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RadOnc Student Scan

Editors: Anthony Alanis[1], Bahareh Sharafi[2], and William Tyree[3]

[1]University of Texas Rio Grande Valley School of Medicine, [2]Ross University School of Medicine, [3]LMU-Debusk College of Osteopathic Medicine-Harrogate

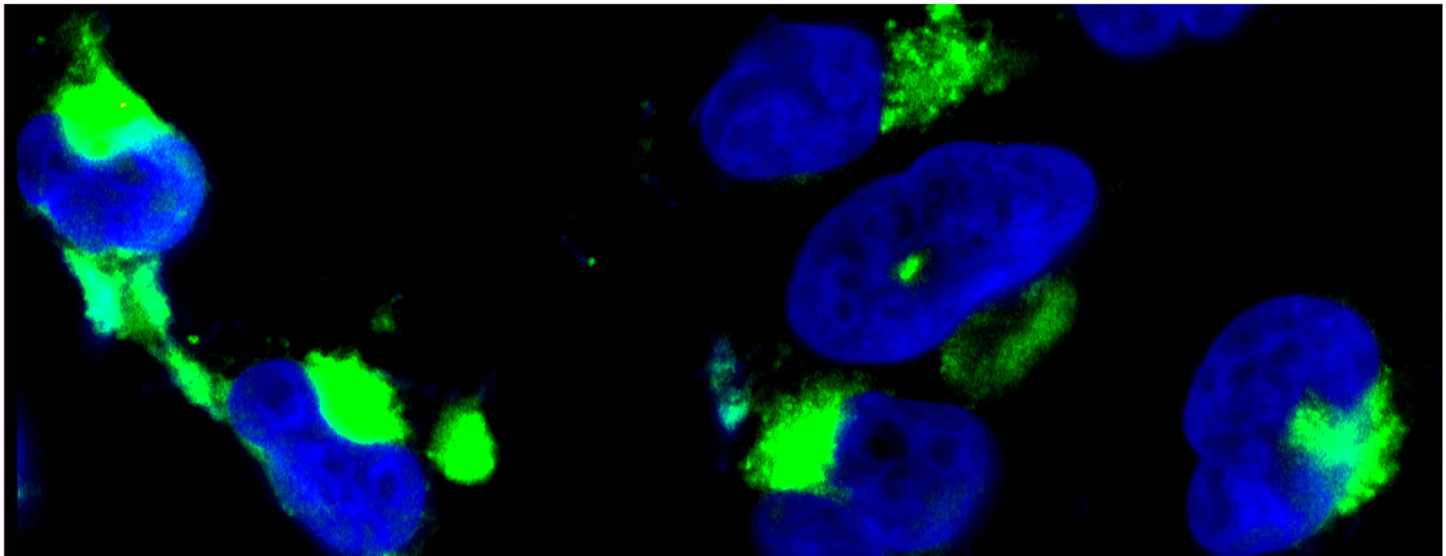


Image courtesy of National Cancer Institute \ Henry Ford Hospital

IN THIS ISSUE

How Is Radiation Delivered?

Radiation can be delivered in 2 ways, internally and externally. Internal radiation, also known as brachytherapy, involves implanting a small amount of radioactive material near the cancer site. External radiation uses a machine outside the body to deliver high-energy rays directly to the cancer site.

Internal Radiation (Brachytherapy)

There are 2 main types of internal radiation therapy or brachytherapy:[1]

1. **Interstitial brachytherapy:** This type of treatment involves placing radioactive sources directly into the tissue around the tumor. This can be done using small seeds or pellets that are inserted with needles, or by placing wires that contain the radioactive source directly into the tissue.
2. **Intracavitary brachytherapy:** This type of treatment involves placing the radioactive sources inside a body cavity near the tumor, such as the vagina, uterus, or esophagus. The sources are typically placed using a catheter or other device that can be inserted into the body.

