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ASTRO news

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IN RADIATION ONCOLOGY

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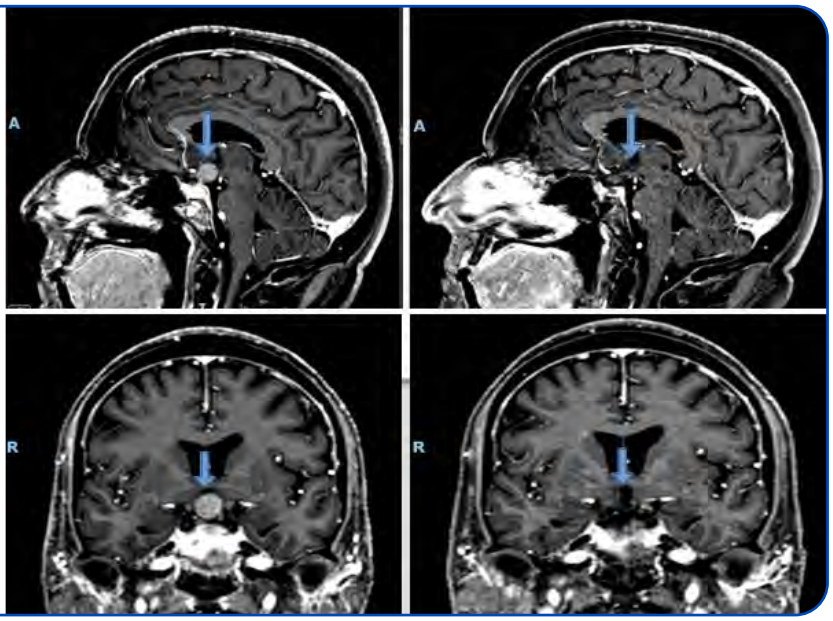

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ADVERTISING:
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703-839-7342
corporaterelations@astro.org

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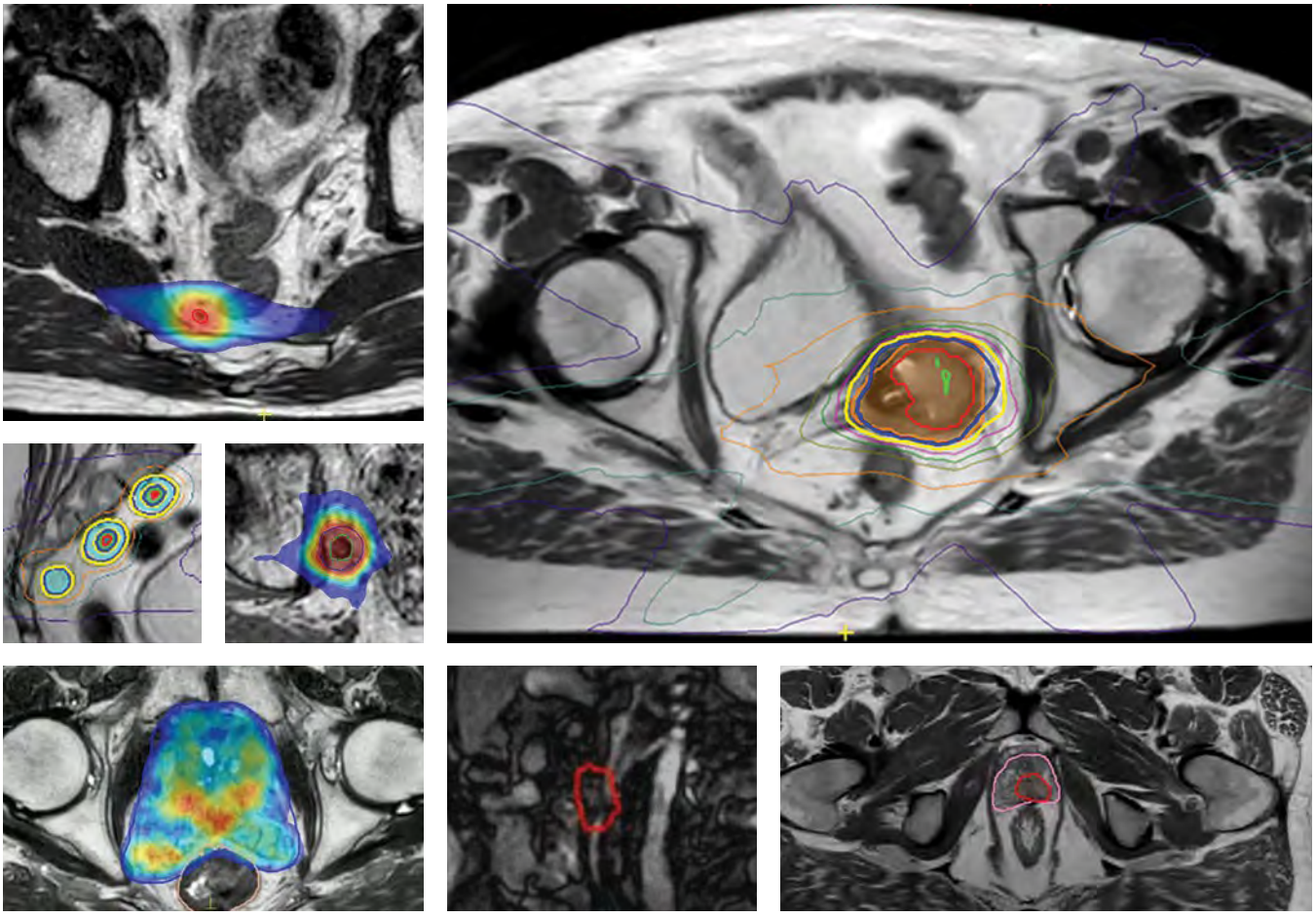

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EDITOR'S*notes*

BY NAJEEB MOHIDEEN, MD, FASTRO
SENIOR EDITOR, *ASTRONEWS*

Tomorrow's World

Real-time adaptive treatments. Stereotactic ablative radiation therapy to minimize sudden cardiac death. Expanding radiation therapy indications in metastatic disease. Pioneering research in DNA repair and metabolism. Novel strategies to decrease immune suppression and resistance to radiation therapy. A look at FLASH. Exciting trials coming to the clinic. Transformations in education, training, certification and meetings. These are a sample of some of the offerings in this issue on what's new in radiation oncology.

In a recent informal survey among radiation oncologists and trainees, the question, "Where must radiation oncology go first in the 2020s?"* was posed ahead of an online panel discussion of the topic hosted by the Red Journal and the Virtual Visiting Professor Network. Artificial intelligence (AI) edged out molecular biology, FLASH radiation therapy, diversity, equity and inclusion, and educational reform in the voting for top priority issue. During the lively debate, Charles Mayo, PhD, elegantly advocated for the need to democratize AI, which, if done properly, can lead to better patient care, expanded access and reduced outcome disparities.[1]

AI tools for auto segmentation and auto planning are continually improving, and reading between the lines of the adaptive process described in this issue, one gets a glimpse of that future. Establishing the standards to validate them and high-quality clinical assessment of these important steps in the patient treatment process are vital. How will these tools impact our work process and interaction with the patient? Hunyh and colleagues addressed this in a recent thought-provoking perspective.[2]

If AI or machine learning tools reach the threshold for a Category 1 CPT code (have supporting peer-reviewed clinical research and validation), or if our work changes significantly for an existing code, they would then need to be valued by the AMA Relative Value Scale Update Committee (RUC). The RUC values physician work (professional component) of a medical procedure based on time, skill, mental effort and judgment. They also value the technical component — physicist, dosimetry, therapist work and equipment costs. When time is saved, unless the intensity of the work goes up, the value of the code generally goes down. But whether the true cost of AI and the work associated with it can be captured in the current system is uncharted territory.

In September 2020, in a groundbreaking rule recognizing AI, CMS granted the first New Technology Add-on Payment (NTAP) status to an AI medical company for software used to detect strokes on CT scans. This program pays hospitals up to $1,040 per use, time-limited to three years. The AI company charges a yearly fee, and the NTAP reimbursement is designed to support health systems in covering that. How did they get to that number? How does one decide when to deploy AI, and can it demonstrably impact outcome? A rapid readout of the CT is just one factor in a complex multi-step algorithm in stroke management and outcome.

The ACR is submitting the first two radiology-specific CPT Category III code proposals (considered tracking codes for new technology, unlike Category 1 codes, Category III codes do not get valued at the RUC) for AI analysis for the detection of vertebral fractures and quantitative ultrasound tissue characterization. More AI-based codes will almost certainly, in time, make their way through the current convoluted process. How will AI affect our workforce and the financial stability of our field? That remains to be seen, but organizations must appreciate that important steps in good and safe patient care now and in the future will not be reflected in the current reimbursement models, be it multidisciplinary discussions on collaborative care or possibly our cognitive interactions and response to the AI output. This reinforces the need for a fair alternative payment model that protects patient access to quality care yet also allows the appropriate use and adoption of new technology besides ensuring financial stability. Unfortunately, the focus of the RO Model released by CMS was to cut payments rather than smooth the transition of radiation oncology from fee-for-service to value-based payment.

The future is, to put it mildly, exciting. You get a sense of how exciting from the enthusiasm of NRG disease site leaders commenting on new trials exploring many themes: incorporating novel biomarkers and therapeutics, making inroads into metastatic disease, reducing intensity and morbidity, exploring combinations of immunotherapy and radiation (page 18). Hopefully, many of them will prove practice changing. Ensuring a better outcome for our patients — that's the real promise of the future.

References

1 The Big Debate: Where must Radiation Oncology go First in the 2020s? YouTube. Published February 11, 2021. https://www.youtube.com/watch?v=ifnDiLxuCEw
2 Huynh E., Hosny A., Guthier C. et al. Artificial intelligence in radiation oncology. *Nat Rev Clin Oncol*. 2020 Dec;17(12):771-781.

*Look for a forthcoming summary (and results of a post-debate survey) in the Red Journal from co-hosts Kaleigh Doke, MD; Sue Yom, MD, PhD, FASTRO; and Brian Kavanagh, MD, MPH, FASTRO.

CHAIR'S*update*

THOMAS J. EICHLER, MD, FASTRO
CHAIR, BOARD OF DIRECTORS

Our Expanding Role on the Global Stage

HELLO, EVERYONE! Those of you who were kind enough to tune in to my Presidential Address last October may recall that I focused on several discrete themes: the future of the workforce; diversity, equity and inclusion; and global oncology, the theme of the Annual Meeting. The last time I spoke with you on these pages, I returned to the workforce question and the evolution of today's radiation oncologist into tomorrow's clinical oncologist. This is a long-haul concern, recognizing that we are in a period of flux within the specialty that will require insightful management by our physician volunteer leaders in conjunction with the voices and experiences of the membership.

Today, I want to return to another of those topics: global oncology. To quickly review, ASTRO has been involved in global oncology for the past decade. Perhaps the most successful program has been a joint venture with ARRO that began in 2011 to provide funding for three senior residents to acquire hands-on experience in global radiation oncology. The Global Health Scholars program has placed 24 individuals in a variety of settings, giving them valuable exposure to diverse clinical environments and an opportunity to consider careers in global health, as some have done. In September 2019, the ASTRO Board of Directors voted unanimously to fund the program for another five years and to identify opportunities to increase that funding and potentially expand the program. Our International Education Subcommittee (IES) has worked with a variety of stakeholders, including other specialty groups, to help realize the objectives of the Global Task Force on Radiotherapy Cancer Control, which I discussed in great depth during my Presidential Symposium, by expanding radiotherapy resources in low- and middle-income countries (LMICs) to help mitigate access disparity.

Prior to the pandemic, I proposed the creation of an International Council to spotlight the issue and deepen ASTRO's commitment, and while there was some momentum for such a council, both financial and practical considerations made this unrealistic. This was not, however, the end of the discussion. On the larger stage, May Abdel-Wahab, MD, PhD, director of the Department of Nuclear Sciences and Applications in the Division of Human Health at the International Atomic Energy Agency (IAEA) in Vienna, Austria, and the current ASTRO IEC chair, has led an impressive effort to coordinate specialty societies globally to populate four workgroups: research, education, communication and global information sharing. These workgroups are a direct result of the three-day Challenges in Global Cancer Care virtual meeting last July, in which ASTRO played a highly visible role. We have continued to be supportive of the IAEA mission and have shared appropriate education and communication resources with the respective workgroups.

In the wake of the Annual Meeting and the advent of the IAEA efforts, the ASTRO Board of Directors voted unanimously on December 18, 2020, to elevate the IES to full committee status. This new International Committee (IC) is well positioned for meaningful interaction with the IAEA under Dr. Abdel-Wahab's dual role leadership for the next two years. It will be incumbent, however, on those ASTRO members who are interested in global oncology — and there are many — to channel your passion by volunteering on the IC as ASTRO deepens its commitment to alleviating cancer disparities in LMICs and rural and urban America. I also call upon my colleagues in academia, especially those in SCAROP and ADROP, to explore the possibility of adding a global health component to resident education programs (a great undertaking for a junior faculty member!), as well as investigating creative avenues for attending physicians to volunteer for overseas assignments without penalty to their tenure track. It is an entirely achievable proposition as outlined in some detail by University of Pennsylvania Chair, Jim Metz, MD, during the Presidential Symposium last October. Reach out to him — he remains a valuable resource!

As I write this, the first steps are being taken by the IAEA to create a new International Radiation Oncology Society, an umbrella organization that would comprise various specialty societies — ASTRO, ESTRO, AAPM, among others — to coordinate activities and prevent

Continued on page 28

SOCIETY NEWS

Best of ASTRO licensing opportunities available

BY UĞUR SELEK, MD, FASTRO

I HAVE HAD THE PRIVILEGE of being coordinator of one of the pilot programs, along with India and Mexico, for the Best of ASTRO Licensing program, which started in 2014. The Turkish Society for Radiation Oncology has held a Best of ASTRO meeting annually since then.

The event in Istanbul, organized by the Turkish Society for Radiation Oncology, is presented in Turkish by Turkish faculty who have attended the ASTRO Annual Meeting. This event is considered one of the Society's annual courses and allows a friendly gathering for attendees. Although the overall expenses, including the ASTRO fee, are a little over the total revenue supplied by corporate sponsorship, no registration fee is required, as expenses are covered by the Society for its members.

Attendance is typically around 200-250 practitioners and faculty, about a third of all Society members. We are pleased to report that over 95% of attendees would recommend the meeting to a colleague. Over 90% of attendees say that the meeting provides new approaches to help them manage patient care, and over 60% say they intend to change their practice and/or patient care as a result.

The Best of ASTRO meeting content comes from the ASTRO Annual Meeting, where the Scientific Program Committee selects the "best of" ASTRO presentations, resulting in up to 100 abstracts in the major disease sites plus the faculty discussant presentations.

