Getting External Beam Radiation Therapy

On this page

- Types of beams used in external radiation therapy
- Types of external radiation therapy
- How does your doctor plan your radiation treatment?
- How much radiation is given?
- How long does external radiation treatment take?
- What happens during each treatment visit?
- Will I be radioactive during or after external radiation treatment?

External radiation (or external beam radiation) is the most common type of radiation therapy used for cancer treatment. A machine is used to aim high-energy rays or particles from outside the body at the tumor. External beam radiation is given most often as photon (x-ray) beams and less often as particle (proton, neutron) or electron beams (see below).

Radiation technology allows the very careful delivery of external beam radiation therapy. The machines focus the radiation beam on the exact location in such a way to maximize the radiation reaching the cancer, but also to affect normal tissues as little as possible.

External radiation is usually done during outpatient visits to a hospital or treatment center. Most people get external radiation therapy over many weeks. Usually, they visit the treatment center every weekday (Monday through Friday) for a certain number of weeks. But some people might get radiation on a different schedule, such as twice a day for a fewer number of weeks. Your cancer care team will speak with you about how much radiation is needed to treat your cancer and how often you need to get it.

Types of beams used in external radiation therapy

Photon beam radiation therapy: Photon beams are the same type of radiation that is used during an x-ray (like a chest x-ray), but the beams are much stronger. The radiation is released from the machine as a wave of energy. Photon beams can travel deep into the body to reach the tumor, but they can also damage healthy tissue in front of and behind the tumor.

Photons are given by a machine called a **linear accelerator.** The photon beams are invisible and cannot be felt when they are passing through the skin to reach the cancer.

Particle beam radiation therapy: Particle beams are made up of separate units of energy, such as protons or neutrons. The radiation is released from the machine as a stream of high-energy particles. Particle beams can travel deep into the body like photon beams, but their energy only is released at a certain distance. This means that this type of radiation can often be used to deliver more radiation to the tumor while limiting its effects on normal tissues in front of and behind the tumor.

Particle beams are given by special machines called **particle accelerators**, such as a cyclotron or synchrotron. The particle beams are invisible and cannot be felt when they are passing through the skin to reach the cancer.

Electron beam radiation therapy: Electron beams are also separate units of energy and can act like particle beams or can be converted into photon beam radiation. Electrons do not travel very far into the body, so they are most often used to treat cancers on the skin[1] or near the body surface.

Electron beams can be given from a linear accelerator or a particle accelerator. The electron beams are invisible and cannot be felt when they are aimed at the skin.

Types of external radiation therapy

Photon beam radiation therapy

Three-dimensional conformal radiation therapy (3D-CRT): 3D-CRT delivers radiation beams from different directions designed to match the shape of the tumor. This helps to reduce radiation damage to normal tissues and better kill the cancer cells by focusing the radiation dose on the tumor's exact shape and size.

Intensity modulated radiation therapy (IMRT): IMRT is like 3D-CRT, but it also changes the strength (intensity) of some of the beams in certain areas. This allows stronger doses to be aimed at certain parts of the tumor and helps lessen damage to nearby normal body tissues.

Helical tomotherapy is a form of IMRT that delivers radiation in a special way. For this treatment, the radiation machine delivers many small beams of radiation at the tumor from different angles around the body. This may allow for radiation to be even more precisely focused.

Stereotactic radiosurgery (SRS): This isn't really surgery, but a type of radiation treatment that gives a large dose of radiation to a small tumor area, usually in one session. It's used for brain tumors and other tumors inside the head. Once the exact location of the tumor is known from brain scans, radiation is aimed at the area from many different angles so it affects nearby tissues as little as possible. While it's called "radiosurgery" because of how exact it can be in terms of where it delivers the radiation, there is no cutting or incision involved.

When this type of treatment is used outside the brain, it is called **stereotactic body radiation therapy (SBRT)**. SBRT can be used for some lung, spine, liver, kidney, prostate, and other tumors.

In many radiation therapy clinics this technology is called by the name of the company that makes the machine. You might hear these names being used at the treatment center or when talking to your cancer care team or other patients.