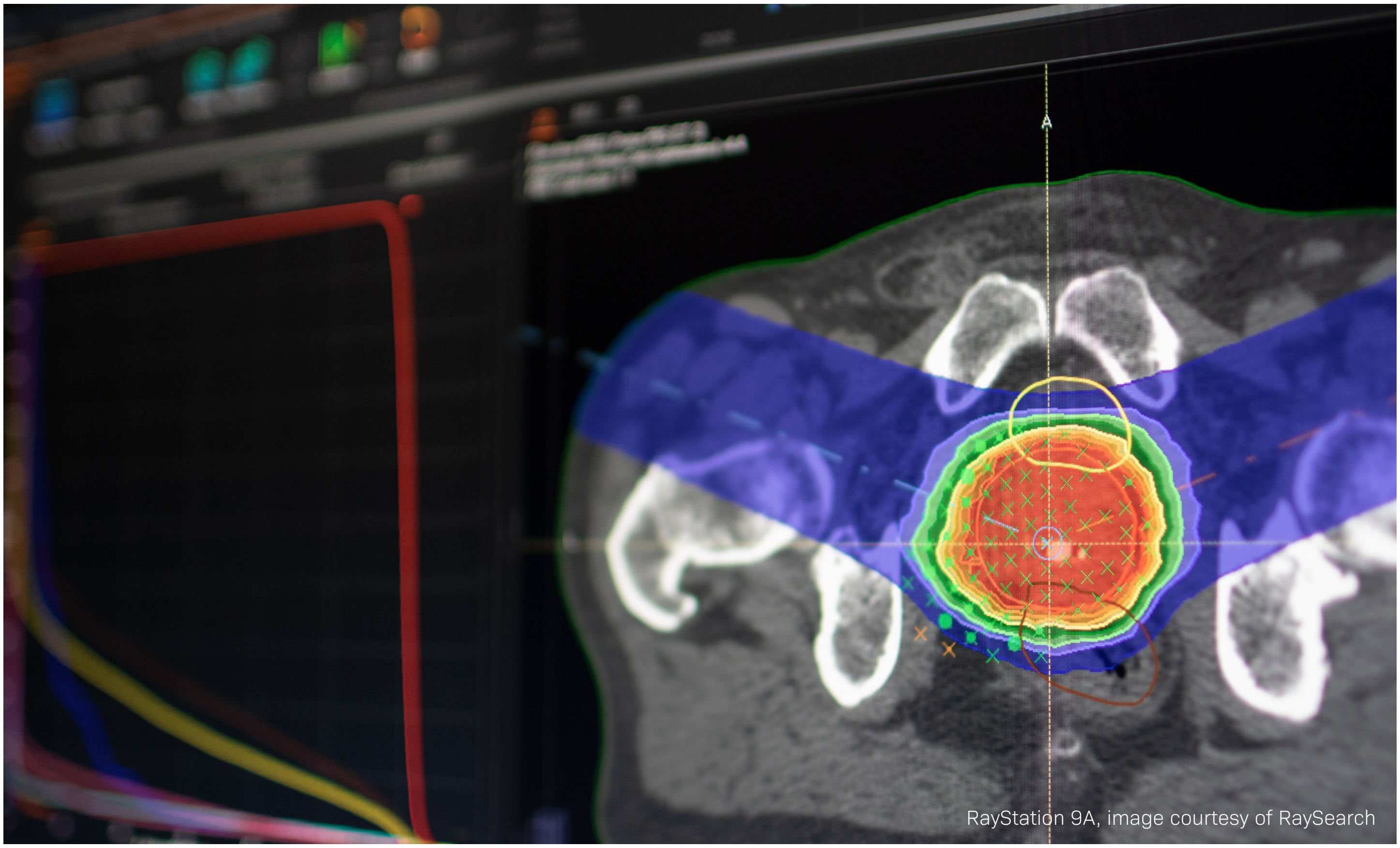
Brachytherapy can be used as a singular form of treatment or can be utilized in conjunction with external radiation therapy.[2] Furthermore, this means of radiation can either be permanent or temporary.

In regard to temporary brachytherapy, radioactive material is implanted for a certain amount of time and then removed prior to the patient going home. This form of radiation therapy, also known as a low dose rate or LDR, can be administered at a low dose over a longer period. With LDR brachytherapy, patients are typically hospitalized for the period in which the radioactive implants are in place (usually 2 to 3 days). Temporary brachytherapy, known as a high dose rate or HDR, can also be administered at a higher dose over a shorter duration. These patients can receive their therapy as an outpatient. Such therapy can be used in various cancers including breast, prostate, cervix, vagina, and head and neck.