We are pleased to be a part of this ongoing commitment by ASTRO to extend the reach of educational opportunities around the world and look forward to a continued partnership with ASTRO on behalf of our local physician community. For more information on the Best of ASTRO Licensing program, visit www.astro.org/BOAlicensing.

Uğur Selek, MD, FASTRO, is chair at American Hospital, MD Anderson Department of Radiation Oncology, Istanbul; professor, Koc University, Department of Radiation Oncology, Istanbul; and adjunct professor, University of Texas, MD Anderson Cancer Center, Department of Radiation Oncology, Houston.

Advocacy's 2020 buzzer beater and 2021 game plan

BY COLIN WHITNEY, ASTRO GOVERNMENT RELATIONS SPECIALIST

LAST YEAR WAS ONE FOR THE RADIATION ONCOLOGY RECORD BOOK, thanks not only to historic struggles, but also historic triumphs. Life-altering developments came seemingly every month, making uncertainty and oftentimes pessimism the norm. But as the year came to its end, things started to turn for the better.

ASTRO Advocacy faced a similar timeline of challenges in 2020. With a flawed radiation oncology alternative payment model (RO Model) and Medicare payment cuts set to start in January 2021, the waning days of 2020 were looking bleak, as progress stalled. The ASTRO Advocacy team of volunteers and staff did not let that discourage them, though, and continued to work toward the Society's goals. Thankfully, the hard work paid off, and ASTRO secured crucial year-end wins for radiation oncology. Here's a breakdown of how 2020 shook out and what lies ahead for ASTRO Advocacy in 2021.

Between the release of the RO Model and the payment cuts triggered by evaluation and management (E/M) coding changes as part of the 2021 Medicare Physician Fee Schedule (MPFS), Medicare related priorities required a lot of energy last year. Given the financial instability caused by the COVID-19 public health emergency, the drastic cuts in both the RO Model and E/M would have added unnecessary burden to already struggling providers.

To combat these cuts, ASTRO mobilized campaigns to delay the implementation of the RO Model and reduce the E/M cuts. The Advocacy team organized two RO Model oversight letters to the Department of Health and Human Services (HHS) signed by 22 bipartisan members of Congress, sent countless letters to HHS and the Centers for Medicare and Medicaid Services (CMS) advocating for changes and secured support from key stakeholders, including the American Medical Association and the American Hospital Association. ASTRO membership also rallied to send over 2,000 messages to their representatives and senators as part of five grassroots campaigns aimed at urging Congress to take action.

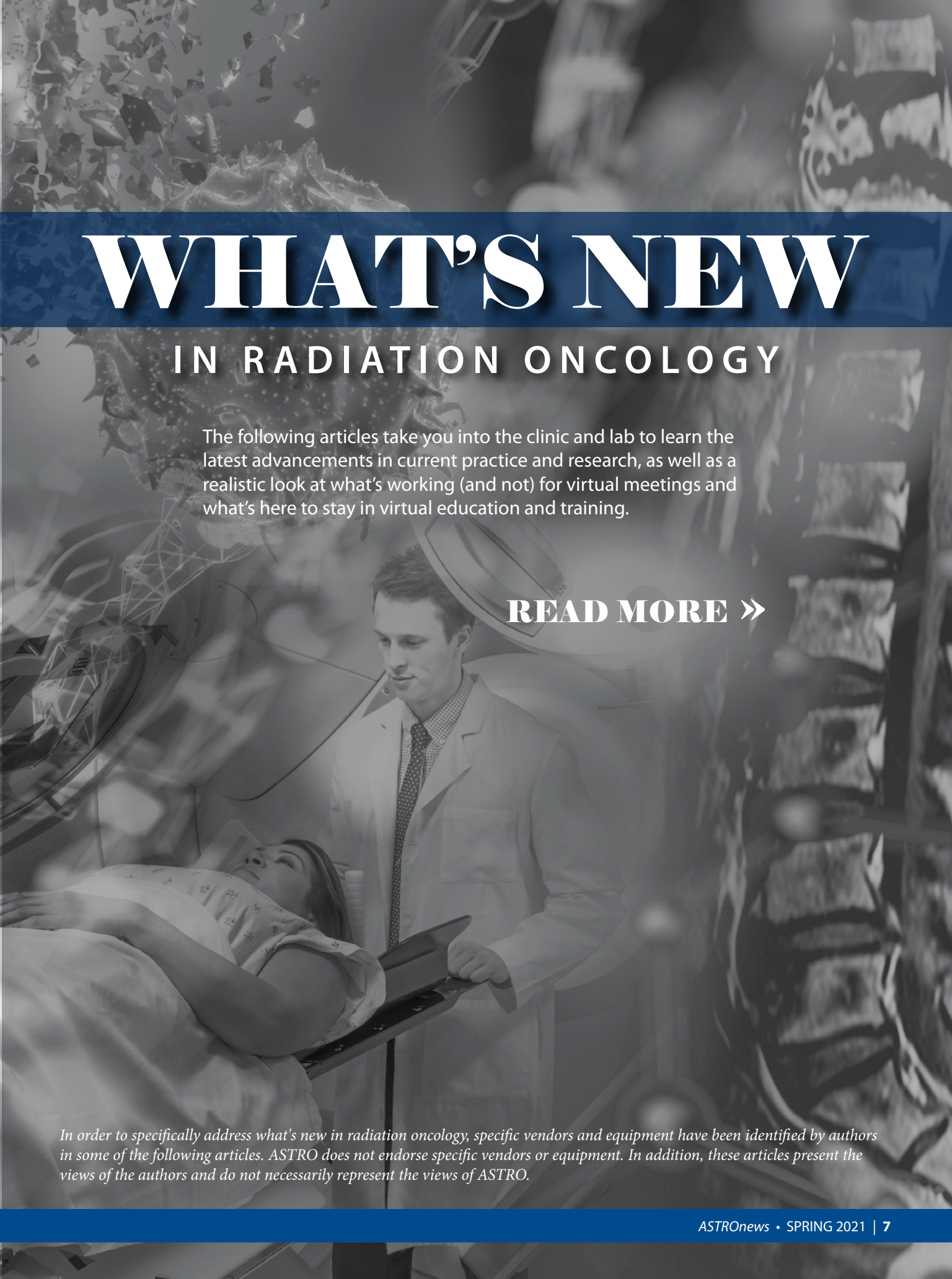
When combined with direct lobbying from ASTRO staff, these efforts resulted in a delay in the implementation date of the RO Model until January 1, 2022, saving model participants approximately $45 million in 2021. In addition, by partnering with other affected medical specialty societies, ASTRO secured a significant reduction in the E/M payment cuts, saving radiation oncology approximately $100 million in 2021. While the delay of the RO Model start date is a welcome win for would be participants, ASTRO will not settle for just the delay and will continue to work toward fixing the RO Model before it's implemented.

"This is a prime example of the power of grassroots advocacy," said ASTRO Chair Thomas Eichler, MD, FASTRO. "Engagement is crucial to our efforts to effectively influence Congress in a rapidly evolving and often hostile regulatory environment. ASTRO members need to understand the importance and value of taking action and raising their collective voices. Supporting ASTRO's advocacy efforts is the responsibility of every domestic member."

> "Engagement is crucial to our efforts to effectively influence Congress in a rapidly evolving and often hostile regulatory environment."

Another priority for ASTRO Advocacy in 2020 was advancing the fight to fix prior authorization. ASTRO continued its push for members of Congress to support legislation that would take the first steps in fixing runaway prior authorization requirements. House legislation now boasts more than 280 bipartisan co-sponsors. Additionally, ASTRO helped foster the introduction of a companion prior authorization bill in the Senate, which sets the stage for ASTRO's 2021 push to have the new Congress finally take action on much needed prior authorization reform.

While these are all great achievements, ASTRO Advocacy will not be resting on its laurels, and we hope members won't either. The RO Model still needs vast improvements, and prior authorization reform is a battle far from won. The powerful collaboration of Advocacy leadership and ASTRO members, shared through our grassroots advocacy platform, is the key for future success. Keep an eye out for ASTRO action alerts, and make sure your representatives and senators know how they can support the radiation oncology community, and together we can make 2021 another successful year.



WHAT'S NEW

IN RADIATION ONCOLOGY

The following articles take you into the clinic and lab to learn the latest advancements in current practice and research, as well as a realistic look at what's working (and not) for virtual meetings and what's here to stay in virtual education and training.

READ MORE »

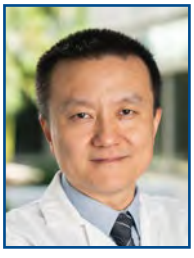
In order to specifically address what's new in radiation oncology, specific vendors and equipment have been identified by authors in some of the following articles. ASTRO does not endorse specific vendors or equipment. In addition, these articles present the views of the authors and do not necessarily represent the views of ASTRO.

MRI-GUIDED RADIOTHERAPY: FROM "PEEK AND SHOOT" TO REAL-TIME ADAPTIVE RADIATION THERAPY

BY AMAR U. KISHAN, MD, MINSONG CAO, PHD, AND MICHAEL L. STEINBERG, MD, FASTRO

THE LATE 1990s AND EARLY 2000s witnessed the emergence of novel radiation therapy technologies at an almost unprecedented pace, with the advent and widespread implementation of intensity-modulated radiation therapy, modern image-guided radiation therapy and stereotactic body radiation therapy. All of these advancements improved the therapeutic ratio. We believe that MRI-guided radiation therapy (MRgRT), which is a nascent technology as we enter this new decade, will be the next such technology. As of 2021, there are two commercially available linear accelerators that can deliver MRgRT: the Viewray MRIdian MR Linac (Viewray Inc, Oakwood, Ohio), which uses a 0.35 Tesla MRI, and the Elekta Unity (Elekta AB, Stockholm, Sweden), which uses a 1.5 Tesla MRI. The purpose of this article is to provide an overview of the operational process of implementing an MRgRT program and briefly discuss ongoing clinical trials investigating novel applications of this technology.

Amar U. Kishan, MD



Minsong Cao, PhD

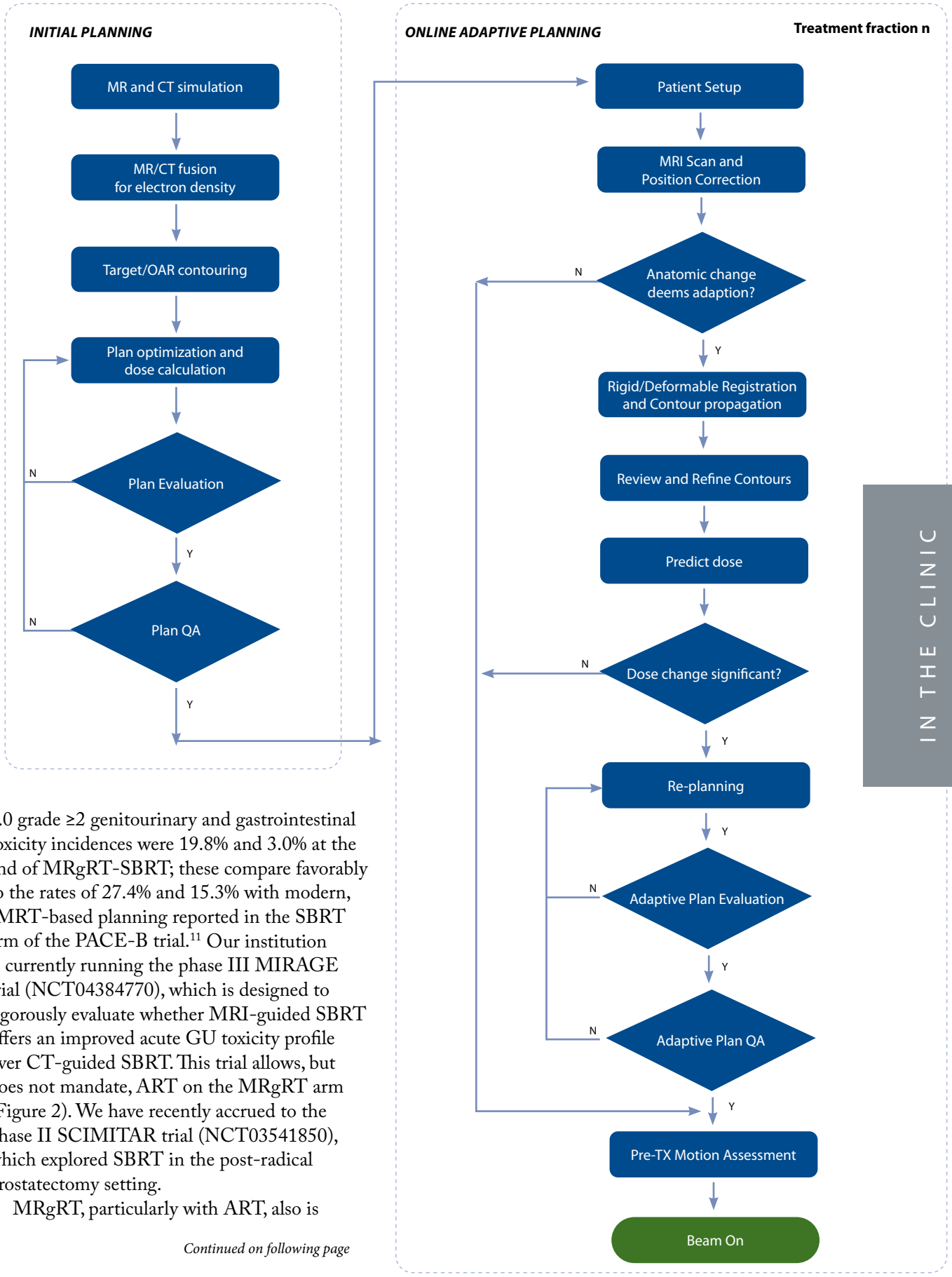
Michael L. Steinberg, MD, FASTRO

Our department began using the legacy tri-60Co-teletherapy platform from ViewRay in December 2014. In December 2019, we implemented the MRIdian LINAC. All patients undergo consecutive CT simulation scans and MR simulation scans on the MRIdian LINAC. While MRI-only workflows have been described,[1,2] we have retained an in-department CT simulator for reasons of practicality and expanded access. Particular challenges to an MRI-only workflow are difficulties with electron density information required for accurate dose calculation and the delivery of treatments that are directed by radiopaque fiducial markers. MRgRT-specific phantoms and MR-safe devices are required for quality assurance as well.[3,4]

