Radiation Therapy for Prostate Cancer
A Patient Guide

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This guide is designed to provide general information that may be helpful to you before starting and during radiation therapy. We hope this helps you understand what to expect from, and how to deal with, all aspects of being treated with radiation therapy. Special thanks to all previous contributors to this document. Definitions for words in **bold** can be found at the end of this document.

If you have non-urgent questions related to your health and treatment, please contact your healthcare provider through the UCSF online patient portal **MyChart**. If you think you may be experiencing a medical emergency, please call 911 or go to your closest emergency room. The **MyChart** portal can be accessed at: http://www.ucsfhealth.org/ucsfmychart.

Your Feedback

We regularly revise the information presented in this guide to keep it up to date and ensure it is as useful as possible to the reader. Because changes and new developments can occur frequently, we suggest that you talk to your health care provider for the latest information.

Your feedback about any aspect of this guide is much appreciated. You can e-mail your comments to urologyresearch@UCSF.edu or send them by regular mail to Your Health Matters Box 1695, UCSF Department of Urology, San Francisco, CA 94143-1695.

If you wish to talk with a patient advocate, please call (415) 885-7210.

This guide, along with other urologic oncology documents, can be viewed online with this link:

https://urology.ucsf.edu/prostate-cancer-education-documents

If you are reading a hard copy, please also refer to the above link for the most up-to-date information.

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Overview

Radiation therapy (RT) is an effective treatment for prostate **cancer**. This guide is a brief introduction to radiation therapy and an explanation of how it is used to treat prostate cancer. It is not meant to be all-inclusive but rather to provide enough information to empower you to have an informed discussion with your healthcare providers. As you read through *Radiation Therapy for Prostate Cancer – A Patient's Guide*, you will find words and terms in **bold** defined in the GLOSSARY at the end of this guide.

What is the prostate gland, and where is it located?

The **prostate gland** is typically about the size of a walnut and is located in front of the rectum and below the bladder. The urethra, a hollow tube for draining urine from the bladder, exits the bottom of the bladder, passes through a urine control valve, through the middle of the prostate, out another urine control valve, and exits through the penis.

As a part of the male reproductive system, cells in the prostate secrete fluid that makes up part of the semen. Semen is the milky fluid that nourishes, carries, and protects the sperm that are produced in the testicles. The prostate forcefully ejects semen into the urethra during ejaculation. The two urine control valves are also part of the ejaculation process to prevent urine leakage during ejaculation.

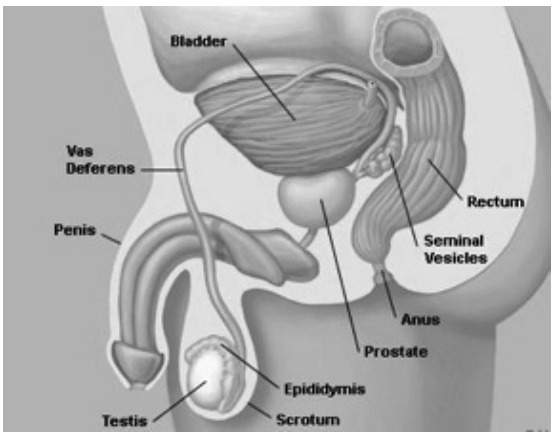


Figure 1: Male Anatomy

What is prostate cancer?

Like most cells in the body, prostate cells are continuously, slowly being replaced. Cancer happens when something goes wrong with the replacement process. Mutations in the cell division process cause the mutated cell to grow and divide when it should not, and/or to not die when it should. The mutations are passed on to the daughter cells and a growing mass called a tumor may result.

Prostate cancer can behave very differently from one patient to the next. Most patients at diagnosis have a slow growing tumor that takes years to spread beyond the prostate and become a threat to their life. Active surveillance or observation is appropriate for these patients, as many will never need treatment. Others have rapidly growing tumors that may quickly access lymphatic channels or the bloodstream. Sometimes these circulating tumor cells will lodge in another organ, such as a lymph node or a bone, and start a new colony of tumor cells called a metastasis. Widespread metastatic disease may lead to life-threatening complications or death.

What is Radiation Therapy?

Radiation therapy uses **ionizing radiation** in the form of photons or protons to kill cancer cells by damaging their DNA. Cancer cells with damaged DNA cannot divide or multiply and will eventually die. The overarching goal of radiation therapy is to deliver a therapeutic dose of ionizing radiation to the tumor while minimizing the dose to surrounding healthy normal tissues. There are many methods for achieving this goal, as detailed below.

Why Would I Choose Radiation Therapy?

Radiation therapy (RT) is an important resource for treating prostate cancer in many different clinical settings. For patients with localized (tumor confined to the prostate and seminal vesicles) or regionally advanced (tumor spread to adjacent pelvic lymph nodes only) prostate cancer, RT may be used with curative intent, and provides outcomes comparable to surgery. For those who undergo radical prostatectomy and have high risk prostate cancer features, RT may be used as an adjuvant or salvage therapy to improve cure rates compared to surgery alone. For those with metastatic disease, RT may be used to delay disease progression or palliate symptoms caused by tumors. The rationale, risks, and benefits of RT will depend on the clinical setting and the radiation technique employed. You should discuss all treatment options with your healthcare providers. For additional information on possible alternative therapies at UCSF see Localized Prostate Cancer and its Treatment and Radical Prostatectomy Basic Information at https://urology.ucsf.edu/prostate-cancer-education-documents.