External-Beam Radiation Therapy (EBRT)

External-Beam Radiation Therapy: Typically delivered for approximately 6 to 8 weeks, this outpatient form of therapy is given through machines called linear accelerators.[3] These modern machines produce high-energy radiation beams, delivering radiation in deep parts of the body where cancer is present. EBRT has allowed radiation oncologists to provide effective treatment to malignant tissues while reducing side effects. Before treatment, the patient will have a planning session to determine the exact location for the radiation and how much radiation to deliver. During treatment, the patient lies still on a table while the machine moves around to deliver the radiation. The entire process is painless and typically lasts only a few minutes. The following are various kinds of EBRT:

1. **Three-dimensional (3D) conformal radiation therapy:** In this type of treatment, imaging techniques such as CT scans are used to create a 3D image of the tumor and surrounding tissue. This allows for more precise delivery of radiation to the tumor while minimizing exposure to healthy tissue.
2. **Intensity-modulated radiation therapy (IMRT):** This treatment uses advanced computer software to deliver radiation with varying intensities, which allows for even more precise targeting of the tumor while sparing healthy tissue.
3. **Stereotactic body radiation therapy (SBRT):** This is a type of radiation therapy that delivers a high dose of radiation to the tumor in a few large doses, typically over the course of a week or less. This type of treatment is often used for small tumors that are difficult to remove surgically.
4. **Image-guided radiation therapy (IGRT):** This treatment uses imaging techniques such as CT scans or X-rays to guide the delivery of radiation to the tumor. This allows for adjustments during treatment to ensure the radiation is delivered accurately.
5. **Proton therapy:** This is a type of radiation therapy that uses protons (charged particles) to deliver radiation to the tumor. Proton therapy can be more precise than traditional radiation therapy and may be used for tumors located near sensitive structures such as the brain or spinal cord.


RayStation 9A, image courtesy of RaySearch

Revolutionizing Cancer Treatment: How Machine Learning Is Changing the Game in Radiation Oncology

Predictive modeling for radiation therapy toxicity: Machine-learning algorithms can be used to build predictive models for toxicity outcomes in radiation therapy patients. **Example:** A 2020 study by Hart et al demonstrated that a machine-learning-based model could be used to predict pulmonary metabolic radiation response and radiation pneumonitis in esophageal cancer patients with high accuracy.[4]

Automated treatment planning: Machine learning can be used to automate the process of treatment planning, which can save time and improve the quality of treatment plans. **Example:** A 2012 study by Craft et al showed that a multicriteria optimization (MCO) model is superior to current trial-and-error-based planning in intensity-modulated radiotherapy (IMRT) in terms of efficiency and dose distribution quality.[5]

Tumor segmentation: Machine learning can be used to segment tumors on medical images, which can help radiation oncologists better target the radiation dose to the tumor. **Example:** A 2015 study by Ronneberger et al used a deep-learning algorithm to segment tumors on MRI scans.[6]

Response prediction: Machine learning can be used to predict the response of tumors to radiation therapy, which can help radiation oncologists adjust treatment plans as needed. **Example:** A 2019 study by Xu et al showed that deep-learning models could be used to accurately predict survival and cancer-specific outcomes using time-series CT images from patients with locally advanced non-small cell lung cancer (NSCLC).[7]

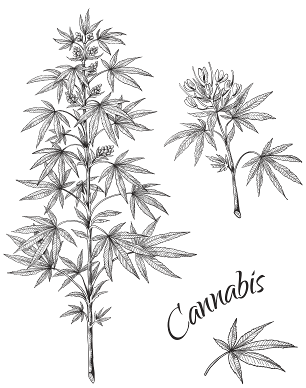
Dose prediction: Machine learning can be used to predict the radiation dose that will be delivered to different structures in the body during radiation therapy. **Example:** A 2020 study by Murakami et al demonstrated an accurate and rapid dose prediction by training a general adversarial network (GAN) using patient CT datasets.[8]