A major advantage of both MRgRT platforms is the ability to perform online adaptive radiation therapy (ART). By actively integrating information regarding interfractional changes in anatomy, organ deformation and stochastic motion, ART provides the ability to minimize toxicity while allowing focused intensification or de-intensification.[5,6] For online MRgRT ART, an on-board MRI image is obtained prior to treatment and used to evaluate target and OAR anatomy. Our workflow has required a dosimetrist, physicist and physician to review OAR and target dosimetry based on either rigid or deformed transfer of contours and manual refining of critical structures (Figure 1). If deemed appropriate per pre-specified criteria, a new plan is generated for consideration of delivery. However, this process does significantly extend treatment time, likely necessitating auto-segmentation tools for streamlining widespread implementation.[7]

We have primarily explored MRgRT for the treatment of prostate cancer and hepatobiliary/pancreatic malignancies. MRgRT has multiple potential benefits with regard to prostate radiotherapy.[8] These include allowing smaller planning target volumes due to improved motion management, lower uncertainty from superior soft-tissue contrast, lower contouring uncertainty from MRI-MRI registration versus MRI-CT fusion, the capacity for online ART, the lack of need for fiducial markers and auxiliary diagnostic MRIs for treatment planning and lack of radiation dose from on-board imaging. These advantages could be leveraged to improve quality of life following treatment and/or intensify treatments (e.g., with simultaneous integrated boosting of MRI-defined lesions). ART may be particularly important for post-prostatectomy radiotherapy given the considerable organ deformation in that clinical context.[9] While several smaller reports have been published, the only prospective data to date for prostate SBRT with MRgRT technology come from a recently reported phase II trial (NCT03961321) of 101 patients.[10] Bruynzeel et al. delivered MRI-guided SBRT in 5 fractions of 7.25 Gy to the target volume using daily plan adaptation, simultaneously limiting the urethra dose to 6.5 Gy per fraction. Acute CTCAE version

Figure 1. Online Adaptive Radiotherapy Schema



4.0 grade ≥2 genitourinary and gastrointestinal toxicity incidences were 19.8% and 3.0% at the end of MRgRT-SBRT; these compare favorably to the rates of 27.4% and 15.3% with modern, IMRT-based planning reported in the SBRT arm of the PACE-B trial.[11] Our institution is currently running the phase III MIRAGE trial (NCT04384770), which is designed to rigorously evaluate whether MRI-guided SBRT offers an improved acute GU toxicity profile over CT-guided SBRT. This trial allows, but does not mandate, ART on the MRgRT arm (Figure 2). We have recently accrued to the phase II SCIMITAR trial (NCT03541850), which explored SBRT in the post-radical prostatectomy setting.

MRgRT, particularly with ART, also is

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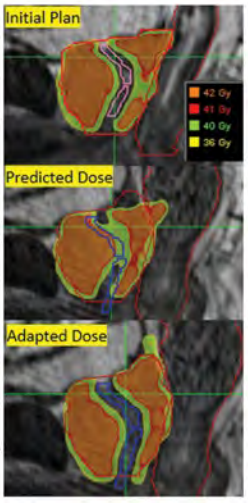
Figure 2. Potential for Adaptive Prostate SBT



conceptually attractive for hepatobiliary/pancreatic malignancies.[12] The complex motion and deformation patterns of the target, liver, bowel and stomach limit the delivery of adequate doses of radiation without risking catastrophic toxicities. The tumors themselves can be impossible to see with CT-based imaging, requiring surrogate-based image-guided radiotherapy (e.g., with alignment to implanted fiducial markers) and introducing errors from MRI-CT fusions for contouring. A recent multi-institutional study of 26 patients receiving MRgRT-based liver SBRT found excellent local control rates with <8% experiencing a drop in Child-Pugh score versus 20-30% in other large SBRT series.[13] A retrospective analysis of patients receiving MRgRT-based SBRT for pancreatic cancer with online ART found that daily image visual review was unreliable for making decisions regarding adaptive radiation therapy.[14] The multi-institutional SMART trial (NCT03621644) is evaluating acute grade ≥3 gastrointestinal toxicity rates after MRgRT-based SBRT for pancreatic cancer, with online ART used for each session.

Overall, MRgRT has the potential for improved precision and accuracy of radiation by leveraging the substantially improved soft-tissue contrast over CT-based imaging as well as the capability for online ART. Ideally, this will allow a clinically meaningful broadening of the therapeutic window by minimizing adverse events while improving efficacy. We eagerly await the results of the ongoing and planned studies in this realm.

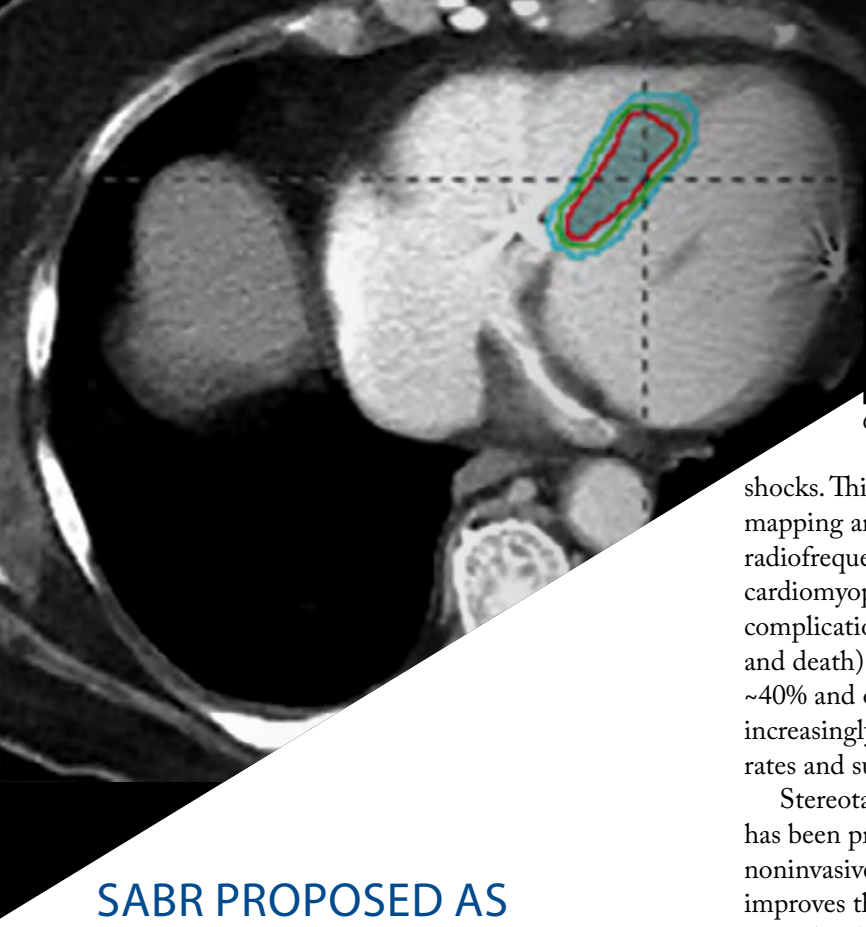
Amar U. Kishan, MD, is the vice-chair of Clinical and Translational Research and chief of the Genitourinary Oncology Service in the Department of Radiation Oncology at UCLA.

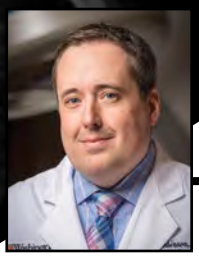
Minsong Cao, PhD, is an associate professor at the Department of Radiation Oncology at UCLA, where he also serves as the program director of the Medical Physics residency program.

Michael Steinberg, MD, FASTRO, is a professor and chair of the Department of Radiation Oncology at UCLA and a former ASTRO President, as well as a recipient of the ASTRO Gold Medal in 2017.

References

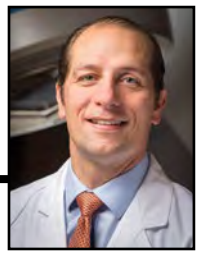
1 Paulson ES, Crijns SPM, Keller BM, et al. Consensus opinion on MRI simulation for external beam radiation treatment planning. *Radiother Oncol.* 2016;121(2):187-192. doi:10.1016/j.radonc.2016.09.018.
2 Tyagi N, Zelefsky MJ, Wibmer A, et al. Clinical experience and workflow challenges with magnetic resonance-only radiation therapy simulation and planning for prostate cancer. *Phys Imaging Radiat Oncol.* 2020;16:43-49. doi:10.1016/j.phro.2020.09.009.
3 Singhrao K, Fu J, Wu HH, et al. A novel anthropomorphic multimodality phantom for MRI-based radiotherapy quality assurance testing. *Med Phys.* 2020;47(4):1443-1451. doi:10.1002/mp.14027.
4 Hu Q, Yu VY, Yang Y, et al. Practical Safety Considerations for Integration of Magnetic Resonance Imaging in Radiation Therapy. *Pract Radiat Oncol.* 2020;10(6):443-453. doi:10.1016/j.prro.2020.07.008.
5 Yan D, Vicini F, Wong J, Martinez A. Adaptive radiation therapy. *Phys Med Biol.* 1997;42(1):123-32. doi:10.1088/0031-9155/42/1/008.
6 Glide-Hurst CK, Lee P, Yock AD, et al. Adaptive radiation therapy (ART) strategies and technical considerations: A state of the ART review from NRG Oncology. *Int J Radiat Oncol Biol Phys.* 2020;In Press. doi.org/10.1016/j.ijrobp.2020.10.021.
7 Kieselmann JP, Fuller CD, Gurney-Champion OJ, Oelfke U. Cross-modality deep learning: Contouring of MRI data from annotated CT data only. *Med Phys.* Published November 30, 2020. doi:10.1002/mp.14619.
8 Tocco BR, Kishan AU, Ma TM, Kerkmeijer LGW, Tree AC. MR-Guided Radiotherapy for Prostate Cancer. *Front Oncol.* 2020;10:616291. doi:10.3389/fonc.2020.616291.
9 Yoon S, Cao M, Aghdam N, et al. Prostate bed and organ-at-risk deformation: Prospective volumetric and dosimetric data from a phase II trial of stereotactic body radiotherapy after radical prostatectomy. *Radiother Oncol.* 2020;148:44-50. doi:10.1016/j.radonc.2020.04.007.
10 Bruynzeel AME, Tetar SU, Oei SS, et al. A Prospective Single-Arm Phase 2 Study of Stereotactic Magnetic Resonance Guided Adaptive Radiation Therapy for Prostate Cancer: Early Toxicity Results. *Int J Radiat Oncol Biol Phys.* 2019;105(5):1086-1094. doi:10.1016/j.ijrobp.2019.08.007.
11 Brand DH, Tree AC, Ostler P, et al. Intensity-modulated fractionated radiotherapy versus stereotactic body radiotherapy for prostate cancer (PACE-B): acute toxicity findings from an international, randomised, open-label, phase 3, non-inferiority trial. *Lancet Oncol.* 2019;20(11):1531-1543. doi:10.1016/s1470-2045(19)30569-8.
12 Witt JS, Rosenberg SA, Bassetti MF. MRI-guided adaptive radiotherapy for liver tumours: visualising the future. *Lancet Oncol.* 2020;21(2):e74-e82. doi:10.1016/s1470-2045(20)30034-6.
13 Rosenberg SA, Henke LE, Shaverdian N, et al. A Multi-Institutional Experience of MR-Guided Liver Stereotactic Body Radiation Therapy. *Adv Radiat Oncol.* 2019;4(1):142-149. doi:10.1016/j.adro.2018.08.005.
14 Tyran M, Jiang N, Cao M, et al. Retrospective evaluation of decision-making for pancreatic stereotactic MR-guided adaptive radiotherapy. *Radiother Oncol.* 2018;129(2):319-325. doi:10.1016/j.radonc.2018.08.009.





Clifford Robinson, MD

Geoffrey Hugo, PhD



Phillip Cuculich, MD

SABR PROPOSED AS NONINVASIVE CARDIAC RADIOABLATION (CRA) FOR IMPROVED VT PATIENT EXPERIENCE

BY CLIFFORD ROBINSON, MD, GEOFFREY HUGO, PHD, AND PHILLIP CUCULICH, MD

SUDDEN CARDIAC DEATH (SCD) represents a major worldwide public health problem, accounting for 15-20% of all deaths. Ventricular tachycardia (VT), the most common source of SCD, is caused by abnormal electrical circuits formed within scarred heart muscle, frequently from a previous myocardial infarction. Treatment for individuals with VT is limited to a combination of an implantable cardiac defibrillator (ICD) and an antiarrhythmic drug, such as amiodarone. If the medication fails to prevent VT, then the ICD delivers a life-saving, high-energy shock.

Unfortunately, ICD shocks are painful and have a substantial negative impact on quality of life. Catheter ablation (CA) is an invasive procedure used to treat the electrical short circuits in scarred heart tissue and prevent ICD shocks. This procedure requires several hours of mapping and ablation using heat generated by radiofrequency energy. In patients with advanced cardiomyopathy, risk of serious procedural complications (i.e., bleeding, stroke, heart failure and death) approaches 10%, VT recurrence is ~40% and one-year survival is under 50%. In increasingly high risk patients, VT recurrence rates and survival parallel metastatic lung cancer.[1]

Stereotactic ablative radiotherapy (SABR) has been proposed as one option to deliver noninvasive ablation for VT. In theory, SABR improves the patient experience by both reducing procedural risk and providing a more complete homogenization of the scar than can be achieved with a small RF catheter tip. In more than a dozen preclinical animal studies, single doses of radiation ranging 5-160 Gy were delivered to portions of myocardium with few serious adverse events. Cardiac structural changes were noted around 25-30 Gy.[2]

In 2015, we published our initial experience with a totally noninvasive cardiac radioablation (CRA) workflow (see figure on following page) using noninvasive scar and electrical imaging combined with a single SABR dose of 25 Gy in five patients with high risk refractory VT.[3] Overall VT reduction was 99%, with no serious radiation related toxicity. Subsequently, we carried out a prospective phase I/II trial (ENCORE-VT, NCT02919618) of 19 additional patients with high risk refractory VT using the same CRA workflow. Overall VT reduction of 94% was achieved, with concomitant reductions in antiarrhythmic drug use and improvements in QoL.[4] CRA-related late adverse events included two grade 3 pericardial effusions and one grade 3 gastropericardial fistula, all of which presented two years after treatment. More than a dozen additional case series have been reported to date

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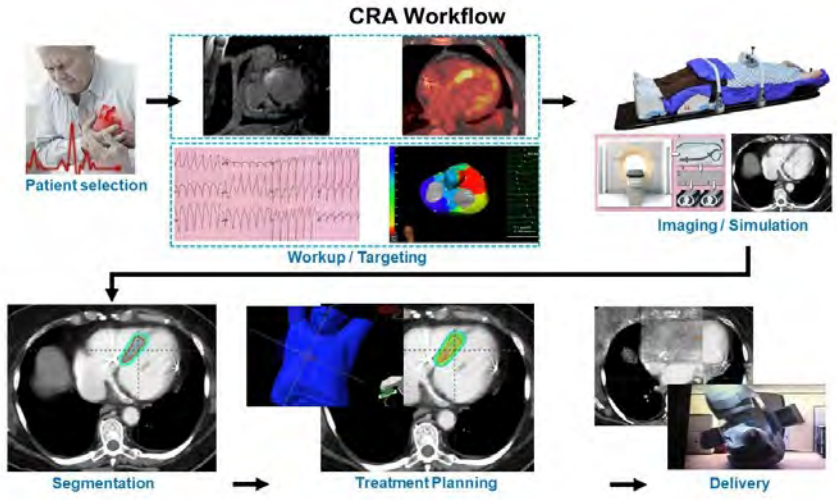

in patients with high risk refractory VT, largely echoing the results achieved in ENCORE-VT.[2]

Many questions remain about CRA. What is the biologic mechanism for VT response? How can we reproducibly target the VT circuits without catheters? And how can we leverage existing radiation oncology infrastructure to extend access to VT treatment in countries where CA is not available? To answer these and other questions, we recently created the Center for Noninvasive Cardiac Radioablation (http://cncr.wustl.edu) at Washington University.

