

RADIATION THERAPY FOR **CANCER**



Your Partners in Cancer Treatment

ASTRO

AMERICAN SOCIETY FOR RADIATION ONCOLOGY

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Remember, your radiation oncologist, radiation therapist and radiation oncology nurse are the best people to make recommendations and answer questions about radiation treatments.

Introduction

This booklet is for people who want to know more about radiation therapy as a treatment option for cancer and other diseases. Radiation, either alone or in combination with other cancer therapies, can be used to successfully treat and cure many different types of cancers and other diseases. Finding out that you have cancer may lead to a flood of feelings and concerns. Learning about your disease and ways to treat it can be overwhelming and confusing. As you prepare for treatment, it may be helpful to learn as much as you can about your treatment options and what you may experience. Radiation therapy techniques and procedures may vary among different doctors, hospitals and treatment centers. Be sure to ask questions if the advice of your doctor is different from what you read here, see in other publications, hear on the news or find on the Internet. Your care will be individually tailored for you by your treatment team. There is no way to fully describe the many combinations of therapies given to patients in this type of brochure. Rather, some general themes and principles are provided for your information.

Cancer doctors can treat cancer with radiation therapy, surgery or with systemic therapy such as chemotherapy, hormonal therapy, biologic therapy or immunotherapy. Sometimes a combination of these are used. If your cancer can be treated with radiation therapy, you will be seen by a radiation oncologist — a doctor who specializes in treating patients with this technology. Your radiation oncologist will work with your primary doctor and other cancer specialists, such as surgeons and medical oncologists, to oversee your care. He or she will discuss the details of your cancer, the role of radiation therapy in your overall treatment plan and what to expect from your treatment.



HOW DOES RADIATION THERAPY WORK?

Radiation therapy, or **radiotherapy**, is the use of various forms of radiation to safely and effectively treat cancer and other diseases. Radiation therapy works by damaging the genetic material within cancer cells. Once this happens, the cancer cells are not able to grow and spread. When these damaged cancer cells die, the body naturally removes them. Normal cells are also affected by radiation, but they are able to repair themselves in a way that cancer cells cannot as effectively. Your radiation oncologist will develop a plan to deliver the radiation to the affected area or tumor, shielding as much surrounding normal tissue as possible.

Your radiation oncologist may recommend using radiation therapy in a number of different ways. When the goal is to **cure** the cancer, radiation therapy may be used to:

- Eliminate tumors.
- Reduce the risk that cancer will return after you undergo surgery or chemotherapy by killing cancer cells that might remain.
- Shrink the tumor before surgery.

Sometimes, even after the cancer has spread, it may have only spread to a limited number of areas around your body, or you may have one or more areas that grow while others remain stable on other treatments. Radiation can sometimes be used in this setting to treat or eliminate these tumors as well.

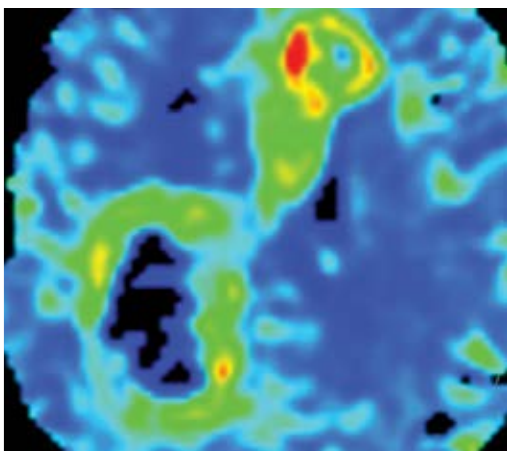
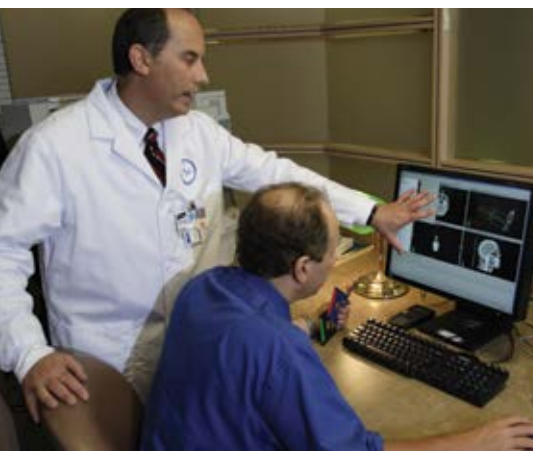
When the goal is to reduce the symptoms caused by growing tumors, radiation may be used to improve your quality of life. When radiation therapy is given for this purpose, it is called **palliative care** or **palliation**. In this instance, radiation therapy may be used to:

- Shrink tumors that are harming your quality of life, such as a lung tumor that is causing problems with breathing.
- Relieve pain by reducing the size of a tumor.
- Treat cancer in a bone to prevent it from breaking (pathologic fracture).

It is important for you to discuss the goal of your treatment with your radiation oncologist.

Did You Know?

Physicians have been treating patients with radiation therapy safely and effectively for more than 120 years. Nearly two-thirds of cancer patients are treated with radiation during their illness.



WHAT ARE THE DIFFERENT KINDS OF RADIATION?

The goal of radiation therapy is to deliver enough radiation to kill the cancer cells while preventing permanent damage to surrounding healthy tissue. Depending on the location, size and type of cancer, you may receive one or a combination of techniques. Your treatment team will help you decide which treatments are best for you.

Radiation therapy can generally be delivered in three ways:

- 1. External beam radiation therapy:** The treatment team uses a machine outside the body to direct radiation beams such as high-energy X-rays, or particles, at the cancer. This category includes high-dose therapy called stereotactic radiation therapy.
- 2. Brachytherapy:** This involves placing radioactive sources (such as radioactive seeds or a highly radioactive source) in or near the tumor.
- 3. Systemic radiation therapy:** Radioactive drugs are given to the patient and travel through the bloodstream to treat cancer throughout the body.