Hot Topics in Radiation Oncology

Four Phenotypes of Radiation Oncologists and Their Effect on Our Field and Future

Practical Radiation Oncology, Ronald D. Ennis, MD

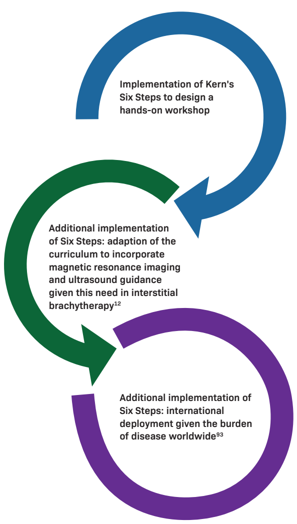
This editorial discusses the different clinical approaches of radiation oncologists and their approach to patient care. It summarizes the physician approach to patient treatment into 4 categories: general oncology care provider, limited medical management, no medical management, and technician. The general oncology care approach is the most comprehensive method with the best physician-patient relationships, whereby the physician goes beyond radiation oncology treatment and involves themselves in patient management, diagnostic testing, as well as psychosocial stressors. In the limited medical management approach, the physician continues to interact directly with the patient but focuses primarily on the direct role of the radiation oncologist. The no medical management approach has physicians only focusing on direct technical details of radiation therapy and only offering opinions regarding the value that radiation therapy may provide, but does retain control over the exact form of treatment provided. The no management approach results in poor physician-patient relationships. Lastly, the technician approach has the radiation oncologist plan treatments as ordered by another physician. The technician approach results in a complete lack of physician-patient interaction and no role in important decision-making regarding treatment methods.[9]



Cannabis Use in Patients Seen in an Academic Radiation Oncology Department

Practical Radiation Oncology, Matthew M. Cousins, MD, PhD; Chuck Mayo, PhD; Theresa Devasia, PhD; et al

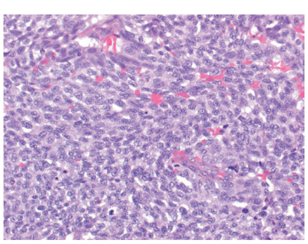
This article discusses the prevalence of cannabis use during radiation therapy treatment and reasons for cannabis use and possible contraindications. The article indicates that 10.9% of patients in this radiation oncology clinic reported recent cannabis use. This study also discusses important points and educational opportunities for patients and clinic staff. In addition, the article emphasizes the importance of patient education on the use of cannabis and that it should not be used as a sole treatment for cancer. There is currently no evidence of benefit to cancer outcomes from cannabis use. Misinformation on the sole use of cannabis for treatment could lead to patients delaying treatment, thus worsening their prognosis. The study showed possible negative correlations between cannabis use and certain mental health conditions.[10]



Future of Radiation Oncology Education: Transforming Scholarly Teaching Into Medical Education Scholarship

Applied Radiation Oncology, Anurag Saraf, MD; Graham Boyd, MD; Alexandra De Leo, MD; et al

This article breaks down the different methods of radiation oncology education at the undergraduate and graduate levels and throughout the physician's career. At the undergraduate medical education level, methods such as integrating education into clinical rotations and incorporating radiation oncology into a general oncology curriculum can increase interest in the field. At the graduate level, it discusses teaching in the form of case-based learning and training programs. In addition, the article discusses the importance of the continuation of medical education as well as the integration of diversity, equity, and inclusion.[11]



Novel Unconventional Radiotherapy Techniques: Current Status and Future Perspectives

Clinical and Translational Radiation Oncology, S Tubin, MC Vozenin, Y Prezado, et al

This review article examines the transition of traditional care delivery models to digital health models and the implications this can have in radiation oncology. Such technologies include therapeutic augmented reality, wearable technologies, smart voice assistants, digital medicines, robots with AI capabilities, continuous and Bluetooth-enabled monitors, and smart cameras. These innovations are set to improve disease prevention and population health initiatives as well as high-acuity care such as cancer care.[7]