Targeting VT, unlike contouring a visible nodule in the lung to generate a GTV, involves close collaboration between the radiation oncologist and electrophysiologist to integrate scar (CT, MRI, PET/SPECT, Echo) and electrical (12-lead ECG, prior catheter maps) data to define a target on the planning CT. This exercise is more akin to defining a CTV, where the multimodality data suggests a "zone" of microscopic disease harboring the VT circuits. This process does not easily lend itself to image co-registration, due to different scan scenarios (e.g., breath-hold/ECG-gated vs. free-breathing/non-gated), ubiquitous artifact from the ICD and leads, different scan orientations and routine use of non-3-D acquisitions in cardiac imaging, and lack of imaging data to co-register (ECG). To address this, our group has devised a robust method to integrate data based on the American Heart Association 17-segment model, which is more geometrically stable and readily defined on the planning CT without the need for image co-registration.

There is an urgent need to confirm efficacy and safety of CRA in prospective trials before this treatment becomes readily available off-label. Decades of experience in radiation oncology have shown us the perils of introducing new technologies without carefully controlled clinical trials. With careful scientific collaboration, standardization of targeting and treatment approaches, and robust enrollment on prospective clinical trials, patients with limited treatment options now have hope for a future without arrhythmias.

Clifford Robinson, MD, is a professor of Radiation Oncology and Internal Medicine (Cardiology) at Washington University in St. Louis. He is director of Clinical Trials for Radiation Oncology, chief of Cardiothoracic Radiation Oncology and Stereotactic Radiotherapy, and co-director of the Center for Noninvasive Cardiac Radioablation (CNCR).

Geoffrey Hugo, PhD, is a professor of Radiation Oncology at Washington University in St. Louis. He is interim director of Medical Physics and director of the Computational Radiotherapy Lab (CORAL).

Phillip Cuculich, MD, is an associate professor of Internal Medicine (Cardiology) and Radiation Oncology at Washington University in St. Louis. He is co-director of the Center for Noninvasive Cardiac Radioablation (CNCR).

References

1 Tzou WS, Tung R, Frankel DS, et al. Ventricular Tachycardia Ablation in Severe Heart Failure: An International Ventricular Tachycardia Ablation Center Collaboration Analysis [published correction appears in *Circ Arrhythm Electrophysiol.* 2018 Aug;11(8):e000029]. *Circ Arrhythm Electrophysiol.* 2017;10(1):e004494.

2 van der Ree MH, Blanck O, Limpens J, et al. Cardiac radioablation-A systematic review. *Heart Rhythm*. 2020;17(8):1381-1392.

3 Cuculich PS, Schill MR, Kashani R, et al. Noninvasive Cardiac Radiation for Ablation of Ventricular Tachycardia. *N Engl J Med*. 2017;377(24):2325-2336.

4 Robinson CG, Samson PP, Moore KMS, et al. Phase I/II Trial of Electrophysiology-Guided Noninvasive Cardiac Radioablation for Ventricular Tachycardia. *Circulation*. 2019;139(3):313-321.

TREATMENT OF OLIGOMETASTATIC CANCERS: RECENT LESSONS AND NEW HORIZONS

BY DAVID PALMA, MD, PHD

NINE YEARS AGO, in February 2012, I was 18 months into my new practice as radiation oncologist, and my new trial, called SABR-COMET, was not accruing well. Actually, it was not accruing at all. We were four months in with a grand total of zero patients enrolled. I was getting worried.

That February, I met a patient who seemed like a good candidate. He had a single adrenal metastasis from colorectal cancer that had grown quickly to 4.9 cm. He was interested in the trial, but I was nervous. I had never treated an adrenal metastasis, and the lesion was big, just a hair below the 5 cm cutoff. I called one of my mentors, George Rodrigues, MD, PhD, for some advice. "Sometimes, you just have to put the first patient on trial," he told me. We needed to start somewhere, and as long as we could do it safely, we should proceed. He made two points. First, in his experience, he had learned that once a first patient enrolls, the trial comes to the forefront of everyone's mind and accrual increases quickly. Second, he would help me with the planning to ensure it was safe.

Fast forward to today, and it turns out that Dr. Rodrigues was right on both counts. After my patient enrolled, accrual took off, and the trial completed pretty much on time. The treatment worked perfectly in this patient, with no toxicity and no recurrence. I'm due to see him next month for his nine-year follow-up.

The treatment of patients with oligometastases is a hot topic today, but it's not a new idea. The term "oligometastasis" was coined over 25 years ago by Sam Hellman, MD, FASTRO, and Ralph Weichselbaum, MD, but the paradigm goes back decades further. The earliest record, as far as I'm aware, is from 1939, in a case report of a 55-year-old woman cured of primary renal cancer and lung metastasis by surgical resection of both lesions. The surgeons concluded with characteristic certainty: "If a metastasis is apparently solitary and accessible to surgical removal, it is definitely worthwhile to undertake removal of the metastasis as well as the primary growth".[1] Viewed through the modern lens of evidence-based medicine, such a strong conclusion from a case report seems irresponsible. But they might have been right (apart, of course, from neglecting to predict that SABR would come along to challenge the surgical approach).

Although the oligometastatic paradigm has been around for decades, it's only in the past few years that we've seen a concerted effort to test the paradigm in randomized trials. While there isn't space here to discuss them all (for that, I encourage you to read an excellent recent review[2]), now is a good time to reflect and ask: What have we learned?

The first lesson is that the outcome achieved by my first COMET patient is not typical. Most patients with oligometastases are not cured with SABR, but they progress at some point with new metastases. In SABR-COMET, fewer than 20% of patients made it to five years without progression. This lesson has impacted my consent discussions with patients. I now tell them that, although we hope the cancer doesn't come back, unfortunately most times it does. In some cases, we can do SABR again, but only a minority of people will be free of disease long term.

A second lesson is that safety should always be our first priority, just as it was for that 4.9 cm adrenal lesion. Although many patients have no toxicity from SABR, the treatment is not harmless. In the SABR-COMET trial, we reported a 4.5% risk of treatment-related mortality. In the Alliance A021501 trial of chemotherapy +/- SABR (or hypofractionated radiation) for borderline-resectable pancreatic cancer, overall survival was 20% lower in the SABR arm.[3] In planning SABR, most radiation oncologists will compromise the dose to areas of the PTV if there is any concern about normal structures, but a decade ago, that approach wasn't clearly established. It went against radiation

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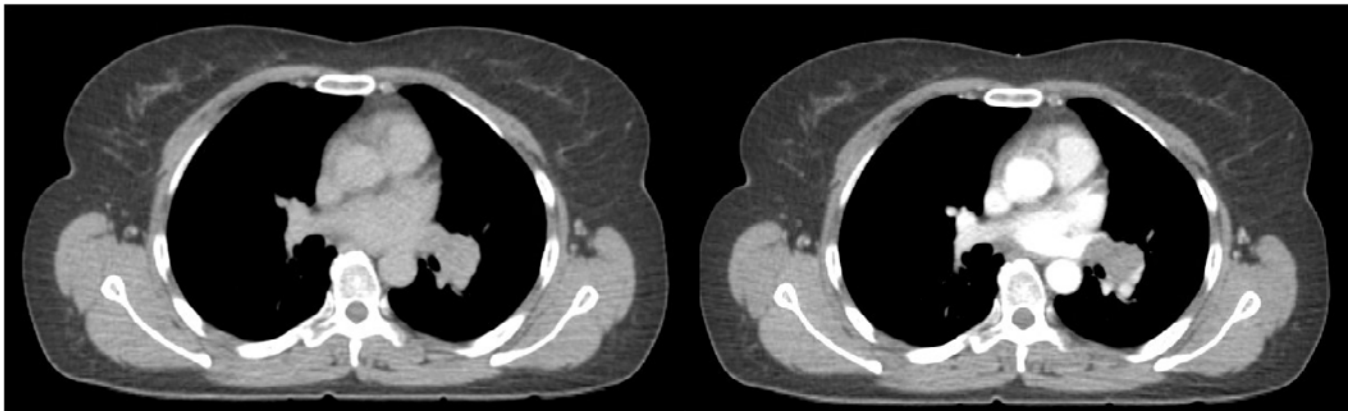
Figure 1. Value of IV Contrast



oncology planning orthodoxy to leave some areas of the PTV "cold." Overall, we need to remain cautious in our radiation planning and dose selection. The use of contrast (intravenous or oral, depending on the target's location) can be very helpful. The figure above shows the value of IV contrast (right) in visualizing a hilar node, compared to a scan without contrast (left).

A final lesson to highlight is that SABR does affect the immune system, but there's more to be learned before we can use SABR merely for a hypothesized abscopal effect. The ORIOLE phase II trial of observation vs. SABR in patients with oligometastatic cancers showed not only an improvement in progression-free survival with SABR, but also an increase in T cell clonotypic expansion after SABR.[4] There are tantalizing hints that SABR can modulate the immune system, but there is much more to be learned.

We are about to enter the era of phase III data for SABR in oligometastatic cancers. The NRG trials LU-002 and BR-002 will provide important histologically specific data for oligometastatic lung and breast cancers. The histology-agnostic SABR-COMET-3 (1-3 mets) and SABR-COMET-10 (4-10 mets), both powered for a primary endpoint of overall survival, are also expected to complete in the next few years. While we've learned a lot in the past few years about treating oligometastatic cancers, we are certain to learn a whole lot more very soon.

David Palma, MD, PhD, is a professor in the Department of Oncology at Western University in Ontario, Canada.

References

1 Barney J, Churchill E. Adenocarcinoma of the kidney with metastasis to the lung cured by nephrectomy and lobectomy. J Urol. 1939;42:269-276.
2 Onderdonk BE, Gutiontov SI, Chmura SJ. The Evolution (and Future) of Stereotactic Body Radiotherapy in the Treatment of Oligometastatic Disease. Hematol Oncol Clin North Am. 2020;34(1):307-320.
3 Katz M, Shi Q, Meyers J, et al. Alliance A021501: Preoperative mFOLFIRINOXor mFOLFIRINOX plus hypofractionated radiation therapy (RT) for borderline resectable (BR) adenocarcinoma of the pancreas. J Clin Oncol. 2021;39(suppl 3)377-377.
4 Phillps R, Shi WY, Deek M, et al. Outcomes of Observation vs Stereotactic Ablative Radiation for Oligometastatic Prostate Cancer: The ORIOLE Phase 2 Randomized Clinical Trial. JAMA Oncol. 2020;6(5):650-659.

ASTRO STAFF GIVES BACK

In February, ASTRO staff donated $2,632, plus an additional $500 donation from ASTRO, for a total of $3,132 to purchase food for the local food bank, Arlington Food Assistance Center (AFAC). AFAC serves Arlington County, Virginia, residents in need. Annually, ASTRO donates food and time through volunteering to the AFAC.

ASTRO staff donated more than 1,631 pounds of food — the largest single contribution of the week for AFAC!

MAYO CLINIC JACKSONVILLE SITE OF FIRST CLINICAL CARBON ION ACCELERATOR IN THE U.S.

BY BRADFORD HOPPE, MD, MPH

ON NOVEMBER 15, 2019, Mayo Clinic announced plans to expand their particle therapy footprint in Florida with a new proton therapy and the first clinical carbon ion accelerator in the United States to be built at the Mayo Clinic campus in Jacksonville, Florida. While heavy ion therapy was first developed at the Lawrence Livermore laboratories in the 70s and 80s using helium, carbon, argon and neon, the center closed in 1993 and no center in the U.S. since then has offered treatment with heavy ion therapy.

Mayo Clinic is well positioned to lead the effort to bring heavy particle therapy back into clinical practice in the U.S., given its clinical and research work in proton therapy at the Mayo Clinic campuses in Rochester, Minnesota, and Phoenix, Arizona. Furthermore, carbon ion therapy has been an area of keen interest for development by Mayo Clinic for the last decade, with close collaboration with QST Hospital (formerly NIRS Hospital) in Chiba, Japan, which was the first and longest-dedicated carbon ion therapy (CIT) center in the world.

CIT is similar to proton therapy in that the charged particle beam can be delivered to specific depths to ensure that most of the radiation dose falls within the target as opposed to normal tissue, which is the main problem with photon radiation. Carbon ion therapy differentiates itself from proton therapy in that the LET (linear energy transfer) is higher, leading to a higher relative biologic effectiveness (RBE), which translates into more DNA double strand breaks within the target cells. The higher RBE of CIT makes it especially important in the management of radioresistant cancers, such as hypoxic tumors, locally recurrent tumors and specific histologies, like sarcomas, adenoid cystic carcinomas and non-small cell lung cancer.

Currently, carbon ion therapy is offered at centers in Japan, China, Germany, Austria and Italy. Carbon ion therapy has most often been used to treat unresectable bone and soft tissue sarcomas, prostate cancer, hepatocellular carcinomas, recurrent rectal cancer, pancreatic cancer, non-squamous head and neck cancers, lung cancer and high-grade gliomas. However, it is being explored in the management of several other types of cancers and may be more effective in priming the immune system to establish an abscopal effect.

The integrative oncology building on the Mayo Clinic Jacksonville campus will be the new home for the Department of Radiation Oncology with linear accelerators, two proton gantries and a carbon ion fixed beam room. It is expected to be completed in 2024, with the first proton patients treated in 2025 and the first carbon ion therapy patients in 2027.