EXTERNAL BEAM RADIATION THERAPY

During external beam radiation therapy, a beam (or multiple beams) of radiation is directed from the outside of the body to the site of the cancer and the immediate surrounding area to destroy the tumor and any nearby cancer cells. If the cancer has been removed or reduced by surgery or chemotherapy before radiation therapy, the target will be the tissues surrounding the location of the tumor at diagnosis. To minimize side effects, the treatments are typically given five days a week, Monday through Friday, for a number of weeks. This allows doctors to give small daily doses of radiation that build up to enough radiation to kill the cancer while giving healthy cells time to recover. Today, doctors can often use slightly higher doses of radiation to safely complete the treatment in a shorter period of time. This is called hypofractionation.

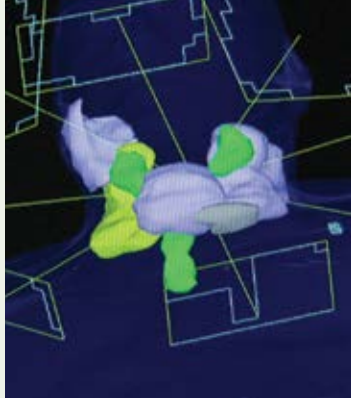
The radiation beam that is used for treatment is usually generated by a machine called a **linear accelerator**, or **linac**. The linear accelerator produces high-energy X-rays or electrons for the treatment of your cancer. Using treatment planning computers and software, your treatment team controls the size and shape of the beam, as well as how it is directed at your body, to effectively treat your tumor while sparing the surrounding normal tissue. Several special types of external beam therapy and planning techniques, used for specific types of cancer, are discussed in the next sections.

Three-Dimensional Conformal Radiation Therapy (3-D CRT)

Tumors are not all the same; they come in different shapes and sizes. Also, every patient's body is unique. **Three-dimensional conformal radiation therapy is a planning technique using** computers and special imaging such as **CT, MR or PET** scans to show the size, shape and location of the tumor as well as surrounding organs. Your radiation oncologist can then precisely tailor the radiation beams to the size and shape of your tumor with special shielding. Because the radiation beams are carefully targeted, nearby normal tissue receives less radiation and is then able to heal better.

Did You Know?

Radiation therapy works by damaging the DNA within cancer cells and destroying the ability of the cancer cells to reproduce. When these damaged cancer cells die, the body naturally eliminates them. Normal cells are also affected by radiation, but they are able to repair themselves in a way that cancer cells cannot.



Intensity Modulated Radiation Therapy (IMRT)

Intensity modulated radiation therapy is a more complex treatment planning technique that allows radiation to be specifically shaped to cover the tumor and potentially spare more normal tissue than 3-D CRT. With IMRT, the radiation beam is broken up into many “beamlets,” and the intensity of each beamlet can be adjusted individually.

Image Guided Radiation Therapy (IGRT)

Radiation oncologists may also use **image-guided radiation therapy** to more accurately deliver radiation to the cancer. IGRT involves radiation treatment guided by imaging, such as CT, ultrasound, X-rays or MRI taken in the treatment room just before or during each radiation treatment. Because tumors can move between or during treatments, due to differences in organ filling or natural movements while breathing, IGRT



allows for better targeting of tumors. You will first undergo a CT scan as part of the planning process. The information from the CT scan is then sent to a computer in the treatment room to allow the team to compare the earlier image with the images taken just before treatment to see if the position of your body needs to be adjusted before the treatment.

In some cases, doctors will implant tiny markers in or near the tumor to help localize the treatment area. These implanted pieces of metal are called fiducial markers. Adaptive radiotherapy allows the radiation oncologist to change the radiation plan based on tumor response or internal organ changes during treatment. Overall, IGRT allows the team to better target the cancer while avoiding nearby healthy tissue.

Stereotactic Radiation Therapy

Stereotactic radiotherapy is a specialized technique that allows your radiation oncologist to use extremely focused beams of radiation to destroy certain types of tumors using higher doses than with daily lower-dose radiation treatments. Since the beam is so precise, your radiation oncologist may be able to spare more healthy tissue. In selected cases, stereotactic treatments can be used to re-treat tumors that have received radiation before.



Stereotactic radiotherapy was first developed to treat brain tumors in a single dose, sometimes called **stereotactic radiosurgery** or **SRS**. In addition to treating cancers, radiosurgery can also be used to treat benign tumors and certain noncancerous neurologic conditions. In some cases, using more than a single dose may allow doctors to treat larger areas or help decrease the risk of side effects with stereotactic radiation therapy. High-dose treatment outside the brain is called **stereotactic body radiation therapy (SBRT)**. It is typically given in a few treatments, sometimes delivered every other day. Often used to treat tumors in the lungs, spine, prostate, pancreas, adrenal glands or liver, SBRT may allow radiation to be given in a way that is safer and more effective than other radiation techniques.

Because specialized treatments with stereotactic radiation are often given at much higher doses than daily radiation treatment, additional precision and quality assurance are necessary. This involves using very secure immobilization of the head or body as well as using techniques that allow the radiation beam to account for organ motion during treatment.

There are several different types of machines capable of delivering stereotactic radiation treatments. Some are used only for certain parts of the body while others can treat many different sites. If you are offered stereotactic treatment, ask your radiation oncologist which machine is best for your treatment.

Electron Therapy

The same machines that make X-ray therapy (linacs) can also make a different type of beam made of electrons. Because electrons are physical, lightweight particles and not energy beams, they do not travel as deeply into the body, which allows doctors to use these types of beams in different ways. Electron therapy can be used on its own or sometimes combined with X-ray therapy to treat skin and breast cancers.

Intraoperative Radiation Therapy

Radiation therapy given during surgery is called **intraoperative radiation therapy**, which can be helpful when vital normal organs are very close to the tumor. Your surgeon and radiation oncologist work closely together to precisely deliver a single dose of radiation during surgery.