- **X-Knife, CyberKnife, and Clinac:** These machine moves around to target the tumor from many different angles. Other brands of this type include **Synergy-S , Edge, Novalis,** and **TrueBeam**.
- **Gamma Knife** uses about 200 small beams of radiation at one time, creating a very large dose. It's usually given in one treatment session. It's important to remember it doesn't use a knife and there's no cutting.
- Another type of machine aims particle beams (like proton or helium ion beams) at the tumor from different angles. These particles release most of the radiation's energy at the end of their paths, at more exact locations. This limits damage to nearby healthy tissues or organs.

Although most patients will be given the full radiation dose in one session with stereotactic radiosurgery, it can be repeated if needed. Sometimes doctors give the radiation in several smaller treatments to deliver the same or slightly higher dose. This may be called **fractionated radiosurgery** or **fractionated stereotactic radiotherapy**.

Image guided radiation therapy (IGRT): Many of the treatment approaches above can be given using IGRT, where imaging scans (like a CT or MRI) are done before each treatment session. A tumor might not be in exactly the same place within the body before each treatment. Using IGRT lets the radiation oncologist adjust the position of the patient or the aim of the radiation beams as needed to be sure that the radiation is focused on the tumor exactly and that exposure to normal tissues is limited.

MRI-guided radiation therapy: This approach, also known as **MRI-guided adaptive radiation therapy**, combines some features of IMRT, IGRT, and SBRT. It is done with a machine known as an **MRI-linac**, which combines an MRI scanner with a linear accelerator (linac, the machine that delivers the radiation).

As with other types of IGRT, MRI pictures can be taken before each treatment, so the aim of the radiation can be adjusted to account for any change in the position of the tumor since the last treatment.

MRI images can also be taken while the radiation is being given. If body functions (like breathing or digestion) cause the tumor to move out of the path of the radiation, the radiation stops until it is aimed correctly again. This can help reduce the amount of radiation to healthy tissues and organs around the tumor as much as possible.

MRI-linac machines are made by MRIdian and Elekta.

Intraoperative radiation therapy (IORT): This is external radiation given directly to the tumor or tumors during surgery. It may be used for tumors that can’t be removed completely or when there’s a high risk the cancer will come back in the same area. While you are asleep (under anesthesia), the surgeon moves normal tissues away from the tumor and protects them with special shields. This lets the doctor give one large dose of radiation to the cancer and limit the effects on nearby tissues. IORT is given in a special operating room.

Particle beam radiation therapy

Proton beam radiation therapy focuses beams of protons instead of photons (x-rays) on the cancer. Unlike photons, which go through the body and expose tissues to radiation both before and after they hit the tumor, protons only travel a certain distance, so the tissues behind the tumor are exposed to very little radiation. Even the tissues in front of the tumor see less radiation than the tumor itself. This means that proton beam radiation can deliver radiation to the cancer while doing less damage to nearby normal tissues.

Proton beam radiation might be used to treat tumors that are close to critical structures such as in the following cancers:

- Eye melanoma[2]
- Prostate cancer[3]
- Tumors of the spine
- Sarcomas near the base of the skull
- Certain head and neck cancers[4]
- Certain childhood cancers

Although proton therapy might be a safe option in certain cases when using x-rays is not, it has not been shown to be clearly better than traditional photon therapy in any adult solid cancer. Given this, more research is needed to find out exactly where proton beam therapy fits in cancer treatment.

Proton therapy is only available at certain treatment centers in the United States. It might also not be covered by all insurance companies at this time.

How does your doctor plan your radiation treatment?

Radiation is planned and given by a team of trained health care providers. The **radiation oncologist** is a doctor who treats cancer with radiation and oversees the care of each patient getting radiation. Working closely with the radiation oncologist, the **radiation therapist** gives the daily radiation treatment and positions patients for each treatment. Other professionals include the medical physicist and dosimetrist who plan and calculate the doses of radiation.

Before starting radiation therapy, your radiation oncologist will examine you, review your medical history and test results, and pinpoint the exact area to be treated. This planning session is called *simulation*. You might hear this referred to as the *sim*. You'll be asked to lie still on a table while the radiation therapist uses imaging scans (like a CT scan or MRI) to define your treatment field (also called the *treatment port*). These are the exact places on your body where the radiation beams will be aimed.

