well-respected radiobiologists came up through that academic route.

Conclusions

IBPRO is a unique and innovative advanced teaching course aimed at providing cutting-edge content using cutting-edge educational techniques. The ultimate goal is to strengthen the research, educational, and clinical infrastructure in radiation oncology and foster interdisciplinary collaboration to improve the future quality of cancer care. With its strong educational design, content, logistics and experienced leadership, this course should have a very high probability of achieving long-term success in positively influencing the future of Radiation Oncology.

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