Proton Beam Therapy

Proton beam therapy is a form of external beam radiation treatment that uses protons rather than electrons or X-rays to treat certain types of cancer and other diseases. The physical properties of the proton therapy beam allow the radiation oncologist to more effectively reduce the radiation dose to nearby healthy tissue. As a result, proton beam therapy is often a favored type of therapy for treating pediatric cancers, tumors in the base of the skull, and for reirradiation. There are ongoing clinical trials to help determine whether proton therapy can reduce side effects or complications when it is combined with surgery instead of X-ray-based radiation therapy.

Neutron Beam and Carbon Ion Beam Therapy

Like proton therapy, **neutron beam and carbon ion beam therapy** are specialized forms of external beam radiation therapy. These treatments involve using subatomic particles called neutrons or larger carbon rather than electrons or X-rays to treat certain types of cancer. These therapies are often used to treat certain tumors that are **radioresistant**, meaning they are very difficult to kill using conventional X-ray radiation therapy. Neutrons and heavy ions such as carbon have a greater biologic impact on cells than other more commonly used types of radiation, including proton therapy. Used carefully, this added impact can be an advantage in certain situations. Neutron therapy is available at only a few centers in the country and carbon ion therapy is currently available only outside the U.S.

BRACHYTHERAPY

Brachytherapy is the placement of radioactive sources in or just next to a tumor. During brachytherapy, the radioactive sources may be left in place permanently (low-dose) or only temporarily (high-dose).

There are two main forms of brachytherapy – **intracavitary treatment** and **interstitial treatment**. With intracavitary treatment, the radioactive sources are put into a space near where the tumor is located, such as the cervix, the vagina or the windpipe (trachea). With interstitial treatment, tubes (catheters) are placed directly into the tissues, such as the prostate, perineum or oral cavity, through which the radioactive sources are delivered. Another use of brachytherapy is surface mold brachytherapy, which can be used externally to treat some skin cancers.

Depending on the technique, a radiation therapy dose from brachytherapy can be delivered with one of two different dose rates – **high-dose-rate (HDR)** or **low-dose-rate (LDR)**. With HDR brachytherapy, radiation dose is deposited at a faster rate with temporary implants. LDR brachytherapy emits radiation at a slower rate with either temporary (pulsed) or permanent implants.

HDR brachytherapy involves the temporary placement of a powerful radiation source, accurately directed by your radiation oncologist and team. It is delivered into the tumor through a tube called a catheter. It is usually given in multiple doses once or twice daily or once or twice weekly. This procedure may require anesthesia and a surgical procedure. Your doctor and team will control this treatment from outside the treatment room, monitoring you as the therapy is being given. Devices called remote afterloader machines allow the team to deliver treatments quickly. You may be able to go home shortly after the procedure, resuming your normal activities with few restrictions. With HDR brachytherapy, you do not have active radiation in your body when you leave the treatment center .

Did You Know?

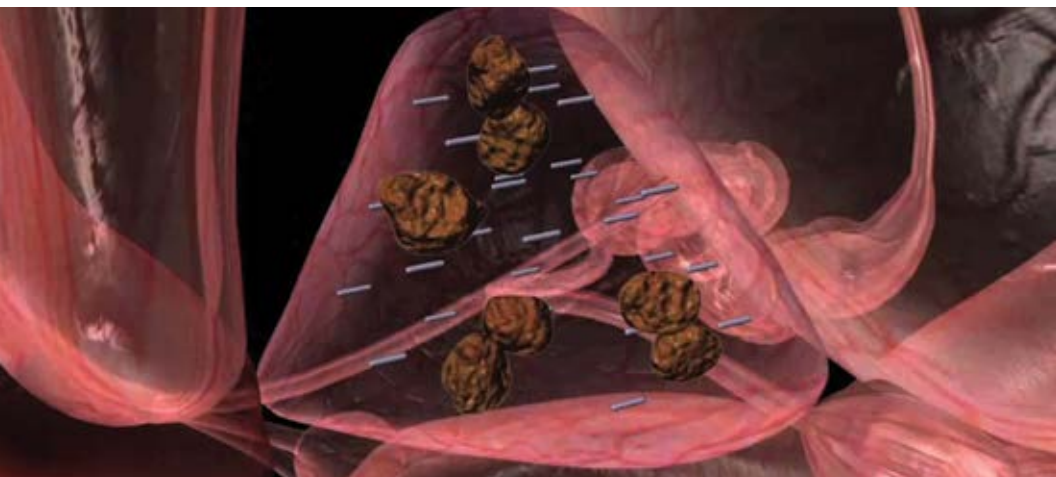
Whether you receive external beam radiation therapy or brachytherapy, your treatment schedule may vary. Although it is often given as a daily treatment Monday to Friday, radiation therapy may be given in different doses. In selected cases, radiation treatments are given in smaller doses twice a day or higher doses every other day. These different schedules are designed to improve tumor control, lessen side effects or both.



LDR brachytherapy involves the placement of temporary or permanent radiation sources into the tumor area. Placement of permanent radiation sources often requires anesthesia, a surgical procedure and a brief stay in the hospital. Patients with permanent implants may have a few restrictions at first due to residual radiation dose and then can quickly return to their normal activities. Temporary implants are left inside the body for minutes, hours or days, depending on the type of brachytherapy. While the temporary radioactive sources are in place, patients stay in a private room. During this period, doctors, nurses and other medical staff will continue to take care of patients, but they will take special precautions to limit their exposure to radiation. Once the temporary implants are removed, these patients have few restrictions and can quickly return to their regular routine.

Most patients feel little discomfort during brachytherapy. If the radioactive source is held in place with an applicator, you may feel discomfort from the applicator. There are medications that can relieve this discomfort. If you feel weak or queasy from the anesthesia, ask your team for medication to help you feel better.

Depending on the type of brachytherapy you receive, you may need to take some precautions after you leave your treatment, particularly if you plan to be around young children or pregnant women. Ask your radiation oncologist or radiation oncology nurse about anything special you should know.