In preparation for the expansion, Mayo Clinic investigators are developing collaborations with other carbon ion centers to conduct pre-clinical research projects to better understand the physics and radiobiology of carbon ion therapy. They are also working together to develop comparative effectiveness research studies to better qualify the benefits of carbon ion therapy over other treatment approaches. Additionally, over the next few years Mayo Clinic will develop phase I/II trials, which will be ready to launch once carbon ion therapy is ready for clinical use.

Bradford Hoppe MD, MPH is professor of Radiation Oncology and the medical director of Particle Therapy at Mayo Clinic in Jacksonville, Florida.

WHAT'S NEW IN THE LAB

Synopses of current research underway in labs at Yale University and the University of Chicago

Cancer Metabolism and DNA Repair

BY RANJIT BINDRA, MD, PHD

THE BINDRA LABORATORY is focused on the development of synthetic lethal targeting strategies to treat a wide range of cancers. We are particularly interested in developing tumor-selective radio- and chemo-sensitizers, using inhibitors of both DNA repair and cellular metabolism. In addition, our group is interested in novel, nanoparticle-based drug delivery strategies to bypass the blood-brain barrier and to allow more efficacious drug combinations.

Our group recently made the seminal discovery that oncometabolites induce a BRCAness state, which can be exploited by PARP inhibitors. This work was published in Science Translational Medicine and Nature Genetics. Most recently, we have further elucidated the mechanistic basis for mutant IDH1/2-induced BRCAness, and this work was published recently in Nature.

We have also identified two novel synthetic lethal interactions in recent work: DIPG-associated PPM1D mutations confer exquisite NAMPT inhibitor (NAMPTi) sensitivity via NAPRT silencing, and loss of MGMT confers synergistic tumor cell killing with ATR inhibitor and TMZ combinations. These two studies were published in Nature Communications and Cancer Research, respectively.

A unique feature of our program is that we actively translate our work from the laboratory directly into investigator-initiated (IIT) phase I/II trials. To this end, we recently designed and executed a phase I trial in glioma, which tested a DNA repair inhibitor that our laboratory identified in a high-throughput drug screen. This trial included a phase 0 component, in which we assessed CNS penetration of the drug. I am also the PI or co-PI of three biomarker-driven phase I/II trials, which are testing the use of PARP inhibitors against IDH1/2-mutant gliomas and other solid tumors, based our group's discoveries above.

Ranjit Bindra, MD, PhD, is a physician-scientist at the Yale School of Medicine. He is a professor of Therapeutic Radiology and co-director of the Yale Brain Tumor Center.

Biological Basis for Oligometastasis

BY SEAN PITRODA, MD

THE PITRODA LABORATORY is working toward improving the treatment of metastatic disease through translational research. Our current investigations specifically pertain to establishing the molecular basis for curable metastatic disease — termed oligometastasis — with a particular emphasis on tumor-host interactions that influence metastatic proclivity. We believe these investigations will have important implications in the discovery of novel biomarkers and targets used for personalization of cancer treatment.

We utilized integrated molecular subtyping to define the metastatic spectrum of colorectal liver metastases, which predicted clinical outcomes for patients who underwent surgical resection of limited de novo liver metastases independently of established clinical and pathological factors. Importantly, this work identified a curable oligometastatic subset of patients with an immune-activated phenotype that achieved a 95% survival at 10 years following surgical metastasectomy. This study was published in Nature Communications and reviewed in Nature Reviews Clinical Oncology and Journal of Clinical Oncology. Our present work examines the mechanisms that lead to failed immune activation and poor prognoses in clinical metastases.

In concert with investigating the biological mechanisms that govern immune evasion in clinical metastases, we are investigating translational biomarkers that predict immunotherapy responses in

patients with metastatic cancers. Building upon our recent work on the intratumoral interactions of radiotherapy and immunotherapy in patients with metastatic disease published in Clinical Cancer Research and reviewed in Lancet Oncology, I was given a Career Development Award from the LUNGevity Foundation to characterize tumor and host determinants as they relate to the survival of non-small cell lung cancer patients treated with ablative radiotherapy combined with immune checkpoint inhibitors. We anticipate these findings will ultimately have important implications in the delineation of those patients with potentially curable metastatic disease from those whose few metastases are part of a large cascade of widespread disease, thereby advancing the paradigm for the treatment of metastatic cancers.

Sean Pitroda, MD, is jointly appointed as an assistant professor in the Department of Radiation and Cellular Oncology and Committee on Cancer Biology. He also serves as a principal investigator in the Ludwig Center for Metastasis Research at the University of Chicago.

Radiation-Immunotherapy Interactions

BY RALPH WEICHSELBAUM, MD, PHD

THE WEICHSELBAUM LABORATORY investigates the importance of host anti-tumor immunity in the response to radiotherapy. Specifically, we study the effects of immune cell populations and commensal microbiota on the anti-tumor effects of ionizing radiation. Ultimately, our group is interested in novel mechanisms to abrogate resistance to radiotherapy by alleviating immunosuppression generated by particular immune cells or microbiota.

Our group recently made a discovery using longitudinal in vivo imaging and functional analyses that tumor-resident T cells are reprogrammed by the tumor microenvironment to promote survival after ablative doses of radiotherapy. Our studies identified TGFβ as a critical regulator of T cell reprogramming of intratumoral T cells. This work was published in Nature Communications.

In addition, we identified two novel mechanisms by which the commensal microbiota impact the anti-tumor immune responses to radiotherapy. In one study, we found that accumulation of the anaerobic *Bifidobacterium* within the tumor microenvironment converted non-responder mice into responders by inducing type I interferon-STING signaling and increasing dendritic cell cross-priming in the response to anti-CD47 immunotherapy. In an independent study, we showed that depletion of gut *Lachnospiraceae* through oral vancomycin administration decreased systemic and intratumoral butyric acid levels and augmented type I interferon-STING signaling by promoting a cytotoxic T cell immune response, which improved the efficacy of radiotherapy. These two studies were published in the Journal of Experimental Medicine.

More recently, we identified a previously unknown abscopal mechanism of local tumor irradiation, which synergized with systemic anti-PD-L1 immunotherapy to kill tumor-induced Ter cells. Ter cells are erythroid progenitor cells that promote tumor progression by secreting artemin, a neurotropic peptide that activates RET signaling. Importantly, we found that a decrease in the Ter cell-artemin axis was associated with favorable treatment responses to radiotherapy, immune checkpoint blockade or the combination in patients with advanced or metastatic solid tumors. This study was published in Science Translational Medicine. Collectively, these studies have elucidated novel strategies to target immune cell populations and commensal microbiota to decrease immune suppression and resistance to radiotherapy and immune checkpoint blockade.

Ralph Weichselbaum, MD, PhD, is currently the Daniel K. Ludwig Distinguished Service Professor and chairman of the Department of Radiation and Cellular Oncology and co-director of the Ludwig Center for Metastasis Research at the University of Chicago.

NRG ONCOLOGY

Advancing Research. Improving Lives.™

RESEARCH OPPORTUNITIES IN NRG ONCOLOGY

BY WALTER J. CURRAN JR., MD, AND MITCHELL MACHTAY, MD, FASTRO

What is NRG Oncology?

NRG Oncology (NRG) is one of five national cancer cooperative groups currently funded by the National Cancer Institute (NCI) as part of the National Clinical Trials Network (NCTN). NCI's support was launched in March 2014 following the NCI-directed reorganization of its cancer cooperative group system conducted between 2011 and 2014. This reorganization reduced the number of groups from 10 to five and enabled three of the legacy groups to form NRG. These groups were the National Surgical Adjuvant Breast and Bowel Project (NSABP), the Radiation Therapy Oncology Group (RTOG) and the Gynecologic Oncology Group (GOG).

NRG's mission is to improve the duration and quality of life of adults with specific cancers by conducting science-driven, NCI-supported multi-institutional clinical trials. NRG is particularly concerned with patients with gender-defined malignancies, including gynecologic, breast and prostate cancer, and in research affecting management of patients with a broad variety of localized or locally advanced solid tumors. This mission and the focused approach to specific patient subgroups is based on the strengths of NRG's members and leaders and build on the strengths of NRG's three legacy cooperative groups.

Learn more about the NRG's work and how you can participate by reading the full article online at www.astro.org/Spring21news.

HIGHLIGHTS OF CUTTING-EDGE NRG STUDIES UNDERWAY

Below are just some of the important trials and research underway with NRG Oncology. Summaries were provided by the disease site committee leaders and members. For additional summaries, disease sites and more details, read the article in full at www.astro.org/Spring21news.

Lung

NRG-LU002 and NRG-LU005

Jeffrey Bradley, MD, FASTRO, chair, Lung Cancer Committee, NRG Oncology

The NRG Oncology Lung Cancer Committee has 11 ongoing trials. We will focus on two trials today: NRG LU002 and NRG LU005. LU002 is a phase II/III for patients with oligometastatic non-small cell lung cancer (NSCLC) who are receiving systemic therapy (chemo, immuno or both). After systemic therapy, patients are randomized to +/- radiation therapy to residual disease. As we see more referrals for patients with oligometastatic NSCLC in radiation oncology, we need to definitely answer this question. NRG/Alliance LU-005 is a phase II/III randomized trial for patients with limited-stage small cell lung cancer (LS-SCLC). LU-005 randomizes LS-SCLC patients to chemoradiation +/- atezolizumab. This trial is actually accruing ahead of schedule despite the pandemic.

Head and Neck

NRG-HN005 and NRG-HN004

Quynh-Thu Le, MD, FASTRO, chair, Head and Neck Cancer Committee, NRG Oncology

NRG-HN005 is a phase II trial leading into a phase III extension for p16 positive oropharyngeal cancer. The standard arm is 70 Gy in 35 fractions/6 weeks combined with only two cycles of high-dose cisplatin. Two experimental arms are tested in the initial phase II component, 60 Gy in 30 fractions with two cycles of cisplatin or 60 Gy/5 weeks and combined with six cycles of nivolumab. NRG-HN005 asks how can we mitigate the toxicity of head and neck irradiation in patients who may live a long time. NRG-HN004 is a phase II/III trial for patients with locoregionally advanced head and neck cancer who have a contraindication to cisplatin and presents an opportunity to clarify the role of immune checkpoint inhibitors in this group of patients. Eligible patients are randomized 2:1 to either experimental therapy or standard therapy. Standard therapy consists of 70 Gy in 35 fractions/7 weeks with concurrent cetuximab (EGF-R inhibitor). Experimental therapy consists of the same RT schedule plus durvalumab (PD-L1 inhibitor). The phase III primary endpoint is overall survival.

Gynecologic

NRG-GY017

Jyoti Mayadev, MD. vice-chair, Cervix/Vulva Cancer Subcommittee, NRG Oncology

Women with node-positive, locally advanced cervical cancer who participate on NRG-GY017 will be randomly assigned to one of two potential treatment arms. Participants on treatment arm one will receive atezolizumab then, if there is no disease progression or unacceptable toxicity, patients will begin to receive concurrent atezolizumab, cisplatin chemotherapy and the standard of care radiotherapy with image-guided brachytherapy. Participants on treatment arm two will receive concurrent atezolizumab, cisplatin chemotherapy and standard of care radiotherapy.

"This trial is of paramount importance to understand the optimal sequencing and underlying immune mechanism when immunotherapy is added to the standard of care chemoradiation in locally advanced cervical cancer," said the trial's study chairs, Jyoti Mayadev, MD, Russell Schilder, MD, and Dmitiry Zamarin, MD, PhD.

Genitourinary

NRG-GU006 and NRG-GU009

Felix Feng, MD, chair, Genitourinary Cancer Committee, NRG Oncology

Over the last few years, the NRG GU group has focused on incorporating novel biomarkers and therapeutics into randomized trials. We just finished accruing to NRG-GU006 (BALANCE), a trial for patients with PSA recurrences after surgery, which stratified patients by a potential predictive biomarker of response to hormone therapy (the PAM50 panel) prior to randomization to radiation +/- the next-generation anti-androgen apalutamide. We recently activated NRG-GU009 (PREDICT-RT), a 2,478 patient phase III study for patients with high-risk prostate cancer by NCCN criteria. GU009 selects patients based on their Decipher score for a randomized trial of treatment intensification (high Decipher score) or treatment de-intensification (low Decipher score). Patients enrolled will have free access to a genomic test, to next generation androgen-directed therapies (on the intensification arm), and to advanced PET imaging approaches (on an optional imaging substudy).

Gastrointestinal

NRG-GI006 and NRG-GI003

Ted Hong, MD, chair, GI Cancer Committee, Non-colorectal Cancer, NRG Oncology

NRG-GI006 is a phase III study comparing proton beam therapy versus intensity-modulated photon therapy in the treatment of esophageal cancer. This study builds upon a phase II study showing a decrease in total toxicity burden with protons compared to photons in patients with esophageal cancer. The hypothesis is that survival can be improved with protons by mitigation of toxicity but also through preservation of immune function through decreased radiation-induced lymphopenia. NRG-GI003 is a phase III study evaluating protons versus photons for hepatocellular carcinoma. The key hypothesis is that the lack of exit dose with protons may decrease rates of hepatic compensation after liver-directed radiation. Both studies seek to provide level 1 evidence regarding the utility of protons in these two difficult to treat disease sites with innovative biological hypotheses.

Brain

NRG-BN001 and NRG-BN005

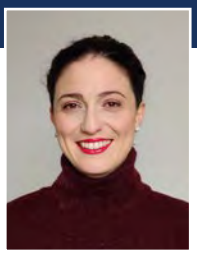
Minesh Mehta, MD, FASTRO chair, Brain Tumor Committee, NRG Oncology

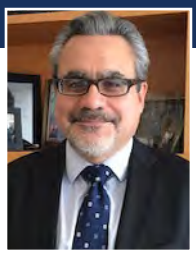
These trials represent examples of efforts to generate and develop level 1 evidence for proton therapy. NRG-BN001 is premised on the hypothesis that circulating lymphocytes represent an organ-at-risk and that daily partial volume brain irradiation contributes to acute significant lymphopenia, which in other clinical series has been associated with inferior outcomes in GBM. The unique aspect of this trial is the testing of a biological/immunological mechanism driving differences between proton and photon radiotherapy. NRG-BN005 is testing whether IMPT would result in superior neurocognitive outcomes compared to IMRT in IDH-mutant WHO grades 2/3 gliomas treated with combinatorial radiotherapy-chemotherapy. This trial is early in its accrual phase and could use the assistance of ASTRO membership to promote the trial and recommend suitable patients for trial participation.

Read more at www.astro.org/Spring21news.

FLASH RADIOTHERAPY: ARE WE READY FOR CLINICAL TRANSLATION?

