



## Intensity-Modulated Radiation Therapy (IMRT)

Intensity-modulated radiotherapy (IMRT) uses linear accelerators to safely and painlessly deliver precise radiation doses to a tumor while minimizing the dose to surrounding normal tissue.

Your radiation oncologist will speak with you to determine whether IMRT is the most appropriate treatment for you. If so, your doctor will perform a physical exam and use CT scanning to conduct a treatment simulation session. Other imaging procedures may be used to help determine the exact shape and location of your tumor, and a special device may be created to help you maintain the same exact position during each treatment. Your doctor will give you specific instructions based on the type of exam being performed.



## What is Intensity-Modulated Radiation Therapy and how is it used?

Intensity-modulated radiation therapy (IMRT) is an advanced mode of high-precision radiotherapy that uses computer-controlled linear accelerators to deliver precise radiation doses to a malignant tumor or specific areas within the tumor. IMRT allows for the radiation dose to conform more precisely to the three-dimensional (3-D) shape of the tumor by modulating—or controlling—the intensity of the radiation beam in multiple small volumes. IMRT also allows higher radiation doses to be focused to regions within the tumor while minimizing the dose to surrounding normal critical structures. Treatment is carefully planned by using 3-D computed tomography (CT) or magnetic resonance (MRI) images of the patient in conjunction with computerized dose calculations to determine the dose intensity pattern that will best conform to the tumor shape. Typically, combinations of multiple intensity-modulated fields coming from different beam directions produce a custom tailored radiation dose that maximizes tumor dose while also minimizing the dose to adjacent normal tissues.

Because the ratio of normal tissue dose to tumor dose is reduced to a minimum with the IMRT approach, higher and more effective radiation doses can safely be delivered to tumors with fewer side effects compared with conventional radiotherapy techniques. IMRT also has the potential to reduce treatment

toxicity, even when doses are not increased. Due to its complexity, IMRT does require slightly longer daily treatment times and additional planning and safety checks before the patient can start the treatment than conventional radiotherapy.

Currently, IMRT is being used most extensively to treat cancers of the prostate, head and neck, and central nervous system. IMRT has also been used in limited situations to treat breast, thyroid, lung, as well as in gastrointestinal, gynecologic malignancies and certain types of sarcomas. IMRT may also be beneficial for treating pediatric malignancies.

Radiation therapy, including IMRT, stops cancer cells from dividing and growing, thus slowing or stopping tumor growth. In many cases, radiation therapy is capable of killing all of the cancer cells, thus shrinking or eliminating tumors.

## Who will be involved in this procedure?

Most facilities rely on a specially trained team for IMRT delivery. This team includes the radiation oncologist, medical physicist, dosimetrist, radiation therapist and radiation therapy nurse.

The radiation oncologist, a specially trained physician, first consults with the patient to determine whether radiation therapy with IMRT is the most appropriate treatment. After obtaining informed consent, the individualized course of treatment is planned. A radiation physicist, who has specialized training in the field of radiation oncology physics, ensures the linear accelerator delivers the precise radiation dose and that computerized dose calculations are accurate. A dosimetrist works with the medical physicist to calculate the IMRT exposures and beam configurations necessary to deliver the dose prescribed by the radiation oncologist. The final treatment plan is verified on the machine with measurement by the medical physicist before being delivered to the patient. A highly trained radiation therapist positions the patient on the treatment table and operates the machine. The radiation oncology nurse assesses the patient and provides the patient with additional information about the treatment and possible adverse reactions. The radiation oncology nurse also helps in managing any reactions or side effects from treatment that may occur, in collaboration with the physician.

## What equipment is used?

A medical linear accelerator (LINAC) generates the photons, or x-rays, used in IMRT. The machine is the size of a small car—approximately 10 feet high and 15 feet long. The energy of the photon or x-ray, in the order of 10 millions of volts, is generated by the LINAC to penetrate the patient's body to the tumor. During the 15 or so minutes of treatment, the patient is required to lie still on the treatment couch while the linear accelerator delivers multiple beams of radiation to the tumor from various directions. The intensity of each beam's radiation dose is dynamically varied according to treatment plan. The patient usually will not feel any sensation while the radiation is on, but will hear noise from the machine, and may smell an odor from the electronic equipment, or see the warning indicator light. The noises and odors from the machine are normal. The patient will be in the room alone during the treatment period with constant monitoring from the radiation therapists from outside the treatment room.

