The Scientists Driving Cancer Care

Technological advances in radiation therapy, imaging, and software increase the need for dedicated medical physicists

A large team oversees an individual's cancer care. There are nurses, radiation therapists, oncologists, and dosimetrists, and then there are medical physicists like Sheri Weintraub, chief physicist at a cancer care center in Fall River, Massachusetts.

Cancer treatment often comes down to physics and, namely, radiation. First, detecting the tumors and imaging them to pinpoint their exact locations and attributes is accomplished by tomography machines, many which, like computed tomography (CT) and positron emission tomography (PET), depend on not-insignificant doses of radiation to provide their cross-section images of the human body.

Then there is the treatment itself, where radiation is often used to shrink the tumors. There is the linear accelerator (LA), which produces photons and electrons in order to create an external radiation beam, and there is brachytherapy, where source radiation in the form of a "seed" is put inside the tumor or inside the body cavity that contains the tumor to provide a localized high-dose radiation to a specific area.

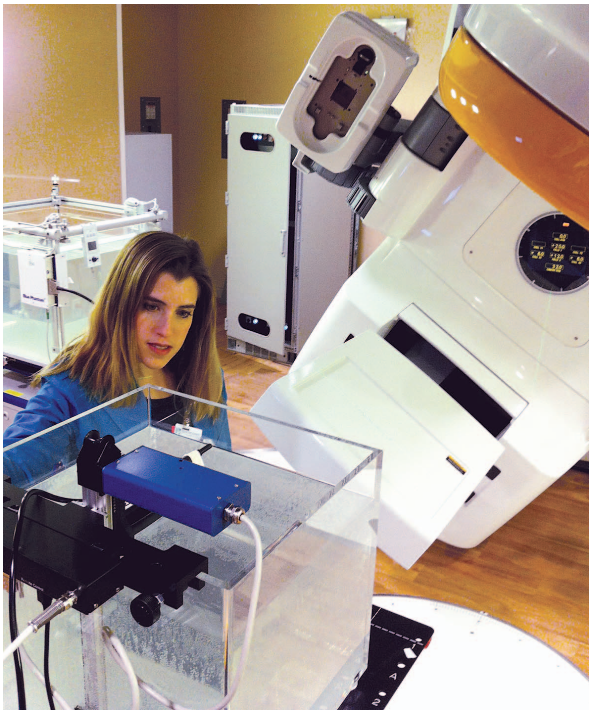
As a medical physicist, Weintraub is responsible for the radiation safety of all of this clinic equipment and for the quality of the radiation treatments. Her work encompasses three critical spheres: checking patients' individual treatment plans, performing quality assurance testing on existing pieces of equipment, and commissioning and safely integrating new technologies into clinical use.

Over the last decade, technological advances in radiation therapy, imaging, and software have increased the need for smart, capable, dedicated medical physicists like Weintraub, and yet many people have never heard of the career.

A Little-Known Path

While an environmental science major at Rutgers University, Weintraub first became interested in radiologic science after taking a course in radiologic health. Then, while she was visiting career services one day, a stack of brochures from the American Association of Physicists in Medicine (AAPM) was literally dropped in front of Weintraub. She kept eyeing the brochure, although the career counselor discouraged her by saying that medical physics was "biology and medicine," while Weintraub was a "math girl."

Undeterred, Weintraub found an internship working with the radiation safety officer at St. Peter's Medical Center in New Brunswick, New Jersey.



While preparing for the opening of a new cancer care center, Weintraub uses water tanks to collect data from radiation beams generated by a Varian Novalis TX linear accelerator.

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From there, Weintraub enrolled at the University of Cincinnati School of Medicine where she completed a two-year medical physics program, and she followed that up with a grueling three-part board certification process.

