CANCER TREATMENT TECHNOLOGY REVIEW: ADVANCEMENTS IN PROTON THERAPY

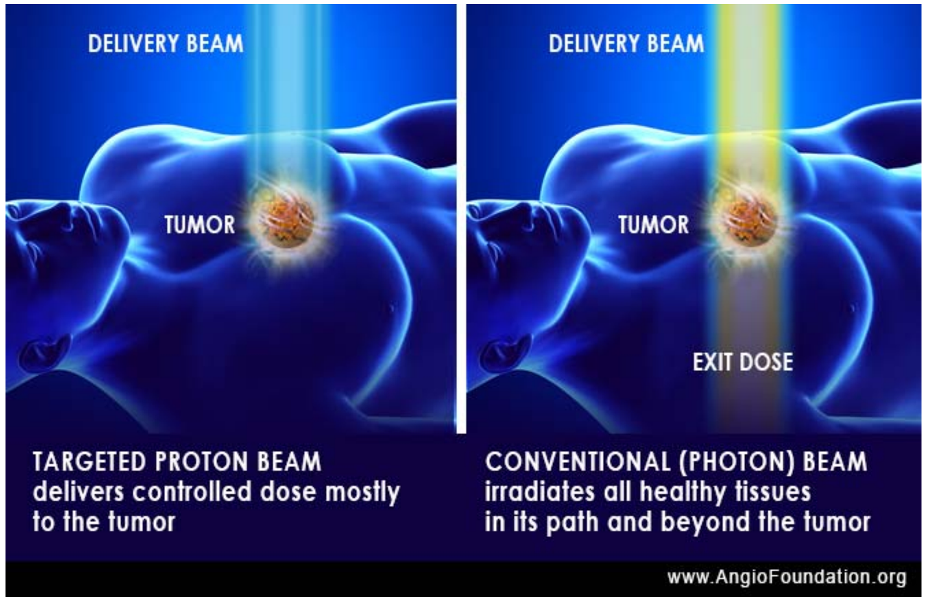
By: Dr. Robert L. Bard & Lennard M. Gettz / NY Cancer Resource Alliance

Medical researchers and developers have historically pursued many similar considerations in the path to improving cancer treatment solutions—much more than simply "killing cancer tumors." The highest priority is typically given toward patient safety and well-being during and after treatment due to the use of highly powerful foreign elements like radiation and chemicals with heavy toxicity levels.

Such is the case with conventional X-ray (photon) treatments like intensity-modulated radiation therapy (IMRT), which has proven to be successful in killing targeted tumors but also can damage nearby tissue, thus causing injury to the patient. IMRT applies high doses of irradiation in order to penetrate the body and reach the depths of the targeted tumor. This powerful beam of energy exposes all tissues along its entire path to radiation, including the normal tissues before the tumor and the normal tissues past the tumor.

An upgrade from using x-rays in radiation therapy came with the delivery of charged (proton) particle beams (originated by Dr. Robert R. Wilson, 1946) to irradiate cancer. This dose is deposited within a controlled range of depth, affecting specific coordinates in the body so most of the dose is delivered to the actual tumor and little or no radiation is delivered to tissues beyond the tumor (called the Bragg peak). This technique, therefore, maximizes the chances of curing patients without cause debilitating side effects, as proton research shows promising results in reducing the damage to healthy tissues and better preserving patient quality of life.

The National Association for Proton Therapy (NAPT) reports that both standard radiation therapy and proton therapy to work on the same principle of damaging cellular DNA of tumor, with the major difference that proton therapy deposits the majority of the radiation dose directly into the tumor and travels no further through the body. According to NAPT spokesperson Jennifer Maggiore, “The FDA approved this technology over 30 years ago, so it's not necessarily new, but recent advancements have made it more accessible in hospitals, and versions are also developed for single-room systems." There are large "big scale" installations with a cyclotron that feeds three to four gantries. This takes up a big footprint of space and a major investment of time and money, which has led to the increase in smaller, single-room centers in recent years.



IMPROVING TRENDS IN CANCER TREATMENT

It is commonly observed that surgeons are increasingly using minimally invasive procedures. Whether it's robotic or video assisted surgeries, we can identify the pattern of new treatment protocols to result in higher quality of life and a reduction in toxicity. In doing so, it allows us, in some cases, to actually improve survival through those same methods of reducing toxicities for patients.

According to Dr. Charles B. Simone II, Chief Medical Officer of the New York Proton Center, "We're going to see more and more customized treatment; it's not a one size fits all approach to cancer. We are going to have individualized ways to deliver radiation therapy, individualized drugs or immune agents—and then, potentially more synergy between modalities such as radiation with systemic therapies."

The concept of the pencil beam scanning or IMPT (intensity-modulated proton therapy) has grown widely accepted as the 'new future' in radiation therapy. Originally recognized to treat brain tumors, proton therapy has since found global success in treating prostate, breast, liver, lung, head and neck, and other cancers.