Interview With a Radiation Oncologist: Clifton D. Fuller, MD, PhD

Dr. Clifton David Fuller is a radiation oncologist and an associate professor in the Department of Radiation Oncology at MD Anderson Cancer Center in Houston, Texas. He is also a faculty member at the MD Anderson Cancer Center UTHealth Graduate School of Biomedical Sciences. Dr. Fuller is committed to training the next generation of radiation oncologists and researchers. He serves as a mentor to medical students, residents, and fellows and is actively involved in teaching radiation oncology and cancer biology courses at MD Anderson Cancer Center. Dr. Fuller's research interests focus on the use of novel imaging techniques, biomarkers, and machine-learning algorithms to improve the accuracy of radiation therapy planning and delivery. He is particularly interested in the use of functional and molecular imaging to guide radiation therapy treatment decisions and in developing personalized treatment plans for patients.[13]

What advice do you have for a medical student interested in radiation oncology?

Get a mentor or mentors as fast as you can and spend as much time in the clinic with them as possible. I think it's incredibly important to go into the field of radiation oncology with your eyes fully open. When I was first introduced to radiation oncology, IMRT was an experimental technology, and the field was considered something that math geeks did in a basement. Over a period of years, radiation oncology transformed into a highly attractive and reimbursable field, attracting the kind of trainees that previously would have gone into dermatology or other "lifestyle specialties." Neither the "basement era" nor "lifestyle era" is reflective of the field today, nor of the future of rad onc.

The field of radiation oncology is changing rapidly, and I encourage anyone interested in the field to determine whether they are intrinsically interested in the discipline of radiation oncology and to spend as much time as possible with radiation oncologists to understand the opportunities and challenges of the field. Rad onc is not like other specialties of medicine and, without significant exposure to our field, I believe medical students have a difficult time understanding the true nature of the specialty, so go get some degree of immersive experience as early as you are able.

How do you see the future of radiation oncology?

The future of radiation oncology is going to be radically different in the next 2 decades, in my humble opinion. I believe we will spend the next decade more fully understanding and implementing innovative methods like ultra-hypofractionation/PULSAR/FLASH; that and the role of (radio)immunotherapy are transformative and disruptive innovations. AI will likely take a large fraction of the current segmentation complexity out of the workflow, but imaging plus adaptive treatments will enable biological image-guided RT, giving more degrees of freedom with radiation delivery.

I believe we will transition to a smaller (in terms of needed providers) but more technical field, and will end up as a component of a multidisciplinary "adaptive resistance" overall treatment approach that uses varying fractions over varying time periods with interval or interleaved local/systemic therapies, in a manner that will increase survival and reduce side effects. I suspect that from a workflow perspective, radiation oncology will look little like today's practice in 20 to 30 years."

What made you pursue the topic of interest you researched?

Since undergrad, I loved statistics so that was an easy engagement. My early work was basic clinical and dosimetric analyses, and since we were entering the IMRT era, I was fascinated by heterogeneous doses and the implications for dose-response models. Additionally, I got really into parametric survival models for a while, before landing on imaging as a research focus. One of my mentors, Dr. Martin Fuss, was an early innovator in IMRT and IGRT, Dr. Charles R. Thomas was a clinical trialist, and Dr. David Rosenthal was a pioneer in toxicity assessment; I think my research career is an amalgam of their passions to a large degree.

Opportunities

University of North Carolina Radiation Oncology Clerkship
For more information, contact sara_tinkham@med.unc.edu

Yale Radiation Oncology Medical Student Clinical Fellowship
For more information, contact Sanjay.Aneja@yale.edu

MD Anderson Radiation Oncology Medical Student Elective
For more information, contact ddlcruz@mdanderson.org

Upcoming Conferences

2023 ASTRO Conference
October 1-4, 2023 | San Diego and Virtual

2023 ASTRO Annual Refresher Course
April 26-28, 2023 | Virtual

Radiation Oncology Education Collaborative Study Group (ROECSG) 6th Annual Spring Symposium
May 5, 2023 | Virtual and Chicago, IL

2023 Midwest Radiation Oncology Symposium
August 18-19, 2023

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Contact: Sharon Breske, managing editor, *Applied Radiation Oncology*, Sharon@appliedradiationoncology.com