Brachytherapy may be used alone or in combination with external radiation treatments. Your radiation oncologist will advise you on whether these treatments are appropriate for you.

SYSTEMIC RADIATION THERAPY

Certain cancers may be treated with radioactive drugs that spread throughout the body via the bloodstream. These treatments may be delivered by swallowing radioactive pills or receiving radioactive fluids in the vein (intravenous). This type of treatment is called **systemic radiation therapy** because the medicine goes to the entire body. For example, radioactive iodine (I-131) capsules are given to treat some types of thyroid cancer. Another example is the use of intravenous radioactive material such as Radium-223 for prostate cancer that has spread to the bone. Other forms of this type of therapy include **radiolabeled antibodies** which are **monoclonal antibodies** with radioactive particles attached. These antibodies are designed to attach themselves directly to the cancer cell and damage it with small amounts of radiation. Theranostic radiopharmaceuticals are used to both diagnose disease and treat areas of cancer in the body. There are emerging theranostic approaches for both metastatic neuroendocrine tumors and prostate cancer.

Did You Know?

Before you receive radiation therapy, your radiation oncologist, dosimetrist and medical physicist work together using sophisticated computer software to calculate the best treatment for you. This treatment planning ensures that the tumor site receives the maximum amount of radiation while minimizing exposure to healthy tissue and organs.



IMMUNOTHERAPY

The immune system plays an important role in keeping us healthy. For example, immune cells fight infections by recognizing that a virus or bacteria does not belong in our body and then destroys it. The immune system also destroys most cancer cells as they form. Unfortunately, some cancer cells figure out ways to “hide” from the immune system. By avoiding destruction by the immune system, these cancer cells have a chance to grow and spread to another part of the body.

Immunotherapy is a type of drug or medication that can block the signals that cancer cells use to “hide” from our immune system. Blocking these signals allows the immune system to fight cancer in a very different way than other treatments like chemotherapy or radiation therapy, which directly damage cancer cells. There is still a lot to learn, though, about how to best use immunotherapy to fight cancer. While some cancers respond extremely well to immunotherapy, many others do not respond well. Most of the time, immunotherapy and radiation are used independently to treat the same cancers. Radiation therapy may help immunotherapy work better in some situations. This is a topic of active research at many cancer centers.

At this time, immunotherapy is most often used to treat cancer that has spread to other parts of the body. This is called metastatic cancer. Immunotherapy is also used along with surgery, radiation and chemotherapy to treat patients with cancer that has not yet spread.

Many research studies are ongoing to determine if radiation and immunotherapy can be combined to further enhance the effects of each treatment. However, these approaches are not widely used yet as part of routine cancer treatment.



WHAT ARE THE SIDE EFFECTS OF RADIATION THERAPY?

Most of the side effects of radiation therapy are limited to the area being treated. They are usually temporary, mild and treatable. These symptoms typically begin in the second or third week of treatment. They may last for a few weeks after the final radiation treatment and typically go away by one to two months after completing radiation therapy. For example, a breast cancer patient may notice skin irritation on the chest, like a mild to moderate sunburn, while a patient with cancer in the mouth may have soreness when swallowing.

The short-term side effect most often reported by patients receiving radiation therapy is fatigue. The fatigue experienced is usually mild or moderate and differs for each patient. Fatigue may also be related to the area being treated and other therapies, such as chemotherapy, that a patient may be receiving.

Patients may be able to continue all or a portion of their normal daily activities during radiation therapy.

However, receiving treatment for cancer often requires considerable mental and physical effort. Whenever possible, try to take time during your treatment to rest and relax. If you experience discomfort or other symptoms during or after treatment, be sure to tell your radiation oncology team. They may be able to recommend strategies, prescribe medication or suggest changes to your diet to help.

Long-term side effects of radiation therapy may occur in any normal tissues in the area that receive treatment. With careful radiation therapy planning using improved technologies, serious long-term side effects are uncommon. The risk of long-term side effects depends on the area receiving radiation as well as the radiation dose being given, and if the same area has already received radiation. It is best to discuss the specific risks of long-term side effects with your radiation oncologist.



Did You Know?

Some patients are concerned that radiation therapy will cause another cancer in the long term. In fact, the risk of developing a second tumor because of radiation therapy is extremely low. For many people, the benefits of radiation therapy to treat the cancer they already have outweigh any small risk that the treatment could cause a later cancer or other serious health condition.

In general, treatment-related cancers take 12 to 15 years or more to develop. To understand your personal risk of long-term effects from cancer therapy, it is best to discuss the risks and benefits of all of your treatments with your treatment team. If you smoke or drink too much alcohol, the most important thing you can do to reduce your risk of a second cancer is to quit smoking and moderate your alcohol consumption.

WHO ARE THE MEMBERS OF THE RADIATION THERAPY TEAM?

A team of highly trained medical professionals will be involved in your care during radiation therapy. This team is led by a radiation oncologist, a doctor who specializes in using radiation to treat cancer.

Radiation Oncologists

Radiation oncologists are the doctors who will oversee your radiation therapy treatments. These physicians work with the other members of the radiation therapy team to develop your treatment plan and ensure that each treatment is given safely and accurately. Your radiation oncologist will also monitor your progress and adjust the treatment as necessary to make sure the radiation is hitting its target while minimizing side effects. Before, during and after your radiation therapy, your radiation oncologist works closely with other cancer doctors such as medical oncologists and surgeons to maximize radiation's effectiveness.

Radiation oncologists are the only physicians with the expertise and training to deliver radiation therapy treatments. In addition to college and medical school, five years of residency training are required for radiation oncologists. They receive extensive training in cancer medicine, in the use of radiation to treat disease and in managing any side effects caused by

radiation. Radiation oncologists must pass a series of four examinations by the American Board of Radiology to become board certified.

Radiation Therapists

Radiation therapists work under the supervision of the radiation oncologist to give daily radiation treatments. They are experts at operating the radiation therapy machines (linacs) and require specialized training. They carefully and skillfully set up patients for their daily treatments.