In the recent past, proton therapy has continued to advance in its design and performance. Over the past two decades, the number of academically affiliated proton therapy centers in the United States has grown from zero to 31. Over the past six years, newer centers have come onboard with pencil beam scanning proton therapy that has enabled IMPT. This new generation of proton therapy allows the radiation to be focused and deposited directly at the tumor, while avoiding normal tissues to an even greater extent than the first generation of proton therapy. Another unique advantage of the pencil beam scanning includes its ability to better sculpt the beam or dose. To match the beam into the shape of the tumor (which is usually not a perfectly square, circle or rectangle shape) allows the deposit of more radiation into the tumor, as it travels into the patient, with even less radiation deposited in the normal tissues in front of and also after the tumor.

According to Dr. Simone, another recent advancement in proton therapy is the ability for physicians to apply volumetric imaging—or the ability to conduct low dose CT scans daily and immediately (in 3D) before treatment—to the targeted area. Volumetric imaging allows radiation oncologists to directly visualize the tumor, or the area that needs the treatment, without having to rely on bony anatomy as a surrogate, as most proton treatment installations do. Most proton facilities still use X-ray or KV images, rather than a cone beam CT image, limiting the ability to have millimeter precision.

Unlike devices such as the CyberKnife system with a regular linear accelerator that essentially plugs into the wall and generates its own radiation, proton therapy requires its own source of energy to generate the proton therapy. The most common model used by proton centers to generate protons, including at the New York Proton Center, is through a cyclotron—a 10-foot-wide machine that accelerates particles about two-thirds of the speed of light to generate protons. From there, the radiation gets siphoned out of the cyclotron through a beam line that's just a few inches wide, and goes into each of the clinical treatment rooms.

Proton therapy has been shown to reduce the risk of secondary cancers in patients, while decreasing the chance of any long-term complications from the treatment. For some cancers, including for most pediatric cancers, it has grown to be called the de facto standard of care, while for other cancers clinical trials are being conducted to determine it as the preferred treatment for specific patient populations.

FROM THE PATIENTS' SIDE

After the patient's radiation oncologist determines that they are qualified for proton therapy, patients would come in for a single preparation appointment, what's called a simulation or radiation mapping appointment. This is generally done with an image (like a CT scan, a PET scan or an MRI), where the physician will work with a radiation physicist, as well as treatment planning dosimetrist, to map out the tumor in three or four dimensions. This helps identify how to deliver radiation to that tumor while avoiding irradiation the normal tissues.

"There are several factors that help us determine the right form of treatment: the type of cancer, the tumor location and other patient characteristics. The length of the treatment varies depending on the case," explained Dr. Simone. "Some patients will go through stereotactic proton therapy, which is generally between one and five day, and others will experience a more conventional treatment that's every day, Monday through Friday, for several weeks. While most treatments with proton therapy are the same number of days as with traditional x-ray therapy, because of the ability for protons to limit side effects, in some cases proton therapy can be administered to patients in high doses per day, leading to shorter treatment times, decreased cost, more patient convenience, and in some cancers better chances of cure."

THE NEW YORK PROTON CENTER

July 2019 marked the opening of the 140,000 square ft. state of the art proton treatment facility on East 126th Street. Managed by ProHealth medical group, the New York Proton Center was established under a joint partnership between Memorial Sloan Kettering Cancer Center, Mt. Sinai Health and Montefiore Health System. The New York Proton Center is projected to treat approximately 1,400 patients annually, receiving patients from its consortium partner institutions and from patients throughout the New York metro area and beyond who are looking for the most effective radiation care possible. The center will be one of the few worldwide that is equipped with the newest and most effective proton therapy technology, provided by globally renowned Varian Medical Systems, the worldwide leader in developing multidisciplinary, integrated cancer solutions.

ABOUT DR. SIMONE

Dr. Charles B. Simone, II is the Chief Medical Officer of the New York Proton Center. He is an internationally recognized expert in the use of proton therapy to treat thoracic malignancies and for reirradiation, and in the development of clinical trial strategies and innovative research in thoracic radiation oncology and stereotactic body radiation therapy. He is a National Institutes of Health, National Science Foundation, and Department of Defense funded investigator who performs clinical and translational research investigating the benefits of proton therapy as part of multi-modality therapy for thoracic malignancies. After years of dedication and service to the American College of Radiation Oncologists, Dr. Simone has been named a Fellow of ACRO, recognizing his highly valued contributions to the field. He has published over 340 scientific articles and chapters, given over 210 scientific lectures to national and international audiences, and is the national Principal Investigator or Co-Chair of 7 NIH-funded cooperative group trials (see complete bio- link https://www.nyproton.com/charles-simone/)

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