BY ANASTASIA VELALOPOULOU, PHD, AND CONSTANTINOS KOUMENIS, PHD





WHEN THE TERM "FLASH irradiation" (F-RT) was introduced by the Vozenin and Favaudon groups in 2014 to describe the sparing of normal tissues by ultra-high dose rates of radiation,[1] it was difficult to foresee the rapid advances that would follow in this field.[2-7] Remarkably, just over six years later, this new technology is being tested in human clinical trials. In November 2020, the Cincinnati Children's/UC Health Proton Therapy Center launched the world's first clinical trial of FLASH Proton RT (F-PRT). It will assess whether F-PRT will ease the pain caused by bone metastases equivalently to standard proton radiotherapy (S-PRT) while abating the occurrence of side effects. Below, we highlight some of the key milestones and briefly address some of the challenges in this new, burgeoning field.

FLASH radiation is defined as the delivery of high doses (>10Gy)[6] at ultra-high dose rates (>40 Gy/s),[6] which far exceed standard dose rates used in the clinic (1-10 Gy/min). The first observation of the "FLASH effect" dates back to the 1960s when single, nanosecond pulses protected cell survival compared to S-RT treatment (100 rads/min).[8]

Despite the tremendous progress in conformational radiotherapy, incidental damage to critical normal tissues remains a major limitation for optimal clinical effectiveness. Therefore, a great deal of excitement was generated when F-RT (≥40 Gy/s) showed protection of the mouse lung from fibrosis when compared to S-RT (≤0.03 Gy/s).[1] Fouillade and collaborators recently extended these results showing amelioration of DNA damage, lung progenitor cell damage and replicative senescence by F-RT.[9] Besides the lung, a variety of other organs spared by the "FLASH effect" includes the brain, intestine and skin.[10-17]

It is quite encouraging that the "FLASH effect" is also seen in animal models closer to humans. When F-RT (300 Gy/s) or S-RT (0.083 Gy/s) were delivered on mini-pig skin at 22-34Gy, no severe radiation-induced cutaneous manifestations were recorded on the F-RT treated skin. The same group conducted a clinical, phase I, single-dose escalation trial (25-41 Gy) with feline patients bearing T2/T3N0M0 squamous cell carcinoma. Interestingly, 50% of the felines presented only depilated skin, whereas the rest developed mild acute mucositis/dermatitis but with no long-term complications.[16]

Clinical implementation of FLASH radiation could benefit multiple malignancies, but especially pediatric brain tumors, where the development of neurocognitive side effects after radiation is a major problem for long-term pediatric cancer survivors. A recent study on radiosensitive juvenile mouse brains appears to confirm the ability of F-RT to alleviate radiation-induced deterioration of behavioral performance, changes in mature and immature neurons and neuroinflammation when compared to S-RT.[12]

Radiation modality will be an important consideration for the future of F-RT. Electron beams are mostly suitable for the treatment of superficial tumors due to their limited tissue penetration and internal scatter.[18] Moreover, LINACs delivering photon radiation cannot reach the energies required for FLASH effects, at least in their current configurations.[19] Conversely, proton beam therapy is highly efficient in targeting deep-seated human tumors. Diffenderfer and colleagues were the first to report the normal tissue sparing effects of FLASH proton therapy in intestinal tissues.[15] Levy and collaborators recently confirmed sparing of abdomen toxicity by F-PRT.[14] These results and the aforementioned clinical trial have propelled F-PRT forward in the field.

A key question in the field remains unanswered: What are the biophysical mechanisms that explain the differential tissue effects for F-RT? The theoretical models currently under investigation include: (a) the rapid depletion of oxygen and radical–radical reactions resulting in a transient tissue hypoxia[20-23] and (b) altered epithelial and immune responses.[9, 24-25] Recent studies have employed simulations and modeling of salient physicochemical parameters considered to be involved in the oxygen depletion paradigm.[26-30] Moreover, FLASH (18Gy, 600 Gy/s) significantly spares prostate cancer cells from death at oxygen concentrations of 1.6% and 4.4% as compared to S-RT (18Gy, 14 Gy/min). The "FLASH effect" disappears at higher oxygen concentrations.[31]

The standardization of delivery methods of F-RT

will be another major hurdle regardless of the employed modality. A coordinated effort to address this issue was recently initiated by 16 participating institutions.[32] Schuller and co-authors present an approach to design precise measurements that will develop attested reference standards relevant to the SI unit system and reference dosimetry methods.[32] These efforts should allow comparison of the experimental settings across labs and clinics as well as secure the cost-effectiveness of F-RT.

In conclusion, FLASH radiation represents one of the most exciting developments in radiation biology and therapy over the past two decades. Broader implementation will require carefully designed, definitive trials to answer these key questions: Is the "FLASH effect" retained in hypofractionation schemes, or is a single dose more optimal? Can autochthonous and larger sized human tumors be effectively controlled with F-RT? Is the impact of F-RT similar across different types of normal tissues (e.g., skin, gut epithelium, cardiac, neuronal etc.)?

Anastasia Velalopoulou, PhD, is a senior postdoctoral scientist in the Department of Radiation Oncology at the University of Pennsylvania.

Constantinos Koumenis, PhD, is the Richard Chamberlain Professor, Research Division director and vice-chair for research in the Department of Radiation Oncology at the University of Pennsylvania.

References

1 Favaudon V, Caplier L, Monceau V, et al. Ultrahigh dose-rate FLASH irradiation increases the differential response between normal and tumor tissue in mice. *Sci Transl Med*. 2014;6:245ra93.
2 Hughes JR, Parsons JL. FLASH Radiotherapy: Current Knowledge and Future Insights Using Proton-Beam Therapy. *Int J Mol Sci*. 2020;21.
3 Esplen NM, Mendonca MS, Bazalova-Carter M. Physics and biology of ultrahigh dose-rate (FLASH) radiotherapy: a topical review. *Phys Med Biol.* 2020.
4 de Kruijff RM. FLASH radiotherapy: ultra-high dose rates to spare healthy tissue. *Int J Radiat Biol.* 2020;96:419-423.
5 Wilson JD, Hammond EM, Higgins GS, et al. Ultra-High Dose Rate (FLASH) Radiotherapy: Silver Bullet or Fool's Gold? *Front Oncol.* 2019;9:1563.
6 Vozenin MC, Hendry JH, Limoli CL. Biological Benefits of Ultra-high Dose Rate FLASH Radiotherapy: Sleeping Beauty Awoken. *Clin Oncol* (R Coll Radiol). 2019;31:407-415.
7 Omyan G, Musa AE, Shabeeb D, et al. Efficacy and toxicity of FLASH radiotherapy: A systematic review. *J Cancer Res Ther.* 2020;16:1203-1209.
8 Berry RJ, Hall EJ, Forster DW, et al. Survival of mammalian cells exposed to x rays at ultra-high dose-rates. *Br J Radiol.* 1969;42:102-7.
9 Fouillade C, Curras-Alonso S, Giuranno L, et al. FLASH Irradiation Spares Lung Progenitor Cells and Limits the Incidence of Radio-induced Senescence. *Clin Cancer Res*. 2020;26:1497-1506.
10 Simmons DA, Lartey FM, Schuler E, et al. Reduced cognitive deficits after FLASH irradiation of whole mouse brain are associated with less hippocampal dendritic spine loss and neuroinflammation. *Radiother Oncol.* 2019;139:4-10.
11 Montay-Gruel P, Bouchet A, Jaccard M, et al. X-rays can trigger the FLASH effect: Ultra-high dose-rate synchrotron light source prevents normal brain injury after whole brain irradiation in mice. *Radiother Oncol.* 2018;129:582-588.
12 Alaghband Y, Cheeks SN, Allen BD, et al. Neuroprotection of Radiosensitive Juvenile Mice by Ultra-High Dose Rate FLASH Irradiation. *Cancers* (Basel) 2020;12.
13 Montay-Gruel P, Acharya MM, Petersson K, et al. Long-term neurocognitive benefits of FLASH radiotherapy driven by reduced reactive oxygen species. *Proc Natl Acad Sci. USA* 2019;116:10943-10951.
14 Levy K, Natarajan S, Wang J, et al. Abdominal FLASH irradiation reduces radiation-induced gastrointestinal toxicity for the treatment of ovarian cancer in mice. *Sci Rep.* 2020;10:21600.
15 Diffenderfer ES, Verginadis, II, Kim MM, et al. Design, Implementation, and in Vivo Validation of a Novel Proton FLASH Radiation Therapy System. *Int J Radiat Oncol Biol Phys.* 2020;106:440-448.
16 Vozenin MC, De Fornel P, Petersson K, et al. The Advantage of FLASH Radiotherapy Confirmed in Mini-pig and Cat-cancer Patients. *Clin Cancer Res.* 2019;25:35-42.
17 Huang CC, Mendonca MS. News FLASH-RT: To Treat GBM and Spare Cognition, Fraction Size and Total Dose Matter. *Clin Cancer Res.* 2021;27:662-664.
18 Montay-Gruel P, Meziani L, Yakkala C, et al. Expanding the therapeutic index of radiation therapy by normal tissue protection. *Br J Radiol.* 2019;92:20180008.
19 Maxim PG, Tantawi SG, Loo BW, Jr. PHASER: A platform for clinical translation of FLASH cancer radiotherapy. *Radiother Oncol.* 2019;139:28-33.
20 Wardman P. Radiotherapy Using High-Intensity Pulsed Radiation Beams (FLASH): A Radiation-Chemical Perspective. *Radiat Res.* 2020;194:607-617.
21 Spitz DR, Buettner GR, Petronek MS, et al. An integrated physico-chemical approach for explaining the differential impact of FLASH versus conventional dose rate irradiation on cancer and normal tissue responses. *Radiother Oncol.* 2019;139:23-27.
22 Pratx G, Kapp DS. Ultra-High-Dose-Rate FLASH Irradiation May Spare Hypoxic Stem Cell Niches in Normal Tissues. *Int J Radiat Oncol Biol Phys.* 2019;105:190-192.
23 Koch CJ. Re: Differential impact of FLASH versus conventional dose rate irradiation: Spitz et al. *Radiother Oncol.* 2019;139:62-63.
24 Jin JY, Gu A, Wang W, et al. Ultra-high dose rate effect on circulating immune cells: A potential mechanism for FLASH effect? *Radiother Oncol.* 2020;149:55-62.
25 Buonanno M, Grilj V, Brenner DJ. Biological effects in normal cells exposed to FLASH dose rate protons. *Radiother Oncol.* 2019;139:51-55.
26 Rothwell BC, Kirkby NF, Merchant MJ, et al. Determining the parameter space for effective oxygen depletion for FLASH radiation therapy. *Phys Med Biol.* 2021.
27 Lai Y, Jia X, Chi Y. Modeling the effect of oxygen on the chemical stage of water radiolysis using GPU-based microscopic Monte Carlo simulations, with an application in FLASH radiotherapy. *Phys Med Biol.* 2021;66:025004.
28 Labarbe R, Hotoiu L, Barbier J, et al. A physicochemical model of reaction kinetics supports peroxyl radical recombination as the main determinant of the FLASH effect. *Radiother Oncol.* 2020;153:303-310.
29 Jay-Gerin JP. Ultra-high dose-rate (FLASH) radiotherapy: Generation of early, transient, strongly acidic spikes in the irradiated tumor environment. *Cancer Radiother.* 2020;24:332-334.
30 Abolfath R, Grosshans D, Mohan R. Oxygen depletion in FLASH ultra-high-dose-rate radiotherapy: A molecular dynamics simulation. *Med Phys.* 2020;47:6551-6561.
31 Adrian G, Konradsson E, Lempart M, et al. The FLASH effect depends on oxygen concentration. *Br J Radiol.* 2020;93:20190702.
32 Schuller A, Heinrich S, Fouillade C, et al. The European Joint Research Project UHDpulse - Metrology for advanced radiotherapy using particle beams with ultra-high pulse dose rates. *Phys Med.* 2020;80:134-150.

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ASTRO 2020 ANNUAL MEETING: THE REVIEW

What worked, what didn't and what's here to stay for virtual meetings

BY NINA TAYLOR, MA, ASTRO VICE PRESIDENT OF LEARNING & EDUCATION

IN EDUCATION AND TRAINING

AGAINST THE BACKDROP of the COVID-19 pandemic, many medical specialty societies found themselves in a scramble to change course and re-imagine education that would have been conducted in a live setting. Live education events that, in many cases, were at various stages in the planning cycle, from completed site visits in exciting and bustling host cities to room selections in spacious, newly redesigned convention centers, from completed multi-hotel contract negotiations to, in the case of ASTRO's 2019 Annual Refresher Course, a meeting in final tie-down with two weeks to showtime. The pandemic removed an entire learning format, live education, and replaced it with one that took social distancing into extreme consideration.

Virtual learning has its upsides and is a familiar territory to ASTRO, with the rollout of the ASTRO Academy more than three years ago. The ASTRO Education team, in collaboration with the Education Committee, set their focus on the development of original content, leaning into new formats, educational designs that were engaging and personalized education on topics that were timely with a strong focus on skills-based learning.

What worked? The overall virtual show design, for one. Attendees of the Annual Meeting enjoyed our show look; opting for a dynamic virtual environment over a static environment was the right call. We gave this significant consideration, given when the Annual Meeting was scheduled on the calendar, as we felt attendees would have online meeting fatigue by October. We also wanted to bring the look of the show online to keep the feel of the ASTRO Annual Meeting, with it being the largest gathering of radiation oncologists in the world.

Opting for a tablet-like game display with a click and play experience, content was organized like the live meeting and no content was reduced from the live meeting experience. Planners were able to increase the number of offerings of popular sessions, like Cancer Breakthroughs, which increased from one session to four, and, after a conversation with the Annual Meeting Program Committee about their virtual annual meeting experiences, the addition of more Science Highlight sessions. New experiences, like Master Classes, focused on skills-based education, including leadership and communication.

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And novel features, such as narration for posters, were leveraged with over 50% of virtual poster presenters taking advantage of the innovative technology.

The Annual Meeting general evaluation suggests that attendees felt overall satisfaction and that their expectations were met: 89% of respondents were satisfied and 92% of respondents' expectations were met or exceeded, with 41% reporting "exceeded," which is 10% higher than the 2019 live meeting in Chicago. The evaluation confirmed the ease of use and how attendees felt comfortable learning online, as both satisfaction with the content presented and the respondents' willingness to make a change at their practice remained unchanged from 2019.

> "The pandemic removed an entire learning format, live education, and replaced it with one that took social distancing into extreme consideration."

Additionally, attending educational sessions, learning about the latest science, technology and treatment and obtaining Continuing Medical Education credit were the main reasons for attendance in 2020, which also remains unchanged from 2019. An interesting change is the increased focus in physician to patient communication and collaboration with treatment team members in 2020 over 2019. The virtual experiences allowed for increased accessibility and inclusion of additional content, and it also improved learning outcomes in ways not possible in person, with content available 24 hours a day for 30 days. Allowing learners to avoid rushing between sessions and increasing access to quality speakers and content drove increased satisfaction.