Radiation Oncology Nurses and Medical Assistants

Radiation oncology nurses and medical assistants work with every member of the treatment team to care for you and your family before, during and after treatment. They help explain the possible side effects that you may experience and describe how you can manage them. Nurses and medical assistants assess how you are doing throughout treatment and can help you cope with the changes you are experiencing.



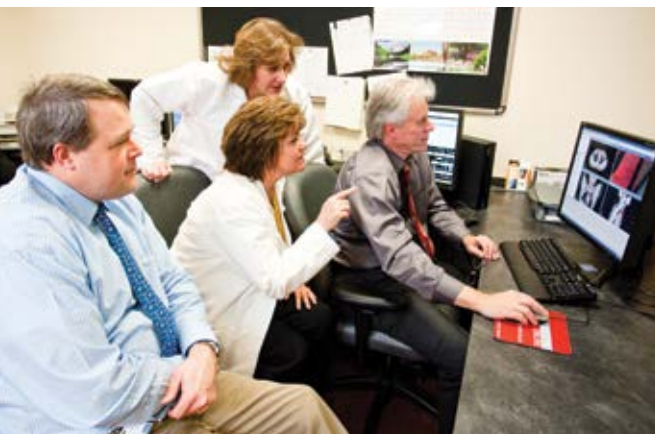
Medical Physicists

Medical physicists work directly with the radiation oncologist during treatment planning and delivery. They oversee the work of the dosimetrist and help ensure that complex treatments are properly tailored for each patient. Medical physicists develop and direct quality control programs for equipment and procedures to ensure maximum treatment safety. They are trained with advanced degrees and are appropriately credentialed to provide this important service. These professionals make sure the equipment works properly by taking precise measurements of the radiation beam and performing other safety tests on a regular basis.

Dosimetrists

Dosimetrists work with the radiation oncologist and medical physicist to develop an optimized treatment plan that best destroys the tumor while sparing healthy tissue. They carefully calculate the dose of radiation to make sure the tumor gets the prescribed amount. These professionals require advanced training to create expert radiation plans.

Other members of the treatment team may include interventional radiologists, nurse practitioners or physician assistants, social workers, nutritionists or dietitians, patient navigators, radiation engineers, physical therapists, radiation data managers and dentists. In cases where radiation is used in combination with systemic therapy (chemotherapy or immunotherapy) or surgery, a coordinated multidisciplinary team often extends beyond the radiation treatment team to include health care professionals from medical oncology and surgery.



IS RADIATION THERAPY SAFE?

Some patients worry about the safety of radiation therapy. Radiation has been used successfully to treat patients for more than 120 years. In that time, many advances have been made to ensure that radiation therapy is safe and effective. With each advance, new quality checks have been developed to ensure safe treatment.

Before you begin receiving radiation therapy, your radiation oncology team will carefully design a customized plan, tailored to your cancer diagnosis and your individual anatomy, to make sure that you receive safe and accurate treatment. Treatment will be carefully planned to focus on the cancer while avoiding healthy organs in the area. Throughout your treatment, members of your team will check and recheck your plan through repeat imaging and review of your medical record. The team will meet with you at least weekly to assess your progress and monitor any unexpected side effects that are occurring. Special computers are also used to monitor and double-check the treatment machines to make sure that the proper treatment is given.

Did You Know?

If you undergo external beam radiation therapy, you will not be radioactive after treatment ends because the radiation does not stay in your body. However, if you undergo low-dose or high-dose brachytherapy, tiny radioactive seeds may be implanted into your body either temporarily or permanently. Your radiation oncologist will explain any special precautions that you or your family may need to take for a short time following treatment to ensure the safety of those around you.



The medical physicist will work with the team to develop an extensive safety and quality assurance plan to ensure that you receive the safe and correct treatment. Dosimetrists use advanced computerized systems to carefully measure the dose of radiation that patients receive to each critical area. Radiation therapists expertly deliver treatments using specialized protocols designed to enhance your safety. Radiation oncologists oversee every step of the entire process, focusing on safe and effective treatment for every patient.

WHAT HAPPENS BEFORE, DURING AND AFTER TREATMENT?

Once a diagnosis of cancer has been made, you will probably speak with your primary care physician along with several cancer specialists, such as a surgeon, a medical oncologist and a radiation oncologist. Before you meet with your treatment team, your case may be presented at a combined meeting of all medical specialties that treat your type of cancer. These meetings are usually organized by the hospital where you received your diagnosis and are called tumor boards. Tumor board participants can help create a combined, customized plan to treat your cancer. When you meet with your medical team, you will want to ask your doctors about all your treatment options. In many cases, your cancer will need to be treated by using more than one type of treatment. For example, if you have breast cancer, you might have surgery to remove the tumor (by a surgeon), then have radiation therapy to destroy any remaining cancer cells in or near your breast (by a radiation oncologist). You also might receive chemotherapy or immunotherapy (by a medical oncologist) to destroy cancer cells that may have traveled to other parts of the body. After reviewing your medical record including imaging, as well as completing a thorough patient history and physical examination, your radiation oncologist will discuss with you the potential benefits and risks of radiation therapy and answer your questions.

BEFORE TREATMENT

If you are considering radiation therapy, you must first meet with a radiation oncologist. During your first visit, your doctor will evaluate you to determine if radiation therapy will be helpful in treating your disease.



This includes reviewing your current medical history, past medical history, past surgical history, family history, medications, allergies, lifestyle and current symptoms. The doctor will also perform a detailed physical exam to assess the extent of your disease and your general physical condition. Your medical record will be reviewed including any relevant imaging and laboratory studies. Frequently, your care will be discussed among other cancer professionals before your treatment is finalized.

The radiation oncologist will discuss the benefits, risks, side effects and treatment alternatives of radiation therapy with you and your caregivers. If you decide to receive radiation therapy, you will proceed to treatment planning at the appropriate time.

