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What is Radiation Therapy? [1]

This section has been reviewed and approved by the Cancer.Net Editorial Board [2], 02/2013

This is the first article in a four-part series, and it provides an overview of radiation therapy. The other articles in this series addresswhat to expect when receiving radiation therapy[3],the side effects of treatment[4], andfrequently asked questions[5].

What is radiation?

Radiation describes the way energy moves from one place to another. Sometimes this is in the form of particles such as protons, while other times it is in the form of waves like x-rays or visible light. The various types of radiation are grouped according to how much energy they contain. Low energy radiation, like radio waves and heat, is known as non-ionizing radiation. High energy radiation, such as ultraviolet (UV) light from the sun and x-rays, is known as ionizing radiation because it has enough energy to break chemical bonds and knock electrons (negatively charged particles) out of atoms. When these changes take place in cells, it can sometimes cause enough damage to kill the cells. As a result, such high-energy x-rays or other particles can be used to destroy cancer cells in a treatment called radiation therapy.

Radiation as therapy

Doctors known as radiation oncologists oversee radiation therapy, which usually consists of a specific number of treatments given over a set period of time. The goal of this treatment is to destroy cancer cells without harming nearby healthy tissue. Radiation therapy may be used as the main treatment or as an adjuvant therapy (treatment given after the main treatment to target any potential remaining cancer cells). Radiation therapy can also be used to shrink tumors and reduce pressure, pain, and other symptoms of cancer (called palliative radiation therapy [6]) when it is not possible to completely eliminate the disease.

More than half of all people with cancer receive some type of radiation therapy. For some cancers, radiation therapy alone is an effective treatment; however, other types of cancer respond best to combination treatment approaches that may include radiation plus surgery, chemotherapy, or immunotherapy.

Types of radiation therapy

External-beam radiation therapy. This is the most common type of radiation treatment, and it involves giving radiation from a machine located outside the body. It can treat large areas of the body, if necessary. The machine typically used to create the radiation beam is called a linear accelerator or linac. Computers with special software are used to adjust the size and shape of the beam and to direct it to target the tumor while avoiding the healthy tissue that surrounds the cancer cells. External-beam radiation therapy does not make you radioactive.

Types of external-beam radiation therapy include:

- Three-dimensional conformal radiation therapy (3D-CRT): As part of this treatment, special computers create detailed three-dimensional pictures of the cancer. This allows the treatment team to aim the radiation more precisely, which means they can use higher doses of radiation while reducing the risk of damaging healthy tissue. Studies have shown that 3D-CRT can lower the risk of complications and side effects, such as damage to the salivary glands (which can cause dry mouth [7]), when people with head and neck cancer are treated with radiation therapy.
- Intensity modulated radiation therapy (IMRT): This treatment better directs the radiation dose at the tumor than 3D-CRT by precisely modulating (varying) the intensity of the beam under strict computer guidance. (The positioning of the beam occurs during a specialized planning process.) Because of the modulation of the beam intensity and the special planning computers, IMRT protects healthy tissues from radiation better than 3D-CRT.
- Proton beam therapy: This treatment uses protons, rather than x-rays, to treat some cancers. Protons are parts of atoms that at high energy can destroy cancer cells. Researchers have found that directing protons at a tumor decreases the amount of radiation delivered to surrounding healthy tissue, reducing the damage to that tissue. Because this therapy is relatively new and requires highly specialized equipment, it is not available at every medical center. The potential benefits of proton therapy compared to IMRT have not been established for some cancers, such as prostate cancer. Learn more about proton therapy [8]**.**
- Stereotactic radiation therapy: This treatment delivers a large, precise radiation dose to a small tumor area. Because of the precision involved in this type of treatment, the patient must remain extremely still. Head frames or individual body molds may be used to limit movement. Although stereotactic radiation therapy is often performed as a single treatment, some patients may need several radiation treatments, sometimes as many as five.

Internal radiation therapy. This type of radiation treatment, also known as brachytherapy, involves placing radioactive material into the cancer itself or into the tissue surrounding it. These radioactive implants may be permanent or temporary and may require a hospital stay. Permanent implants are tiny steel seeds (capsules) about the size of a grain of rice that contain radioactive material and are placed inside the body at the tumor site. The seeds deliver most of the radiation around the area of the implant; however, some radiation can be emitted (released) from the patient?s body. This means the patient needs to take special precautions to protect others from radiation exposure while the seeds are still active. Over time, the implant loses its radioactivity, but the inactive seeds remain in the body.

For temporary implants, the radiation is delivered through needles, catheters (tubes that carry fluid in or out of the body), or specialized applicators and kept in the body for a specific amount of

time, from a few minutes to a few days. Most temporary implant procedures deliver radiation for just a few minutes. If temporary implants are used for more time, the patient remains in a private room while the implants are in place to limit others? exposure to the radiation.

Other treatment options

Intraoperative radiation therapy (IORT). Radiation therapy can be delivered directly to the tumor during surgery, either as external-beam radiation therapy or as internal radiation therapy. This technique allows the surgeon to move healthy tissue out of the way before radiation therapy occurs, and it may be helpful when vital (life-sustaining) organs are located very close to the tumor**.**

Systemic radiation therapy. Systemic (whole body) radiation therapy uses radioactive materials, such as iodine 131 or strontium 89, that can be taken by mouth or injected into the body to target cancer cells. These radioactive materials leave the body through saliva, sweat, and urine, making these fluids radioactive. Additional safety measures must be taken to protect people who come in close contact with the patient. For more information, see the *Safety for the patient and family* section below.

Radioimmunotherapy. A type of systemic therapy, this treatment uses monoclonal antibodies to deliver radiation directly to cancer cells. Monoclonal antibodies are laboratory-made proteins designed to attach to specific factors only found in cancer cells. By attaching radioactive molecules to these antibodies in a laboratory, they can deliver low doses of radiation directly to the tumor while leaving noncancerous cells alone. Examples of these radioactive molecules include ibritumomab (Zevalin) and tositumomab (Bexxar).

Radiosensitizers and radioprotectors. Researchers are studying substances that help radiation better destroy tumors (radiosensitizers) and those that better protect healthy tissues near the area being treated (radioprotectors). Examples of radiosensitizers include fluorouracil (5-FU) and cisplatin (Platinol), while amifostine (Ethyol) is a radioprotector.

Safety for the patient and family

During external-beam radiation therapy, the patient does not become radioactive; the radiation remains in the treatment room. However, because internal radiation therapy causes the patient to emit radiation, a number of safety measures are necessary.

While the implant is in place, women who are pregnant and children younger than 18 should not visit the person receiving treatment. Other visitors should sit at least six feet from the patient?s bed and limit their stay to 30 minutes or less each day. Permanent implants remain radioactive after the patient is discharged from the hospital, so he or she should not have close (less than six feet) or lengthy (more than five minutes) contact with women who are pregnant and children for two months.

With systemic radiation therapy, safety precautions must be followed for the first few days after treatment. The risk of radiation exposure to family and friends can be minimized using the following precautions:

- Washing hands thoroughly after using the toilet
- Using separate utensils and towels
- Drinking plenty of fluids to flush the remaining radioactive material from the body
- Avoiding sexual contact
- Minimizing contact with infants, children, and women who are pregnant

More Information

ASCO Answers Fact Sheet: Radiation Therapy (PDF) [9]

Types of Treatment [10]

Additional Resources

RT Answers: How Does Radiation Therapy Work? [11]

RT Answers: Questions to Ask About Radiation Safety [12]

National Cancer Institute (NCI): External Beam Radiation Therapy [13]

NCI: Internal Radiation Therapy [14]

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