An additional bonus was the cost savings of not having to pay for travel or lodging. We saw an increase in the number of medical students attending the virtual meeting over the live meeting, and we think that was due to the financial savings. The social media engagement from the Annual Meeting exceeded that of the in-person meeting, even with fewer attendees.

Not all aspects of the virtual meeting were complete hits. The concept of a divergent and interactive Exhibit Hall did not seem to be an attractive draw for attendees. Virtual exhibit halls are a new concept, not tested as widely as virtual learning or interacting in a poll. However, growth opportunities were presented as traction increased in virtual exhibitions post-ASTRO 2020. Similarly, attendees felt that the networking opportunities fell flat. While there were 37 dedicated networking chats and some sessions with question-and-answer capabilities, nothing quite replaces face-to-face interactions in the eyes of our attendees.

The future of virtual learning continues to be bright, as presenters continue to make meaningful adjustments in how their content is presented, collaboration tools continue to be enhanced and scientific content is augmented with skills-based and public health knowledge. As we plan for our return to a live meeting, we will use many lessons learned from the 2020 virtual learning experience.

Nina Taylor, MA, is ASTRO's vice president of Learning and Education and oversees all educational offerings, including meetings, ASTRO Academy and live meeting logistics.

EDUCATION IN THE POST-COVID ERA: WHAT'S HERE TO STAY?

BY ELIZABETH B. JEANS, MED, MD, SHAUNA CAMPBELL, DO, AND JENNA KAHN, MD

Elizabeth B. Jeans, MEd, MD

Shauna Campbell, DO

Jenna Kahn, MD

AS VACCINATION ENDEAVORS continue across the globe, the time to contemplate a return to a new normalcy is apparent. Like in many professions, the COVID-19 pandemic brought about sudden changes in our day-to-day workflow. Abrupt changes in patient care, the training of residents and recruitment of new faculty and medical students were unique considerations of the medical field. It is time to consider what changes should remain in the post-pandemic era.

Residency education platforms

A unique consideration for radiation oncology training is the specialty's overall absence from medical school curricula. This, accompanied by the apprenticeship residency training model, made it apparent that amid the COVID-19 pandemic there was a dire need to continue rigorous resident didactics while minimizing in-person gatherings. From this notion, the rapid development of radiation oncology virtual learning occurred. Some of the most successful programs, such as Radiation Oncology Virtual Education Rotation (ROVER)[1] or the Virtual Visiting Professional Network (VVPN)[2] have brought experts in the field into a virtual platform with biweekly webinars and virtual learning for medical students and residents. While the concept of online learning by experts in the field is not novel and has been developed by the Association of Residents in Radiation Oncology (ARRO) Education Committee[3] for many years, virtual education engagement by the field has exponentially increased. Additionally, the pandemic brought about the development of virtual society conferences,[4] which has allowed for residents to attend irrespective of program travel budgets and eased additional burdens associated with in-person conferences.

Virtual educational platforms, including some components of virtual conferences, should remain in the post-pandemic era, as they level the educational milieu for residents. It will be important for residency programs to recognize these virtual initiatives as beneficial to resident education and provide protected time to attend these events. On an individual program level, each program will need to analyze whether virtual conferences should continue for daily didactics. While this has allowed for ease of attendance and convenience, there are concerns for reduced engagement of both learners and educators due to online learning burnout, increased distractions and attempts to multitask.

Medical student educational platforms, away rotations and interviews

Recruitment of medical students into radiation oncology came with specific difficulties this year, as prospective applicants were unable to participate in away rotations or in-person interviews. For years, educational tools for medical students, which also inadvertently promote recruitment into the field, have been developed by the Radiation Oncology Educational Collaborative Study Group (ROECSG)[5]; however, similarly to those for residents, investments into additional educational platforms, including virtual home and away rotations, has furthered this initiative.[1,6-9]

Educational platforms geared toward medical students should remain post-pandemic, as well as some component of virtual rotations, especially in the era of increased telehealth visits. Importantly, virtual rotations have improved inequities of away rotations while also providing any medical student the opportunity to acquire

Continued on following page

experience in radiation oncology. Components of virtual interviews should also remain, given their ability to decrease the inequities associated with required interview travel; however, applicants should be given an opportunity to visit in person, perhaps as a second look, to gain a better sense of the program's culture and the location.[10,11]

Resident job search

The results from ARRO's 2020 Graduating Resident Survey reported that of 179 resident respondents, 81% felt COVID-19 had not impacted their job search or job offers.[12] In 2020, 39% of respondents agreed that the job market was difficult.[12] It can be proposed that a far more significant impact will likely be reported in 2021, as the pandemic will have stretched the entire duration of the job search during 2020. While the trajectory of the job market is outside the scope of this article, data have demonstrated that senior residents overwhelmingly find their jobs through networking, such as direct contact, cold call or personal connections.[13] Given the limitations in virtual networking, careful examination and expansion into networking events — both in person or virtual — is crucial to offset any deficit made by the pandemic.

Similar to medical student interviews, virtual job interviews should remain in some capacity; however, post COVID-19, the in-person second interview should return, so applicants and practices can appropriately determine the best fit.

Conclusions

Many of the novel virtual education strategies born from the COVID-19 pandemic will be permanently adopted by radiation oncology programs and make significant progress in addressing the long-standing inequities that have plagued our specialty for years. The shift to virtual educational opportunities, for both residents and medical students, has resulted in improved access to expert led education and helped address disparities between residency programs. The adoption of virtual interviews, again at the resident and medical student level, has helped us critically evaluate if the personal and financial expenses associated with a first in-person interview is truly necessary. There are some components of education and recruitment that cannot be replaced by a virtual format, and these will likely return to in-person formats in the post-pandemic era. Before adopting a virtual-or-not mentality, we should strive to retain the positive components of virtual education and recruitment and integrate the in-person necessities when beneficial. Furthermore, given that the transition to virtual opportunities was hurried, maturation of data will be necessary to study long-term improvements or detriments from virtual opportunities for medical students and residents.

Elizabeth B. Jeans, MEd, MD, is a radiation oncology resident at the Mayo Clinic Rochester, Minnesota, and serves on the ARRO Executive Committee.

Shauna Campbell, DO, is a PGY-5 resident at Cleveland Clinic and chair of the ARRO Executive Committee.

Jenna Kahn, MD, is a radiation oncologist at Oregon Health and Science University in Portland, Oregon, and serves as vice-chair on the ASTRO Communications Committee.

References

1 Virtual Radiation Oncology for Medical Students. Accessed February 2, 2021. https://www.radoncvirtual.com/rover
2 Kavanagh BD, Doke K. The Virtual Visiting Professor: A Step Toward a Parasocial Common Curriculum?. *Int J Radiat Oncol Biol Phys.* 2020;108(2):466-469. doi:10.1016/j.ijrobp.2020.06.045
3 ARRO Subcommittees. American Society for Radiation Oncology website. Accessed February 2, 2021. https://www.astro.org/Affiliate/ARRO/About-ARRO/ARRO-Subcommittees
4 Nelson BA, Lapen K, Schultz O, et al. The Radiation Oncology Education Collaborative Study Group 2020 Spring Symposium: Is Virtual the New Reality? [published online ahead of print, 2020 Dec 26]. *Int J Radiat Oncol Biol Phys.* 2020;S0360-3016(20)34691-5. doi:10.1016/j.ijrobp.2020.12.026
5 Jimenez RB, Johnson A, Padilla L, et al. The Impact of an Introductory Radiation Oncology Curriculum (IROC) for Radiation Oncology Trainees Across the United States and Canada. *Int J Radiat Oncol Biol Phys.* 2020;107(3):408-416. doi:10.1016/j.ijrobp.2020.02.015
6 Franco I, Oladeru OT, Saraf A, et al. Improving Diversity and Inclusion in the Post-Coronavirus Disease 2019 Era Through a Radiation Oncology Intensive Shadowing Experience (RISE). *Adv Radiat Oncol.* 2021;6(1):100566. doi:10.1016/j.adro.2020.09.006
7 Pollom EL, Sandhu N, Frank J, et al. Continuing Medical Student Education During the Coronavirus Disease 2019 (COVID-19) Pandemic: Development of a Virtual Radiation Oncology Clerkship. *Adv Radiat Oncol.* 2020;5(4):732-736. Published 2020 May 20. doi:10.1016/j.adro.2020.05.006
8 Sandhu N, Frank J, von Eyben R, et al. Virtual Radiation Oncology Clerkship During the COVID-19 Pandemic and Beyond. *Int J Radiat Oncol Biol Phys.* 2020;108(2):444-451. doi:10.1016/j.ijrobp.2020.06.050
9 Kahn JM, Fields EC, Pollom E, et al. Increasing Medical Student Engagement Through Virtual Rotations in Radiation Oncology. *Adv Radiat Oncol.* 2021;6(1):100538. doi:10.1016/j.adro.2020.07.015
10 Everett AS, Strickler S, Marcrom SR, McDonald AM. Students' Perspectives and Concerns for the 2020 to 2021 Radiation Oncology Interview Season. *Adv Radiat Oncol.* 2021;6(1):100554. doi:10.1016/j.adro.2020.08.011
11 Bates JE, De Leo AN, Malouff TD, et al. Resident Considerations for Virtual Interviews in Radiation Oncology: Perspectives from the Sunshine State [published online ahead of print, 2020 Oct 10]. *Adv Radiat Oncol.* 2020;10.1016/j.adro.2020.09.024. doi:10.1016/j.adro.2020.09.024
12 @ARRO_org. Graduating Resident Survey. Posted October 27, 2020. Accessed February 2, 2021. https://twitter.com/ARRO_org/status/1321148820768645121
13 Royce TJ, Doke K, Wall TJ. The Employment Experience of Recent Graduates From US Radiation Oncology Training Programs: The Practice Entry Survey Results From 2012 to 2017. *J Am Coll Radiol.* 2019;16(6):878-885. doi:10.1016/j.jacr.2018.11.021

BY PAUL E. WALLNER, DO, FASTRO, BRIAN J. DAVIS, MD, PHD, AND ANTHONY GERDEMAN, PHD

CHANGES IN AMERICAN BOARD OF RADIOLOGY EXAM DEVELOPMENT AND ADMINISTRATION

INITIAL CERTIFICATION (IC) qualifying (computer-based) and certifying (oral) exams (QEs and CEs) developed and administered by the ABR constantly evolve to mirror changes in clinical and basic science knowledge and practice. For decades, the logistics of these exams remained relatively unchanged. Computer-based exams were administered in geographically dispersed commercial test centers, and oral exams were administered in a Louisville, Kentucky, hotel and, more recently, in Tucson, Arizona. None of the venues was ideal.

The computer-based exams required increasingly greater IT capacity to support significant image storage and retrieval requirements, but the commercial vendor administering these tests could not commit to necessary upgrades. The exam development software used by volunteer item writers and internal ABR editors, psychometricians and development staff was cumbersome, but it was a copyrighted product of the test center vendor. As a small and infrequent user of commercial test center spaces, the ABR had little ability to reserve administration dates that might have been favored by residents and candidates.

Administration of the oral exams posed a different set of challenges. As airline flight schedules declined in smaller markets, access to Louisville and Tucson became more difficult. Discontinuation of the oral exams in diagnostic radiology (DR) in 2015 significantly reduced the overall number of hotel rooms/nights required and, thus, the Board's ability to negotiate favorable room dates and rates for the three ABR disciplines continuing to administer oral exams for radiation oncology, interventional radiology/diagnostic radiology (IR/DR) and medical physics (MP). Furthermore, the practice of administering CEs in hotel rooms was increasingly viewed as unsuitable. When the Board discontinued the DR oral exams, they were replaced by an internally developed computer-based CE that was administered at test centers in Chicago and the ABR office in Tucson. This direct administration by the ABR was necessitated by the significant computer capacity required for the exams. When the ABR was faced with the postponement of the July 2020 RO QEs because of COVID-19, a decision was made to administer a final QE at the commercial sites in December 2020, but then to convert these exams to a remote platform that would enable candidates to use a site of their preference. The previous development of the DR exam enabled the RO conversion to this format at a much faster pace than had been envisioned prior to the pandemic.

Conversion of the oral CEs to a remote platform presented a different and unique set of challenges. Fourteen of the 24 American Board of Medical Specialties Member Boards have continued to administer oral exams, and none had previously employed a remote platform. Although there was active collaboration among the Member Boards in the development process, it soon became apparent that none had a product useful for the RO, IR/DR or MP exam needs, nor did a satisfactory commercial product exist. Thus, the ABR launched an all-hands effort that included exam development and administrative staff, IT hardware and software developers and many dedicated volunteers. A development process that had been estimated to require several years prior to the pandemic was now necessary to complete in an eight- to 10-month timeframe. At the outset of the process, all involved focused on a single set of overriding principles: The new platform must provide the most ideal candidate and examiner experience attainable but retain exam security, validity and credibility.

Every step of CE development has been subjected to multiple levels of scrutiny. As individual functions in software requirements were produced, each was tested frequently; and as new functions were added, they were tested in coordination with the previous iterations. In parallel with software development, separate teams focused on hardware specifications, content inventory, examiner requirements and scheduling. An increase in the number of exam sessions and candidates required additional exam case material. Initial consideration of staggering exam start and stop times to allow for the four continental U.S. time zones was considered but ultimately abandoned as being untenable. Exam security software providers were evaluated and selected.

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A "dry run" of the completed CE was tested in February 2021. This run-through involved only staff and senior volunteers and represented a test of all hardware and software elements. At the end of March, a pilot exam was administered over two days and included a limited number of candidates who volunteered and were selected by lottery. Seasoned examiners administered the pilot, with standard scoring. Volunteer candidates who pass the exam will become certified, and any who condition or fail will be able to take the exam later without prejudice or a record of their previous attempt. In May 2021, the full cohort of candidates who were eligible to take the CE in May 2020 will be able to take the new exam.

The new remote QEs will be available to 2020-eligible residents and candidates in April, with a second administration for those eligible in 2021 in August. A second administration of the CEs will be in September for those candidates originally eligible to take the exams in 2021. Subsequent to 2021, the Board will return to single annual administrations of the QEs and CEs.

The ABR fully recognizes the temporal inconveniences, employment implications and stress produced by the global pandemic on residents and candidates and the Board's subsequent need for exam postponement and reorientation. We appreciate the patience and efforts of all involved.

Continued from **CHAIR'S UPDATE**

repetition of efforts, i.e., reinventing the wheel. This is a nascent endeavor, one that, it is hoped, will serve as a vehicle for regular communication and brainstorming (re: global oncology issues), with leadership rotating among the member societies. ASTRO has already signaled their interest in participating and a willingness to accept the responsibilities that come with leading a diverse specialty society with membership from 87 countries. We have been presented with a moral opportunity to lead on the big stage with a real chance to effect meaningful change.