The draw to medical physics for Weintraub, an articulate, intelligent, unassuming mother of two, is clear. Weintraub speaks often of the importance of family and work-life balance. She rises at four in the morning to complete an hour-long workout, so as not to cut into family time. She owns every episode of *M*A*S*H* and, as she says, could "recite most of them line by line with impressive accuracy." It is no wonder she was drawn by the prospect of a career that combined the science of physics with the promise of medicine and the ability to work in patient care. As she says, "seeing the people depending on your expertise and not being so many steps away from the direct results of your work makes it easier to work your tail off."

Team Effort

When a cancer patient comes for radiation therapy, he or she is attended to by an entire team of experts, and Weintraub is quick to point out that each member brings an important and necessary skill set to the table. Together, they collaborate to provide the best possible care for their patients.

Each patient undergoes a series of CT scan and imaging tests, from which the radiation oncologist determines the course of radiation treatment—how much radiation to be applied and where it should be sent. From here, the radiation oncologist consults with Weintraub and a dosimetrist, and the dosimetrist, responsible for the radiation dose distributions, draws up a treatment plan. Weintraub is responsible for verifying and overseeing this plan.

Always, Weintraub says, "the name of the game is applying the highest radiation dose to the target area and the least dose to anywhere else." It is critical that she understand the oncologist's intentions—"how they are defining the treatment area and what dose they are comfortable allowing the organs at risk to receive."

Using her knowledge of how radiation acts within different organs (be it lungs, bone, or soft tissue, for example), she confirms that the treatment plan presents the best outcome while mitigating side effects and damage to organs. This includes reviewing the geometry of how the radiation will enter and exit the patient, and, as she says, "making sure that it is optimal in terms of sparing as much healthy tissue as possible."

"The name of the game is applying the highest radiation dose to the target area and the least dose to anywhere else."

Lastly, Weintraub completes her quality assurance review by checking that the treatment plan data has been transferred correctly to the appropriate machine and by reviewing "beam on" times. After this point, if all goes perfectly, treatment begins.

Technological Advances

Outside of plan checking, patient chart checking, and quality assurance testing, Weintraub says that she is usually in the middle of commissioning something or bringing a new piece of technology or software into clinical use. At the moment, Weintraub is implementing a prostate seed implant program and a high dose rate brachytherapy program while also opening a new oncology center that will have "a linear accelerator capable of standard treatments as well as high precision stereotactic radiosurgery treatments."

Family is priority. Sheri Weintraub with husband Jacob and daughters Samantha and Alexis.

According to Weintraub, the commissioning of new technologies requires that she first collect massive amounts of data and that she then ensure that "the data is correct and modeled appropriately for use in the treatment planning systems." After this, Weintraub begins the intensive process of setting up the necessary policies and procedures for safe usage. "Building programs and work flows sometimes takes longer than taking the data," Weintraub says.

Part of Weintraub's job also involves knowing when and how to say no to flashy new products for which others might be pushing. In her evaluation of new technologies, Weintraub must decide which will benefit the clinic and its patients. As she says, "Not everything put on the market should be implemented in the clinic, and it is in large part up to the medical physicist to monitor that and balance patient safety with maximizing the quality of patient care."

But there are many technologies to get excited about, and Weintraub is eager to talk about some of the many different imaging and therapy options cancer patients have today and how they are changing the way tumors are treated. "Precision," "customization," and "accuracy" are terms that come up again and again, proof that Weintraub seeks to ensure that the oncology team is doing what they can to "find the safest route to delivering the most optimal radiation treatments."

She believes that the majority of recent changes in radiation therapy have not been to the hardware or the patterns of care themselves, but to advances in imaging and software to allow more precise real-time treatment decisions to be made. Tumors are in constant motion. They grow, shrink, or shift. Patients lose weight. Natural internal movements of organs such as the lungs cause minute shifts. New technologies have allowed oncology teams to take these changes into greater account.

For example, image guided radiation therapy (IGRT) is a now-mainstream advancement in imaging that equips the radiation therapy machines (such as the linear accelerator) with imaging technology so that images can be acquired immediately before or even during treatment.