See the Linear Accelerator page for more information.

## Who operates the equipment?

The radiation therapist operates the equipment from a radiation-protected area nearby. The therapist is able to communicate with the patient throughout the procedure. The therapist observes the patient on closed circuit television.

## Is there any special preparation needed for the procedure?

Before planning treatment, a physical examination and medical history review will be conducted. Next, there is a treatment simulation session, which includes CT scanning, from which the radiation oncologist specifies the three-dimensional shape of the tumor and normal tissues. In most cases, a treatment preparation session may be necessary to mold a special device that will help the patient maintain an exact treatment position. Sometimes, the patient is instructed to follow a certain bowel and bladder preparation regimen prior to the simulation. The dosimetrist and medical physicist use the CT information to design the IMRT beams used for treatment under specification from the radiation oncologist. Sometimes, intravenous contrast material is injected during the CT scan to help define the tumor better. Occasionally, additional scanning procedures, including positron emission tomography (PET) and magnetic resonance imaging (MRI), might also be required for IMRT planning. These diagnostic images can be merged with the planning CT and help the radiation oncologist determine the precise location of the tumor target. In some cases it is necessary to insert radio dense markers into the target for more accurate positioning. Typically, IMRT sessions begin about a week after simulation. Prior to treatment, the patient's skin may be marked or tattooed with colored ink to help align and target the equipment.

## How is the procedure performed?

IMRT often requires multiple or fractionated treatment sessions. Several factors come into play when determining the total number of IMRT sessions and radiation dose. The oncologist considers the type, location and size of the malignant tumor, doses to critical normal structures, as well as the patient's health. Typically, patients are scheduled for IMRT sessions five days a week for five to eight weeks.

At the beginning of the treatment session, the therapist positions the patient on the treatment table, guided by the marks on the skin defining the treatment area. If molded devices were made, they will be used to help the patient maintain the proper position. The patient may be repositioned during the procedure. Imaging systems on the treatment machine such as x-ray or CT may be used to check positioning and marker location. Treatment sessions usually take between 10 and 30 minutes.

## What will I feel during and after this procedure?

As with other external beam radiation therapy treatments, there is no pain expected during the actual treatments with IMRT. However, the machine can be stopped if you experience discomfort due to the treatment position or positioning devices. As treatment progresses, some patients may experience treatment-related side effects. The nature of the side effects depend on the normal tissue structures being irradiated. The radiation oncologist and the nurse will discuss and try to help you with any side effects.

Side effects of radiation treatment include problems that occur as a result of the treatment itself as well as from radiation damage to healthy cells in the treatment area.

The number and severity of side effects you experience will depend on the type of radiation and dosage you receive and the part of your body being treated. You should talk to your doctor and nurse about any side effects you experience so they can help you manage them.

Radiation therapy can cause early and late side effects. Early side effects occur during or immediately after treatment and are typically gone within a few weeks. Common early side effects of radiation therapy include tiredness or fatigue and skin problems. Skin in the treatment area may become more sensitive, red, irritated, or swollen. Other skin changes include dryness, itching, peeling and blistering.

Depending on the area being treated, other early side effects may include:

- hair loss in the treatment area
- mouth problems and difficulty swallowing
- eating and digestion problems
- diarrhea
- nausea and vomiting
- headaches
- soreness and swelling in the treatment area
- urinary and bladder changes

Late side effects, which are rare, occur months or years following treatment and are often permanent. They include:

- brain changes
- spinal cord changes
- lung changes
- kidney changes
- colon and rectal changes
- infertility
- joint changes
- lymphedema
- mouth changes
- secondary cancer

There is a slight risk of developing cancer from radiation therapy. Following radiation treatment for cancer, you should be checked on a regular basis by your radiation oncologist for recurring and new cancers.

Using techniques such as IMRT, radiation oncologists are maximizing the cancer-destroying capabilities of radiation treatment while minimizing its effect on healthy tissues and organs and the side effects of the

treatment itself.

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