The simulation is very important and may take some time. It's used to plan exactly where the treatment will be on or in your body. The radiation can then be delivered as directly as possible to the tumor while affecting normal, healthy tissues as little as possible.

Radiation beams are aimed very precisely. A special mold, mask, or cast of a body part might be made to make sure you are in the same position for each treatment and to help you stay still during treatment. The radiation therapist might mark the treatment field with freckle-sized dots of semi-permanent ink. The marks will likely fade away over time, but they're needed until your treatment is finished. Don't use soap on or scrub these marks. Sometimes the area may be marked with permanent dots like a tattoo. (These can later be removed with a laser.)

How much radiation is given?

Based on the simulation, other tests, and your cancer type, the radiation oncologist will work with the other members of his team to decide how much radiation is needed, how it will be given, and how many treatments you should have. They figure this out based on research that has shown what the minimum and maximum dose of radiation should be for the type of cancer and area of the body being treated.

If the cancer has not completely gone away or if it comes back, more treatment might be needed. In these cases, the radiation team will help decide whether or not radiation therapy is the best option. This decision depends on the type of cancer, where the tumor is, and how much radiation was given to the area before. If the maximum dose has already been reached, radiation might not be the best option and other treatment may be offered. Getting radiation again to the same area is called *re-irradiation*.

How long does external radiation treatment take?

In most cases the total dose of radiation needed to kill a tumor can't be given all at once. This is because a large dose given one time can cause more damage to nearby normal tissues. This can cause more side effects than giving the same dose over spread out over days or weeks into many treatments.

The total dose of external radiation therapy is usually divided into smaller doses called *fractions*. Most patients get radiation treatments daily, 5 days a week (Monday through Friday) for 5 to 8 weeks. Weekend rest breaks allow time for normal cells to recover. The total dose of radiation and the number of treatments is based on:

- The size and location of the cancer
- The type of cancer
- The reason for the treatment
- Your general health
- Any other treatments you're getting

Other radiation schedules might be used in certain cases. For instance, radiation therapy might last only a few weeks (or less) when it’s used to relieve symptoms, because the overall dose of radiation needed is lower. In some cases, radiation might be given as 2 or more treatments each day. Or you might have several weeks off in the middle of treatments so your body can recover while the cancer shrinks. Your doctor will talk to you about the best plan in your case.

What happens during each treatment visit?

External radiation is a lot like getting a regular x-ray. The treatment itself is painless and takes only a few minutes. But each session can last 15 to 30 minutes because of the time it takes to set up the equipment and put you in the right position.

External radiation therapy is usually given with a machine called a linear accelerator which delivers a beam (or multiple beams) of radiation. The machine has a wide arm that extends over the treatment table. The radiation comes out of this arm. The machine can move around the table to change the angle of the radiation, if needed, but it won’t touch you. The radiation beams are invisible and you will not feel anything, but the machine will make noise.

Depending on the area being treated, you might need to undress, so wear clothes that are easy to take off and put on. You’ll be asked to lie on the treatment table next to the radiation machine.

The radiation therapist might put special heavy shields between the machine and parts of your body that aren’t being treated to help protect normal tissues and organs.

Once you’re in the right position, the radiation therapist will go into a nearby room to operate the machine and watch you on a TV screen. The room is shielded, or protected from the radiation so that the therapist isn’t exposed to it. You can talk with the therapist over an intercom. You’ll be asked to lie still during the treatment, but you won’t have to hold your breath.

The machine will make clicking and whirring noises and might sometimes sound like a vacuum cleaner as it moves to aim the radiation beam from different angles. The radiation therapist controls the movement and checks to be sure it’s working properly. If you’re concerned about anything that happens in the treatment room, ask the therapist to explain. If you feel ill or uncomfortable during the treatment, tell the therapist right away. The machine can be stopped at any time.

Will I be radioactive during or after external radiation treatment?

External radiation therapy affects cells in your body only for a moment. Because there's no radiation source in your body, you are not radioactive at any time during or after treatment. Talk to your cancer care team if you have questions about special precautions.