Simulation

Radiation therapy must be aimed precisely at the treatment target each and every time treatment is given. The process of measuring your body and tumor to help your team direct the beams of radiation safely and accurately to their intended locations is called **simulation**.

During simulation, your radiation oncologist and radiation therapist place you on the CT scanner designed to do simulations in the exact position you will be in during the actual treatment. You may also undergo other scans such as a PET or MRI. **Immobilization devices** such as molds, casts, face masks, headrests or other devices are customized to help you remain in the same position during the entire treatment. The radiation therapist, under the radiation oncologist's supervision, marks the area to be treated

on the immobilization devices and/or your skin with either a bright, temporary paint or a set of small, permanent tattoos. This CT scan may be combined with prior diagnostic imaging to help with designing the placement and shape of the radiation beams. Your radiation oncologist may order special blocks, buildup material called bolus or shields be made for you. These devices are used with each treatment to direct the radiation to your tumor and keep the radiation away from normal tissue. Additionally, your radiation oncologist may suggest taking multiple images to measure and understand how a tumor moves with breathing.

Treatment Planning

Once you have finished simulation, your radiation oncologist and other members of the treatment team review information obtained during simulation along with your previous medical tests to develop a **treatment plan**. The goal of radiation therapy is to develop a plan that maximizes the dose to the cancer and minimizes the dose to normal tissues. Radiation treatment technique, radiation dose, as well as beam angles and shapes will be selected during the planning process. A team of experts including your radiation oncologist, medical physicist and dosimetrist will work together to develop the radiation treatment plan. A sophisticated treatment planning computer and associated software may be used to help design the best possible treatment plan. After reviewing all of this information, your radiation oncologist will write a prescription that outlines exactly how much radiation you will receive and to what parts of your body.



Quality Assurance Before Treatment

Once your radiation oncologist approves the radiation therapy plan developed in treatment planning, members of the radiation treatment team work together to ensure that your specific treatment plan works correctly on the linear accelerator before treatment begins. A “dry run” or testing session is often completed one to two days before treatment begins for more complex treatments by the therapists and medical physicist to ensure that the radiation treatment designed for you is as accurate and as safe as possible.

DURING EXTERNAL BEAM RADIATION THERAPY TREATMENTS

When you undergo external beam radiation therapy treatment, each session is painless, just like getting an X-ray. The radiation is directed at your tumor from a machine located away from your body, usually a linear accelerator. External beam radiation therapy is noninvasive which means you will neither see the treatment nor feel it. When the beam is off, there is no more radiation, so you will not be radioactive or a danger to anyone else around you. One of the benefits of radiation therapy is that it is usually given as a series of outpatient treatments so you do not have to stay in the hospital. You may not need to miss full days of work or experience the type of recuperation period that may follow more invasive treatments. The radiation therapists will deliver your external beam treatment following your radiation oncologist’s instructions. If an immobilization device was made during simulation, it will be used during





every treatment to make sure that you are in the exact same position every day. Radiation therapists position you for treatment and set up the equipment. Time spent in the treatment room will vary depending on the type of radiation.

Once you are positioned correctly, the therapist will leave the treatment room and enter the control room next door to begin your treatment. During your treatment, your therapist will closely monitor you on a television screen. There is a microphone and speaker inside the treatment room so you can always speak with the therapist if you have any concerns. The machine can be stopped at any time if you are feeling sick or uncomfortable.

The radiation therapist may move the treatment machine and treatment table to target the radiation beam to the exact area of the tumor. The machine might make noises during treatment that sound like clicking, knocking or whirring, but the radiation therapist is in complete control of the machine at all times.

Your radiation oncologist monitors your daily treatment and may alter your radiation dose based on these observations. Also, your doctor may obtain other tests such as blood tests and imaging to see how your body is responding to treatment. Although it is possible for some tumors to visibly shrink during treatment, assessment of the success of the treatment usually comes many months or even years after the treatment has been completed. If the tumor does shrink during treatment or if your body changes significantly, another simulation may be required. This allows your radiation oncologist to change the treatment to destroy the rest of the tumor and spare even more normal tissue.

Sometimes a course of treatment may need to be interrupted for a day or more. This may happen if you develop side effects that require a break in treatment. Unscheduled machine maintenance may also cause a missed daily treatment. These missed treatments may be made up by adding treatments at the end. However, it is best to arrive on time and not miss any of your appointments.

Treatments are usually scheduled five days a week, Monday through Friday, and continue for multiple weeks. The number of radiation treatments you will need depends on the size, location and type of cancer you have, the goal of treatment, your general health and other medical treatments you may be receiving. Radiation oncologists will take all of this into account when determining your treatment course.

A portion of your external beam radiation therapy may be directed at the tumor and surrounding tissues at risk. This might be followed by treating a smaller area containing the tumor in the final one to two weeks of treatment. When a smaller area receives more total treatments (higher dose), it is called a boost or cone down procedure.

In some cases, you may receive systemic therapy and radiation therapy at the same time. The systemic therapy may be delivered daily, weekly, every three weeks or on an alternate schedule determined by the medical oncologist together with the radiation oncologist. The chemotherapy may work to make the cancer cells more sensitive to radiation therapy in the target area but may also travel elsewhere in the body to help destroy or reduce microscopic cancer cells. Your treatment team will help coordinate these therapies and care for potential side effects.

Weekly Checkups

During radiation therapy, your radiation oncologist and nurse or medical assistant will see you regularly to follow your progress, evaluate whether you are having any side effects, recommend treatments for those side effects (such as medication) and address any



concerns you may have. Many clinics schedule these appointments after one of your daily treatments and call them “On Treatment Visits” or “Doctor Day Visits.” During your treatment, your doctor may make changes in the schedule or treatment plan depending on your response or reaction to the therapy. Your radiation oncology team will gather on a regular basis with other health care professionals to review your case to ensure your treatment is proceeding as planned. During these sessions, all the members of the team discuss your progress and any concerns.

