Focus on Radiation Oncology

Past, Present, and Future of the Radiation Oncology Specialty
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by Paul E. Wallner, DO; Dennis C. Shrieve, MD, PhD; Anthony L. Zietman, MD

In anticipation of the October 2015 meeting of the ABR Board of Governors (BOG) and Board of Trustees (BOT), we were asked to prepare an overview of the state of radiation oncology, including challenges and opportunities that face the specialty in the coming decade as they might relate to initial certification (IC) and Maintenance of Certification (MOC) development and programming. The request provided an opportunity for a review of the dramatic changes in the specialty over the past 100-plus years, and how those changes have impacted IC and, more recently, MOC.

As a primary specialty of medicine, radiation oncology is fairly “young,” but its clinical and scientific roots extend back to the latter part of the 19th century, shortly after the discovery of radiation, and shortly thereafter, the discovery of radium and polonium by the Curies. An early empirical observation was that radiation, especially when applied directly to tumors in the form of brachytherapy, had a profound effect on tumor (and normal) tissue. Many subsequent radiation-related interventions through the early 1950s were related to surgical procedures involving brachytherapy or orthovoltage (energy levels up to 300kVp) external beam radiation.

The discipline of therapeutic radiology, as it was then known, was dominated by surgeons, and surgery and radiation therapy, often in combination, were the only modalities capable of definitive cancer treatment. No dedicated training programs existed in the U.S., and what training did exist was typically embedded as relatively brief rotations within diagnostic radiology programs. Biologic concepts of radiation effect were related primarily to macroscopic and light microscopic observations of tumor and normal tissue response to radiation. Physics observations were directed to calculations of machine output and delivered doses, as well as a variety of brachytherapy calculation regimens, almost exclusively related to rigid radium or cesium sources. Radiation-related items in early certification examinations clearly reflected this limited knowledge base and practice patterns.

In the early 1950s, $^{60}$Co teletherapy devices were introduced. These units were capable of delivering megavoltage (greater than 1 million volts) radiation in the clinic setting, with improved depth dose, large field size capability, and skin-sparing characteristics; this stimulated...
a renewed interest in the incorporation of radiation into routine cancer care. There was a sharp increase in the number of physicians limiting their clinical interest to radiation therapy, in physicists committed to radiation therapy delivery, and in radiation biologists investigating the impact of radiation at the cellular level in malignant and normal tissues. In 1958 the first dedicated radiation therapy program was founded, and in 1967 the first independent department of radiation therapy was created. Consistent with this change, the ABR increased the basic science components of IC examinations and emphasized the role of radiation in the therapy of many cancers.

By 1968 there were 59 training programs in radiation therapy with 92 trainees, but certification was still typically combined in “general radiology” programs. In 1975 the Accreditation Council for Graduate Medical Education (ACGME) determined that radiation therapy should be a stand-alone training program, and the ABR responded by developing a separate primary certificate, which thereafter was designated as “radiation oncology.” The 1970s proved to be watershed years for radiation oncology and for ABR testing in the specialty. The widespread introduction of medical linear accelerators with superior beam characteristics, CT scanners for three-dimensional imaging of tumor volumes, and dedicated radiation treatment-planning computer systems added the dimension of rapid evaluation of a variety of improved treatment plans. Radiation oncologists were able to deliver increasing doses to tumor targets with greater ability to protect surrounding normal tissues.

Around the same time, medical oncologists were beginning to introduce multi-agent cytoreductive and cyto-toxic regimens that enhanced radiation response, but regrettably, often in both malignant and normal tissues. Many of these changes in the clinic, associated with a significant increase in radiation biology training and research funding, stimulated a new generation of dedicated radiation biologists to begin to explore the effects of radiation at the subcellular level. Adapting to these developments, the ABR intensified its IC testing in complex multimodality therapy management, including combined modality toxicities, sophisticated treatment-planning methods, and a greater level of imaging knowledge.

By the 1990s, there were new isotopes for low dose-rate brachytherapy, miniaturized sources and novel delivery systems for high dose-rate brachytherapy, and sophisticated computer-controlled linear accelerators capable of delivering intensity-modulated radiation therapy (IMRT). Concomitant introduction of a new generation of systemic chemotherapy and biological therapy agents, and a reduction in employment of some “radical” surgical procedures in favor of radiation and systemic agents, increased the necessity for new levels of knowledge and skills by radiation oncology trainees. The ABR responded accordingly, with greater emphasis on these combined approaches and their underlying basic science principles.

The early years of the 21st century have seen many significant changes in the discipline, including an increased interest in particle beam radiation (particularly protons); stereotactic body radiation therapy (SBRT) and stereotactic radiosurgery (SRS) employing smaller, more focused beams with significantly higher daily doses and shorter treatment courses; image-guided and respiratory-gated treatment delivery; and, in 2003, mapping of the human genome, which introduced the disciplines of genomics and proteomics into the clinic. To adapt to these
advances, the ABR’s radiation and cancer biology exam items were strengthened to include the new discoveries and their impact on cancer management, physics items were broadened to include the new technologies and their quality assurance and safety requirements, and clinical material was adapted to the new realities of combined management, using biological agents and genetic signaling pathway modifiers. There was also a greater emphasis on identification of normal and pathologic anatomy.

Looking toward the future, big changes are ahead in the evolution of radiation oncology. The emphasis on ablative therapies is increasing, and the use of imaging, not only for initial field design but now for daily targeting, is changing the shape of practice. Radiographic anatomy will, more than ever, be emphasized in practice and in our examinations. Changes in the curriculum may be necessary to mandate this within training, but for now, ABR examiners are emphasizing it in both the computer-based “written” and oral examinations.

Another challenge will be to test radiation oncologists on the basic skill that is most required in everyday modern practice. This is the art of drawing target volumes and identifying normal structures in three, and in some cases four (if time is included), dimensions. At present the ABR does not have a strategy for practice simulation but it has, in recent years, worked with vendors to identify software that can test these skills and consistently provide metrics by which they can be judged. More than anything, we can envisage the capacity to evaluate this skill in both the IC and MOC examinations, which will make the exams truly relevant to practitioners.

Another critical evolution has been the movement toward practice within multidisciplinary teams. Radiation oncologists are now as likely to work and see patients in cancer centers as they are in traditional radiation oncology departments. More than ever, they need to fluently speak the language of the surgeons and medical oncologists with whom they work in order to avoid being marginalized in the future. This is recognized at a political level (the specialty societies) and is much discussed by the ABR trustees. A thorough understanding of the drugs used in cancer care and the details of common surgeries will be tested during the ABR certification process.

Radiation oncology continues to be a vibrant and growing discipline, attracting high-quality trainees, many with nonmedical doctoral degrees and other advanced training. The trainee pool continues to be among the strongest in medicine. There are currently 89 ACGME-accredited radiation oncology training programs with 777 available resident slots, most of which are filled each year. As the field changes, with advances in our understanding of emerging technologies, their physical and biological implications, and the relationship of radiation to other evolving interventions, the ABR will continue to modify its examinations to meet these changes.