ASTRO's greatest asset is you, our members. That assertion is what prompted the authors of the Lancet Oncology Commission's 2015 paper, which I have often cited, to conclude that "Professional associations have an important role in expanding worldwide access to radiotherapy through education, training, setting quality standards, disseminating knowledge and evidence, and planning of human and other resource needs. There is an urgent need for global collective action and for the professional societies to work together more effectively to accelerate the progress in expanding worldwide access to radiotherapy." Much has been done over the past year to coordinate and facilitate access to cancer care, but the heavy lifting has just begun. This is an exciting time in global oncology! Consider sharing your time, treasure and talent. A gratifying experience awaits.

CORPORATE AMBASSADORS

ASTRO PROUDLY RECOGNIZES THE ONGOING COMMITMENT OF OUR CORPORATE AMBASSADORS FOR THEIR OUTSTANDING YEAR-ROUND LEADERSHIP AND PROMOTIONAL SUPPORT OF RADIATION ONCOLOGY.

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BY PAUL E. WALLNER, DO, FASTRO, ON BEHALF OF THE ASTRO HISTORY COMMITTEE (CHAIR: NAOMI R. SCHECHTER, MD)

GIANTS OF RADIATION ONCOLOGY

Biographical sketches from the ASTRO History Committee

GILBERT H. FLETCHER, MD (1911-1992)

In the post-World War II era, radiation oncology emerged as a discipline independent of diagnostic radiology. Led by a small cohort of physician-scientists, the specialty began to create dedicated clinical departments and training programs and a more robust scientific foundation. Among the most noteworthy of this early group of pioneers was Gilbert Fletcher, MD. Dr Fletcher was born in France, but with an American father and French mother held American citizenship from birth. In the spirit of classical European education, he received significant training in Latin, Greek, civil engineering, physics, mathematics and medicine. This background served him, and radiation oncology, well in later years. He emigrated to the U.S. permanently in 1942 to complete his medical training, initially serving an internship in obstetrics and gynecology and then a residency in radiology in New York City. In 1945, he was commissioned a captain in the U.S. Army. Following his discharge in 1947, he remained in Europe for a year to spend time at cancer hospitals in London and Paris. In 1948, he was recruited to develop a radiology department at the new MD Anderson (MDA) Hospital and Tumor Institute in Houston, where he would remain for the remainder of his career. Dr. Fletcher retired from his administrative duties at MDA in 1981, at the age of 70, but continued to remain active in clinical care, education and research until his death 11 years later. In his early years at MDA, Dr. Fletcher practiced general radiology but progressively moved into radiation oncology, where he used his background in physics, mathematics and engineering to develop a more precise and logical approach to the field. He was a pioneer in strategizing the concepts of dose-response of varying tumor volumes and tissue types, in the management of subclinical disease and in the design of the first cobalt-60 devices introduced into the U.S., as well as the appropriate use of high-energy X-rays and electrons. With his colleagues Luis Delclos, MD, FASTRO, and Herman Suit, MD, MSc, PhD, FASTRO, he designed the Fletcher-Suit-Delclos intracavitary applicators that were the basic brachytherapy devices used in gynecologic malignancies for decades.

Gilbert Fletcher, MD, (center) examining a patient.

Fletcher's Textbook of Radiotherapy remained the definitive resource for the specialty for several generations of radiation oncologists, and along with his outstanding teaching skills and acolytes, remains an enduring legacy. His more than 300 trainees have gone on to leadership positions within the specialty, and as a demonstration of their admiration and appreciation, in 1975, established the Gilbert H. Fletcher Society. During his lifetime, Fletcher was honored by the American Cancer Society "for revolutionizing the field of radiotherapy and improving the quality of life of thousands of cancer patients," the American Society for Radiation Oncology, the Radiological Society of North America, the American College of Radiology, the Royal College of Radiologists (UK) and many other international institutions and organizations.

References

1 Dodd GD. Gilbert Hungerford Fletcher, MD, 1911-1992. *Radiol.* 1992;185(1):287. doi.org/10.1148/radiology.185.1.287

2 Linton O. They were giants: Gilbert Fletcher. *Jour Amer Coll Radiol.* 2008;5(11):1159-1160. doi.org/10.1016/j.jacr.2008.07.017

3 University of Texas MD Anderson Cancer Center Records, Gilbert H. Fletcher Society Records, 1977-2011. Availability verified November 9, 2020. https://mdanderson.libguides.com/FletcherGHRecords

4 Gilbert H. Fletcher, 81, Cancer Therapy Expert. T*he New York Times.* January 13, 1992. Accessed November 10, 2020. https://www.nytimes.com/1992/01/13/obituaries/gilbert-h-fletcher-81-cancer-therapy-expert.html

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JOURNALS

HIGHLIGHTS FROM *INTERNATIONAL JOURNAL OF RADIATION ONCOLOGY • BIOLOGY • PHYSICS*

January 1, 2021

NRG Oncology Updated International Consensus Atlas on Pelvic Lymph Node Volumes for Intact and Postoperative Prostate Cancer

Hall et al.

In this article, an updated NRG Oncology consensus contour atlas was developed for contouring prostate pelvic nodal clinical target volumes (CTVs). This atlas serves as an update to the 2009 RTOG atlas. Data were presented to a panel of international experts. After data review, participants contoured nodal CTVs on three cases: postoperative, intact node positive and intact node negative. Eighteen radiation oncologists' contours (54 CTVs) were included, four regions of CTV controversy were identified and consensus for each of these areas was reached.

February 1, 2021

Current Status of Clinical Trials for Cervical and Uterine Cancer Using Immunotherapy Combined with Radiation

Dyer et al.

This review explores current immunomodulatory and multimodality therapeutic approaches in the treatment of cervical and uterine cancer through ongoing clinical trials investigating the combination of immunotherapy and radiation therapy. Early phase trials are demonstrating promising efficacy and overall tolerable toxicity profiles of combined modality treatment. Of note, there is significant interest in optimizing treatment for patients with locally advanced cervical cancer beyond the standard of care, chemoradiation. Additionally, because of the inherent immunogenicity of MSI-high tumors often found in uterine cancer, combined immune modulation strategies are being explored to improve treatment outcomes.

March 1, 2021

Safety, Efficacy and Patterns of Failure After Single-Fraction Stereotactic Body Radiation Therapy (SBRT) for Oligometastases

Sogono et al.

The researchers of this retrospective study analyzed 371 patients with 494 extracranial oligometastases. Patients received single-fraction (SF) stereotactic body radiation therapy (SBRT) ranging from 16 Gy to 28 Gy. Between February 2010 and June 2019, patients who received SF SBRT to one to five sites of oligometastatic disease were included in the study. The primary objective was to describe patterns of first failure after SBRT. Secondary objectives included overall survival, progression-free survival, high-grade treatment-related toxicity (Common Terminology Criteria for Adverse Events grade ≥3) and freedom from systemic therapy (FFST). SF SBRT was determined to be safe and effective for patients with extracranial oligometastases, and a significant proportion of patients remained FFST for several years after therapy. The authors note this approach could be considered in resource-constrained or bundled-payment environments.

HIGHLIGHTS FROM *PRACTICAL RADIATION ONCOLOGY*

January/February 2021

The Evolution and Future of the American Society for Radiation Oncology (ASTRO) Clinical Practice Guidelines: A Report from the ASTRO Methodology Work Group on Behalf of the Guideline Subcommittee

Zaky et al.

This article provides an overview of the ASTRO guidelines development process along with explanations of how the strength of guideline recommendations is determined. The article also explores how the guidelines process has evolved over the years. The authors discuss future directions for the guidelines process, including additional collaboration with other societies, increasing availability of guideline products and providing patient-centered tools for decision making.

National Cancer Institute Workshop on Artificial Intelligence in Radiation Oncology: Training the Next Generation

Kang et al.

This article reports the action plan developed by the Training and Education Working Group of the NCI Workshop on Artificial Intelligence (AI) in Radiation Oncology for radiation-specific training for utilization of AI. The working group's plan consists of four action points: Creating awareness and responsible conduct of AI, implementing practical didactic curriculum, creating publicly accessible resources and accelerating learning and funding opportunities. The authors believe that AI will be a transformative force in medicine but caution that utilizing new technology without enough understanding can compromise the safety and efficacy of use in the clinical setting.

Article in Press

A Practical Guide for Navigating the Design, Build and Clinical Integration of Electronic Patient-Reported Outcomes in the Radiation Oncology Department

Philipson et al.

This study reports an institutional experience of developing tools to collect electronic patient-reported outcomes electronically (ePROs) as necessitated by COVID-19 and the shift to telehealth. The authors developed disease-site specific ePRO surveys to use for routine clinical practice and as part of prospective trials. The authors then interviewed members of their departments as well as electronic health record build analysts and compiled their feedback for others considering migration to ePROs. Their 11-step guide is intended as a framework to help other departments hoping to leverage telehealth in continuing to monitor patient reported outcomes.

HIGHLIGHTS FROM *ADVANCES IN RADIATION ONCOLOGY*

The Declining Residency Applicant Pool: A Multi-Institutional Medical Student Survey to Identify Precipitating Factors

Wu et al.

Over the past decade, a considerable number of radiation oncology (RO) positions have been left unmatched. This article aims to identify and understand factors associated with the declining RO residency pool. A survey was sent to all U.S. affiliated residency programs and medical students who were expected to graduate in 2020. Some positive factors contributing to medical students choosing RO were potential high salary, technological focus and favorable lifestyle and workload. Some negative factors were the need for a competitive United States Medical Licensing Examination (USMLE) board score, research focus and physics knowledge. The study found that most medical students were either not exposed to RO (60.8%) or never considered RO as a career option (63.8%).

Students' Perspectives and Concerns for the 2020-2021 Radiation Oncology Interview Season

Everett et al.

Due to the COVID-19 pandemic, the Coalition for Physician Accountability Work Group on Medical Students recommended that medical students complete their residency interviews virtually, limit visiting rotations and delay the normal application timeline. This article explores the themes from the needs assessment that was conducted to understand the students' perspective on the 2020 to 2021 RO interview season. Two main themes resulted from the focus group that was conducted with 10 participants: anticipated challenges to learn about the culture of a residency program and city (theme 1) and obtaining accurate objective information about residency programs (theme 2). The authors concluded that programs should focus on portraying the culture of their programs and providing opportunities for virtual electives.

Hypofractionated Post-Mastectomy Radiation Therapy

Sayan et al.

Standard fractionation has been the standard of care for post-mastectomy radiation therapy (PMRT) resulting in excellent tumor control and low toxicity. However, recent studies are exploring the use of hypofractionated (HF) approaches in the post-mastectomy setting. This article is a literature review of randomized trials that looks at the treatment of locally advanced breast cancer using HF-PMRT. The study showed that while standard fractionation is the most common treatment for PMRT, the data are evolving; early results of recent clinical trials show that HF-PMRT is safe and efficacious. The authors concluded that long-term data are needed to determine if HF-PMRT will be the new standard of care.

AMERICAN SOCIETY FOR RADIATION ONCOLOGY

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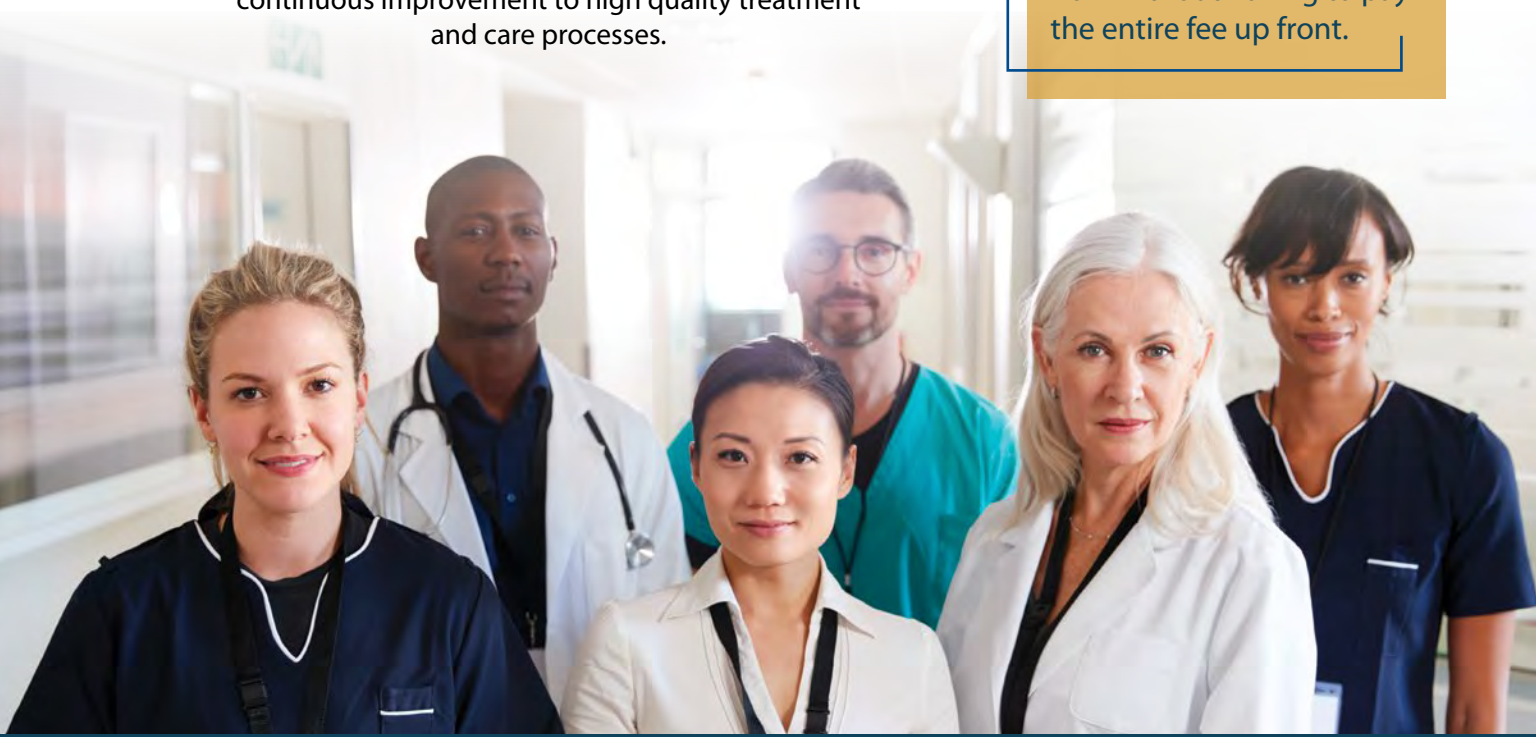

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