Quality Assurance During Treatment

During your course of treatment, correct positions of the treatment beams will be regularly verified with images made using the treatment beam itself. These images (called port films, beam films or portal verification) represent an important quality assurance check but do not evaluate the tumor itself. Depending upon what kind of treatment you receive and what your doctor thinks will work best, the type of images used (e.g., X-ray, CT scan, ultrasound, MRI, etc.) may vary. These images assure your radiation oncologist that the treatment setup accurately matches the intended target.

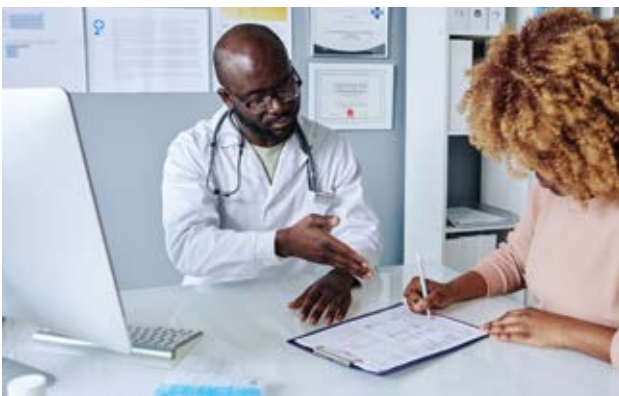
AFTER TREATMENT FOLLOW-UP

After treatment is completed, follow-up appointments will be scheduled so that your radiation oncologist can make sure your recovery is proceeding normally. Your radiation oncologist, together with other members of your treatment team, may order additional diagnostic tests such as CT scans, MRIs or PET scans. Reports on your treatment may be sent to the other doctors helping to treat your cancer. Continued follow-up in the radiation oncology clinic is recommended to evaluate for long-term side effects of radiation therapy and to ensure that the cancer does not return. As time goes by, the number of times you need to visit your radiation oncologist throughout the year will decrease. However, you should know that your radiation oncology team will always be available should you need to speak to someone about your treatment.



WHAT ARE CLINICAL TRIALS?

Cancer specialists regularly conduct studies to test new treatments. These studies are called clinical trials. Most standard cancer treatments are based on the results of previous **clinical trials**. Many national clinical trials are available through cancer doctors everywhere, not just in major cities, university centers or in large hospitals.



Some clinical trials try to determine if a therapeutic approach is safe and potentially effective. Many large clinical trials compare the more commonly used standard treatment with a treatment that cancer experts think might be better. Patients who participate in clinical trials

help doctors and future cancer patients find out whether a promising treatment is safe and effective. Clinical trials should be reviewed by an independent ethics committee that approves and monitors the research study such as an institutional review board (IRB). All patients who participate in clinical trials are carefully monitored to make sure they are getting quality care. Enrolling in clinical trials is completely voluntary. You can leave a trial at any time. Clinical trials testing new treatments are carried out in phases.

Phase I — Is the Treatment Safe?

When doctors are developing a new treatment, the first step is to determine the maximum safe dose of treatment that can be administered. This needs to be done before any determination of whether the drug is effective. Radiation phase I trials are different since radiation oncologists already know the standard doses of radiation that are effective. Phase I radiation trials may investigate combining radiation therapy with other treatments such as surgery or drugs or evaluate new techniques of delivering radiation therapy. These trials examine if the new treatment is safe and feasible.

Phase II — Does the Treatment Work?

In a phase II radiation study, radiation oncologists are trying to establish if the new treatment is effective for the cancer type they are trying to study. Researchers want to know if the new treatment shows enough promise in terms of controlling the tumor that it is worth testing against the standard therapy in a phase III trial. Side effects are closely monitored.

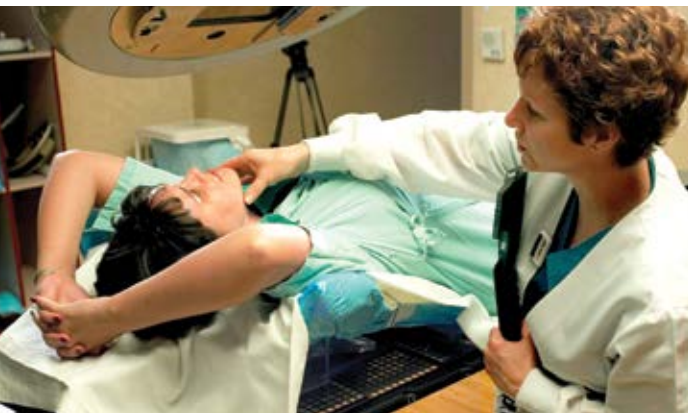
Phase III — Is the Treatment Better?

Phase III trials compare the new treatment against the current standard therapy and randomly assign patients into one of two groups. This is the gold standard of clinical research trials. If a new treatment is shown to be better than standard treatment in terms of cancer control and side effects in a phase III trial, experts will reconsider standard of care treatment.

Phase IV — Are There Better Ways to Use the Treatment?

In this final step, treatments are tested to make sure they are safe and work well over a long period of time. This phase most often occurs once the new treatment has been approved for standard use. Several hundred to several thousand people are enrolled in a phase IV trial.

Deciding to participate in a clinical trial is a personal decision that only the patient can make. Before enrolling, patients should learn as much as possible about cancer treatment and the clinical trials that are available. Patients should ensure that the clinical trial has been reviewed by an institutional review board. The radiation treatment team can answer any questions if a patient is considering a trial. Another good resource is the **National Cancer Institute** at **1-800-4-CANCER** or **www.cancer.gov**.



HOW CAN PATIENTS BEST CARE FOR THEMSELVES DURING RADIATION THERAPY?

You should get plenty of rest. Many patients experience fatigue during radiation therapy, so it is important to make sure you are well rested. If possible, ask friends and family to help during treatment by running errands and preparing meals. This will help you get the rest needed to focus on fighting cancer. If more help is needed, social workers or nurses may have more information on local cancer support groups or other resources. Volunteers also may be able to help.