From there, recent advancements to IGRT therapy itself are the introduction of high-resolution two-dimensional (2-D) imaging as well as three-dimensional (3-D) imaging capabilities. The high resolution 2-D imaging allows the oncology team to "more accurately position targets that have implanted markers," while the 3-D imaging capability allows the team to "evaluate the patient's position based on three-dimensional information and then reposition [the patient] accordingly to line up his/her targeted treatment area per the treatment plan," Weintraub says.

Weintraub's role in IGRT is to understand the technology and make sure it is used appropriately. For example, she must protect patients from receiving unnecessary imaging doses. On the other hand, high-resolution 2-D imaging has so reduced the radiation dose that she is able to advocate for increased imaging in certain situations.

Thanks to IGRT and these advances of 2-D and 3-D imaging, oncology teams can now also use the imaging information to evaluate the dose pattern of radiation more frequently. What further helps here is that the reduced radiation dose of both 2-D and 3-D imaging means patients can be imaged daily as opposed to once or twice a week. This more frequent adaptation of treatment plans is called adaptive radiation therapy (ART), and with adaptive therapy coming into the mainstream, oncologists, dosimetrists, and medical physicists can constantly reevaluate and "tweak" treatment plans.

While Weintraub's clinic already practices ART on a small number of patients using existing hardware and software, Weintraub is in the process of acquiring new software that will allow her to develop a true ART system. In particular, the new software will use the 3-D images from the linear accelerator to generate more current treatment plans. This system will increase the ease and practicality of offering ART and will thus allow the clinic to offer the benefits of ART to a much larger set of patients.

Real People Doing Real Work

Weintraub loves her career. She thinks what makes her a successful medical physicist is that family is her number one priority. As she says, her family fuels her. That is where she gets her energy and drive. From her family she finds the enthusiasm and passion and inspiration needed to do what she does. She describes herself as content and balanced. And, as chief, she looks for medical physicists who are also "real people that do real work."

Her job is at the intersection of science and humanity, and Weintraub feels fortunate to have stumbled across such a wonderful field. She cannot think of anything else she would be happier doing. What she loves about her job is how the physics skills and the mental tools she uses every day tie into something personally fascinating to her.

—Katianne Williams

Innovating New Products and Technologies

Cross-function teams benefit Cambridge Consultants

For many engineers, innovative problem solving is the name of the game, and the women at Cambridge Consultants are no different—except for their business model. "We are a design, development, and engineering company," explains the organization's U.S. president, Pamela McNamara, "and we work with our customers, clients, and partners to take early stage concepts and ideas and work them all the way through our laboratories up to project launch."

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One of the greatest benefits of consulting work is being able to get involved at different stages along a product's development journey and also the opportunity to work in cross-functional teams in many different industries. While McNamara adds that the focus at Cambridge Consultants is ultimately on "innovating new products and technologies," she points out that work is done across several areas, including: medical technology and healthcare, consumer products, wireless telecommunications, defense and security, transportation, smart metering/energy, and more.


Pamela McNamara

A variety of interests suits people well in consulting. As a civil engineering student at Tufts University, McNamara says she was "interested beyond engineering and supplemented engineering coursework with classes in international relations and political science." This led her to a career in management consulting at Arthur D. Little (ADL), which, at the time, owned Cambridge Consultants, where she worked in industrial operations and supply chain planning for pharmaceutical companies. A cemented passion for healthcare has resulted in an over 20-year career for McNamara in that sector, including stints as CEO of Arthur D. Little, CEO of a start-up electronic patient diary and mobile record company in Finland called CRF, Inc., and, ultimately, the president of Cambridge Consultants, Inc., where she was charged with building up the U.S. business after the company was spun off from ADL.

Though an essential aspect of consulting is the requirement to keep client names and information confidential—especially in the healthcare sector, where it can take years to get U.S. Food and Drug Administration approval and put projects out into the public domain—McNamara is able to share one of her more recent, internal projects related to the wireless and medical areas. "Our