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Hi-tech radiation imaging, 3-D planning increase intensity with fewer downsides

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Once his mask is snapped to the table, Ross Harrison can barely blink.

That's crucial to the course of radiation he'll finish at Princess Margaret Hospital in a few weeks. It follows surgery that removed a cancerous growth from his neck last February.

Harrison is one of approximately 7,500 patients who receive radiation here each year, one of the largest and most respected cancer treatment facilities in the world.

"They certainly go out of their way to make people comfortable," says the 65-year-old retired forestry products specialist. Harrison expects to fully recover, and anticipates a summer of golf, gardening and cycling when he returns home to his wife, a retired schoolteacher, and their two cats in Sault St. Marie.

Almost 400 professionals plan and deliver radiation to cancer patients at PMH each year. The process begins with physicians, who spend hours on a computerized planning system with multiple images of the body site to be radiated.

Slice by slice, millimetre by millimetre, a pattern for radiation – which can take between one and 42 treatments – is painstakingly contoured for each patient. "There is a lot of judgment," says Dr. Mary Gospodarowicz, PMH's head of radiation medicine.

New technology allows the precise shaping of radiation beams to the tumour site, which minimizes the volume of tissue being treated, reducing toxicity and sparing healthy cells.

"If you have a normal structure next to the tumour, what do you shave off? It's almost like the surgeon when he operates, he needs to make (continual) decisions," says Gospodarowicz.

Next, a radiation therapist generates a treatment plan, based on the doctor's prescription, to determine the correct radiation dose. Too much is toxic, not enough won't kill the cancer cells.

Levels of patient-specific quality assurance follow with radiation therapists, physicists and physicians checking and rechecking the plan before it goes down to the treatment area. In the treatment area, calculations – sometimes thousands per patient – are tailored specifically for each case by computer, based on the contouring done by the physician. After all that, the patient is ready for treatment, a process that takes mere moments each day.

Radiation therapy has come a long way since x-rays first treated skin cancer in 1896. In the 1950s, higher energy x-rays enabled treatment of deeper tumours and in the '70s, linear accelerators broadened the choice of treatment energies.

In the last five years, radiation therapy has become patient-specific, with 3-D imaging of bodies showing the doses needed. One of the elements to the success of modern radiation therapy is having the patient reproduce the exact same position every day, for up to several weeks.

Hence the mask for Harrison, a custom-made device for treating cancer in the head or neck. The plastic form is softened in warm water, then stretched across the patient. Other devices are used for different body parts.

Stabilizing the outside of the body is one thing, but organs can shift. Now, thanks to the inventiveness of Dr. David Jaffray, head of radiation physics at PMH, Image Guided Radiation Therapy machines allow last-minute adjustments for precise radiation focus each treatment.

IMRT's success is unquestionable, according to Gospodarowicz. It enables staff to see cancer tumours as they are being treated, rather than before and after. It can target tumours too large to be treated with surgery or chemotherapy, she notes. It spares healthy tissue – such as salivary glands when treating certain head and neck cancers; it preserves sight when treating tumours around the eyes; it improves cure rates of prostate cancer by allowing a higher dose of radiation without also increasing complication rates.

"This technology makes the treatment less, reduces the toxicity and, in some instances, improves results. But it's a step-by-step fashion," she says.

"First you have new technology, then you have to learn to use it safely, then you have to gradually push the envelope to exploit it to spare more normal tissue without sparing the cancer."

A complex case may require up to 3,000 orientations of beams. "This whole thing can become much more dynamic and it can respond to the changes that we're seeing within the patient " Gospodarowicz says.

Reacting to changes in the size and shape of tumours during treatment is on the horizon. "That is where we are going," Gospodarowicz says. "How can we do that quickly and efficiently and how often do we have to do it?"