Even though rest is important, there is good evidence to suggest that some physical activity during treatment can help decrease fatigue. For example, many patients feel a daily walk helps decrease some of their treatment-related fatigue. You should ask your radiation oncologist what the best form of daily exercise might be for you.

Follow the doctor's orders. In many cases, your doctor will ask you to call if any concerning symptoms develop. For example, the treatment team may direct you to call with a fever of 101 degrees F or higher. It is important to read and follow these instructions during treatment. If you are unsure, you should not hesitate to contact the treatment team with questions.

Eat a balanced, nutritious diet.

A nutritionist, dietician, nurse, medical assistant or doctor may work with you to make sure you are eating the right foods to get the vitamins and minerals needed to fight the cancer and allow the body to heal. With certain types of radiation, you may need to change your diet to minimize side effects. You should not attempt to lose weight during radiation therapy since you will need more calories during treatment and your radiation plan is based on your body weight at the time treatment begins.

Stay hydrated. In some cases, you may be at risk of becoming dehydrated during treatment. Helpful fluids may include electrolyte solutions, juice, sorbet, broth and water. You should discuss with your doctor what strategies will work best.

Treat skin exposed to radiation with extra care. The skin in the area receiving treatment may become red and sensitive, similar to a sunburn.

The radiation oncology nurses will review specific instructions for skin care. Some guidelines include:

- Clean the skin daily with warm water and a mild soap recommended by the team.
- Avoid using any lotions, perfumes, deodorants or powders in the treatment area unless approved by the team. Avoid products containing alcohol, which may cause dryness.
- Unless instructed to do so by your doctor, avoid putting anything hot or cold on the treated skin. This includes heating pads and ice packs.
- Stay out of the sun. If you must be outdoors, you should wear a hat or clothing to protect the skin. After treatment, use sunscreen with an SPF of at least 15.

Seek out support. There are many emotional demands on you and your caregivers during cancer diagnosis and treatment. It is common to feel anxious, depressed, afraid or hopeless. It may help to talk about these feelings. To find a support group in the area, ask the radiation treatment team. There are many groups that meet in person, over the phone or on the Internet. Some support organizations can even help manage financial issues such as insurance and co-pays.

WHAT QUESTIONS SHOULD PATIENTS ASK?

Questions to Ask Before Treatment

- What type and stage of cancer do I have?
- What is the purpose of radiation treatment for my type of cancer?
- How will the radiation therapy be given? Will it be external beam or brachytherapy?
- What do the treatments feel like?
- How long will I receive radiation? How many treatments will I receive per week?
- What are the chances that radiation therapy will work? Are there any other effective treatments?
- What is the chance that the cancer will spread or come back if I do not have radiation therapy?

- Will I need chemotherapy, surgery or other treatments? If so, in what order will I receive these treatments? How soon before or after radiation therapy can I start them? How will the treatments be coordinated?
- Is there a clinical trial for which I might be eligible? Should I participate in a clinical trial?
- What are the benefits and risks of treatment including short-term and long-term side effects?
- What are some of the support groups I can turn to during treatment?
- Will radiation therapy affect my ability to have children?
- If I have questions after I leave here, who can I call or email?
- Is there a patient portal that I can use to communicate with the office and view my results?
- Is financial counseling available?
- Is this the most convenient location for me to receive treatment (close to home or work?)

Questions to Ask During Treatment

- Can I drive myself to and from the treatment facility? Where should I park?
- What side effects may occur from the radiation treatment and how are they managed?
- Do I need a special diet during or after my treatment?
- Will I be able to continue my normal activities?
- Can I smoke or drink alcohol?
- Is it safe to take vitamins or other supplements during treatment?
- How can I expect to feel during treatment and in the weeks following radiation therapy?

Questions to Ask After Treatment Ends

- What are reasons that I should call you after my treatment ends?
- How and when will I know if I am cured of cancer?
- What are the chances that the cancer will come back?
- How often do I need to return for checkups?
- What are the concerning long-term side effects? How can I monitor for these?
- How soon can I go back to my regular activities? Work? Sexual activity? Exercise?

NOTES/QUESTIONS FOR YOUR DOCTOR OR TREATMENT TEAM

What type and stage of cancer do I have?

How long will I receive radiation? How many treatments will I receive per week?

Will I need chemotherapy, surgery or other treatments? If so, in what order will I receive these treatments? How soon before or after radiation therapy can I start them? How will the treatments be coordinated?

Is there a clinical trial for which I might be eligible? Should I participate in a clinical trial?

What are the benefits and risks of treatment including short-term and long-term side effects?

If I have questions after I leave here, who can I call or email?

What side effects may occur from the radiation treatment and how are they managed?

Will I be able to continue my normal activities?

Is it safe to take vitamins or other supplements during treatment?

How can I expect to feel during treatment and in the weeks following radiation therapy?

How often do I need to return for checkups?

What are the concerning long-term side effects? How can I monitor for these?

How soon can I go back to my regular activities? Work? Sexual activity? Exercise?



I Have Cancer. Now What?

Receiving a diagnosis of cancer can be frightening and confusing. [RTAnswers.org](https://www.rtananswers.org) provides detailed information and resources for cancer patients and their caregivers, including:

- Treatment information by disease site.
- Videos walking you through the radiation therapy treatment process.
- Stories from patients and caregivers sharing their experiences from diagnosis and treatment to survivorship.
- A “Find a Radiation Oncologist” portal where you can search by city, state and disease site specialty.

THE AMERICAN SOCIETY FOR RADIATION ONCOLOGY (ASTRO) is the largest radiation oncology society in the world, with more than 10,000 members who specialize in treating patients with radiation therapies. As the leading organization in radiation oncology, biology and physics, ASTRO's mission is to advance the specialty of radiation oncology through promotion of equitable, high-quality care for people with cancer, cultivating and educating a diverse workforce, fostering research and innovation, and leading policy development and advocacy. Visit www.astro.org for more information.

ASTRO

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