Radiation Oncology

While technological advances open many new doors, they also present challenges requiring novel solutions. The field of radiation oncology, which uses high-tech computerized equipment to deliver therapeutic doses of radiation for cancer treatment, has advanced tremendously in the last decade, leading to better treatments for patients at Huntsman Cancer Institute (HCI). While HCI is a well-established leader in the use and development of new technologies for radiation treatment, “this past year may well break all previous records,” says Bill Salter, PhD, DABR, HCI director of Radiation Oncology and division chief of Medical Physics at the University of Utah School of Medicine.

Ten years ago, intensity modulated radiation therapy (IMRT) emerged as a revolutionary new form of radiation treatment. Instead of firing three or four large beams of radiation at a cancerous tumor, treatments evolved to target cancer with hundreds or even thousands of pencil-thin beams controlled by a computer. “We went from ‘painting in’ radiation dose with a big brush to painting with a tiny brush,” Salter says. “This was a giant step forward in our ability to tailor the delivered dose to the specific shape of an individual patient’s tumor. We could deliver more radiation to the tumor while doing less damage to surrounding structures.”

For several years, HCI has provided IMRT to patients with recurrent and metastatic brain cancers as well as tumors in surgically risky locations using Novalis® Shaped Beam Surgery™ and Varian linear accelerators and MultiLeaf Collimators. The ability to deliver radiation so intricately using IMRT posed a new challenge: how to place these radiation doses precisely. This led to the current revolution in radiation oncology: image guided radiation therapy (IGRT).

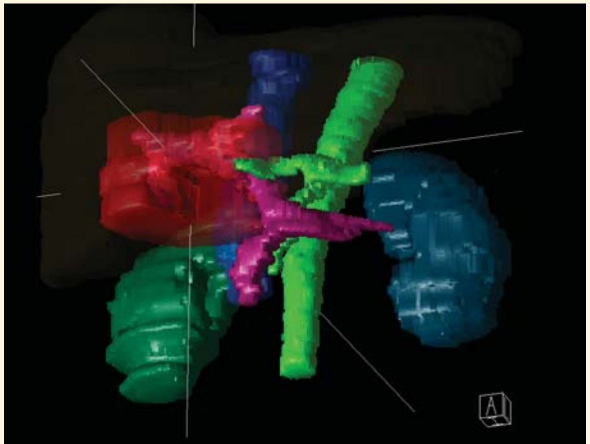
The “smart bomb” of radiation delivery, IGRT delivers IMRT radiation doses by using images of a person’s internal anatomy taken immediately before delivery of the treatment. This is important because structures inside the body, including tumors, move around from day to day and even minute to minute—if only by fractions of an inch. Knowing the exact location of the tumor and sensitive structures—down to the millimeter—is very important so the tumor is always treated precisely, and nearby healthy tissue is spared from damage as much as possible.

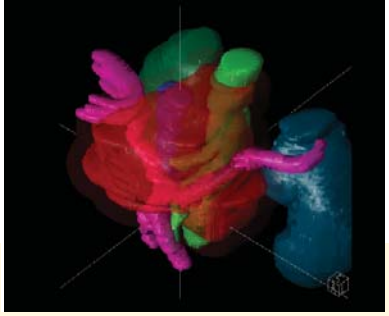
In 2007, HCI’s Department of Radiation Oncology implemented numerous upgrades to its imaging and delivery systems that “maintain HCI’s status among very few centers worldwide capable of offering such cutting-edge treatments,” Salter says.

Among these new imaging capabilities is stereotactic ultrasound guidance, a method for precisely targeting prostate cancer. Immediately before radiation treatment, technicians place a small ultrasound probe on the outside of the patient’s body where the cancer is known to be. Two “stereo” cameras on opposite sides of the room point to the probe, learn its position, and allow for production of a three-dimensional (3-D) ultrasound data set of the patient’s internal anatomy. “Just as our two eyes give us depth perception, the stereo cameras give the system depth perception so it can determine in 3-D where the prostate is at that precise moment in time. The system shows us if the prostate has moved and if we should adjust the patient’s position so we treat only the intended area,” Salter explains.

The radiation treatment planning process begins with 3-D computed tomography (CT) images that show the location of the tumor and nearby sensitive structures. “It has always been a challenge for us to image things that are moving in the

This 3-D image shows a tumor (in red) with nearby blood vessels and kidneys to be avoided.





These images show three different tumors (in red) located in areas where motion poses a challenge (the first two are pancreas tumors; the last is a liver tumor).

body. Just like a picture you take with your camera gets blurred when someone is moving, pictures of a patient's internal anatomy get blurred if the anatomy is moving—when a patient breathes, for instance." To address this challenge, in 2007 HCI added both a GE Large Bore, 16-slice CT scanner and 4-D imaging capability. "This allows us to essentially 'freeze' motion in our images and capture precise representations of where the tumor is, how it's shaped, and where it moves when a patient breathes," Salter says. This capability allows physicians to deliver precise and effective radiation treatments to parts of the body that move. While advanced 4-D imaging has helped make the delivery of radiation more exact than ever, it still provides only an extremely close estimation of tumor location. "It would be ideal," says Salter, "to visualize the tumor's position directly."

Perhaps the most exciting advancement in Radiation Oncology at HCI in 2007 occurred with the acquisition of technology that allows this direct visualization, the Calypso Body GPS System. "This is the first of only a handful of such systems to be installed worldwide," Salter says. "It places HCI among very few academic centers capable of answering important research questions regarding how to treat moving tumors." The Calypso System uses small "beacons" implanted within and around a patient's tumor. The beacons are inactive until stimulated with electromagnetic waves to "wake up" and report their position. As a patient breathes or moves—by even the slightest degree—the beacons report to a computer the tumor's exact position and allow for precise adjustments to align the target before and throughout treatment. Radiation oncologists and researchers at HCI and the University of Utah will partner in studies using the Calypso System and report findings back to the company, helping further this field.

Salter envisions the emergence of a Center for Image Guided Radiation Therapy at HCI—a compilation of many technologies, researchers, and expert clinicians at a single location, maximizing treatment options for patients. "Bringing together our resources from various departments at HCI and the University of Utah, along with these state-of-the-art technologies, we are well on our way to establishing ourselves as a national leader in this emerging field of image guided radiation therapy. And HCI continues to be the place where patients receive the treatments of tomorrow today."

Dennis Shrieve, MD, PhD (left), and Bill Salter, PhD, DABR (right), help maintain Huntsman Cancer Institute's status as a worldwide leader in cutting-edge treatments such as image guided radiation therapy.

On the web: Learn how HCI patients with brain tumors benefit from advances in the Radiation Oncology Department's BrainLab: huntsmancancer.org/annualreport2007