Hyperlinks

1. www.cancer.org/cancer/skin-cancer.html
2. www.cancer.org/cancer/eye-cancer.html
3. www.cancer.org/cancer/prostate-cancer.html
4. www.cancer.org/cancer/head-neck-cancer.html

References

American College of Radiology and the Radiological Society of North America. E*xternal beam therapy*. Accessed at https://www.radiologyinfo.org/en/info.cfm?pg=ebt on December 26, 2019.

American College of Radiology and the Radiological Society of North America. *Introduction to cancer therapy (radiation oncology)*. Accessed at https://www.radiologyinfo.org/en/info.cfm?pg=intro_onco#part_two on December 26, 2019.

American College of Radiology and the Radiological Society of North America. *Radiation therapy*. Accessed at https://www.radiologyinfo.org/en/submenu.cfm?pg=onco on December 26, 2019.

American Society for Radiation Oncology (ASTRO). *ASTRO/ASCO/AUA guideline on hypofractionation for localized prostate cancer.* Accessed at https://www.astro.org/Patient-Care-and-Research/Clinical-Practice-Statements/ASTRO-39;s-guideline-on-hypofractionation-for-loca on December 26, 2019.

Drapek L. Radiation therapy. In Newton S, Hickey, Brant, JM, eds. *Mosby's Oncology Nurse Advisor*. 2nd ed. St Louis, MO: Elsevier; 2017:168-171.

Forshaw K, Hall AE, Boyes AW, et al. Patients' experiences of preparation for radiation therapy: A qualitative study. *Oncol Nurs Forum*. 2017; 44(1):E1-E9.

Goodburn, RJ, Philippens, MEP, Lefebvre, TL, et al. The future of MRI in radiation therapy: Challenges and opportunities for the MR community. *Magn Reson Med*. 2022; 88: 2592- 2608. doi:10.1002/mrm.29450

Halperin EC. Particle therapy and treatment of cancer. *Lancet Oncol*. 2006;7(8):676-685. doi:10.1016/S1470-2045(06)70795-1.

Mitin T. Radiation therapy techniques in cancer treatment. In: Vora SR, ed. *UpToDate*. Waltham, Mass.: UpToDate, 2022. https://www.uptodate.com. Accessed April 8, 2022.

Morgan MA, Ten Haken RK, Lawrence TS. Chapter 16 - Essentials of Radiation Therapy. In: DeVita VT, Lawrence TS, Rosenberg SA, eds. *DeVita, Hellman, and Rosenberg's Cancer: Principles and Practice of Oncology*. 11th ed. Philadelphia, Pa: Lippincott Williams & Wilkins; 2019.

National Cancer Institute. External Beam Radiation Therapy for Cancer. 2018. Accessed at https://www.cancer.gov/about-cancer/treatment/types/radiation-therapy/external-beam on April 8, 2022.

National Cancer Institute. Is Proton Therapy Safer than Traditional Radiation? 2020. Accessed at https://www.cancer.gov/news-events/cancer-currents-blog/2020/proton-therapy-safety-versus-traditional-radiation on April 8, 2022.

Otazo R, Lambin P, Pignol J-P, et al. MRI-guided radiation therapy: An emerging paradigm in adaptive radiation oncology. *Radiology*. 2021;298(2):248-260. doi:10.1148/radiol.2020202747

Trikalinos TA, Terasawa T, Ip S, Raman G, Lau J. *Particle Beam Radiation Therapies for Cancer*. Rockville (MD): Agency for Healthcare Research and Quality (US); November 2009.

Zeman EM, Schreiber EC, Tepper JE. Chapter 27 – Basics of Radiation Therapy. In: Niederhuber JE, Armitage JO, Doroshow JH, Kastan MB, Tepper JE, eds. *Abeloff's Clinical Oncology*. 6th ed. Philadelphia, Pa: Elsevier; 2020.

Last Revised: February 13, 2023

Written by

The American Cancer Society medical and editorial content team
(www.cancer.org/cancer/acs-medical-content-and-news-staff.html)

Our team is made up of doctors and oncology certified nurses with deep knowledge of cancer care as well as journalists, editors, and translators with extensive experience in medical writing.

cancer.org | 1.800.227.2345