How is Radiation Therapy Delivered?

There are two broad categories of radiation therapy: teletherapy ("healing from a distance") and brachytherapy ("healing from close by").

Teletherapy is commonly referred to as external beam radiation therapy (EBRT) and involves an external source of radiation that beams photons (x-rays or gamma rays) or particles (protons or heavy ions) from outside the body into the tumor. The most common external radiation source in the modern era of radiation oncology is a megavoltage linear accelerator (LINAC) equipped with devices that allow precise shaping of x-ray photons and accurate tumor targeting.

Brachytherapy involves temporary or permanent implantation of radioactive sources directly into the tumor. Prostate cancer may be treated with EBRT alone, brachytherapy alone, or a combination of EBRT and brachytherapy, depending on the clinical situation.

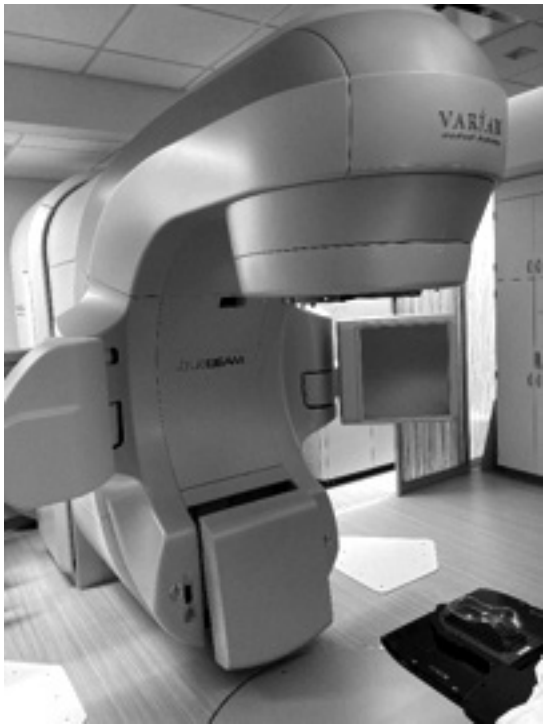
External Beam Radiation Therapy Technological Advancement

In its early days, EBRT was planned by drawing the radiation target on x-ray films, using only 2-dimensional information, typically bony anatomy. With the advent of computers and computed tomography (CT) scans in the 1980s, radiation oncologists began incorporating 3-dimensional soft tissue anatomic information to generate 3D conformal radiation therapy (3DCRT) plans, reducing radiation exposure to surrounding healthy tissues and thereby permitting delivery of higher radiation doses to the tumor. In the 1990s, technological advancement enabled computer-optimized radiation planning with a technique called intensity modulated radiation therapy (IMRT), in which the radiation beam is divided into "beamlets" that are individually adjusted to conform radiation dose to the shape of the tumor. In the late 1990s and 2000s, a sophisticated form of IMRT called volumetric modulated arc therapy (VMAT) was invented. VMAT involves continuous modulation of the radiation beam as the LINAC gantry rotates in an arc. VMAT and IMRT are the most used photon EBRT planning techniques used to treat prostate cancer today.

Analogous advancements have been made in proton beam therapy over time, with older 3D conformal and newer pencil-beam scanning technologies. Whereas photons pass through the body entirely, protons enter the body but stop within the radiation target, thereby eliminating "exit dose" to organs on the other side of the target. While proton therapy in principle may reduce the low-dose radiation exposure of healthy normal tissues, any clinical benefits of proton therapy over photon therapy in terms of prostate cancer cure rates and impact on patient quality of life remain unproven.

In addition to advancements in radiation planning techniques, technology has evolved to improve tumor targeting through image-guided radiation therapy (IGRT). The prostate is not a fixed target—its position changes with patient movement, bladder filling and emptying, and the passage of gas or stool in the abdomen and pelvis. IGRT permits positional adjustments during radiation therapy to compensate for these changes. Examples of IGRT include orthogonal X-ray imaging of implanted gold seed fiducial (reference) markers, low dose cone beam CT scans, and real-time intra-fraction target tracking during radiation delivery.

At UCSF, prostate cancer patients receiving EBRT are treated using either a gantry-based LINAC (e.g., a Varian TrueBeam) equipped with the latest IGRT technology, or else with the Accuray Cyberknife, a LINAC mounted on a robotic arm with intra-fraction target tracking capability. These technologies enable UCSF radiation oncologists to provide state-of-the-art care to their patients.



LINAC - Varian TrueBeam at UCSF
Photo by Dr. Anthony Wong

External Beam Radiation Therapy Fractionation

EBRT is typically delivered over multiple treatment sessions called fractions, with one fraction delivered per day on weekdays. The dose of radiation delivered with each fraction is measured in Grays, which is a scientific unit of energy per unit mass (1 Gray is equal to 1 Joule per kilogram).

Conventional fractionation refers to treatment of 1.8-2.0 Gy per fraction. A course of conventionally fractionated radiotherapy for curative treatment of prostate cancer typically involves 35-45 fractions total, requiring about 8 to 9 weeks to complete. Each fraction takes about 5 minutes to deliver once the patient has been set up appropriately on the LINAC, although door-to-door time in the radiation oncology clinic may be approximately 30 minutes.

Hypofractionation refers to radiation therapy delivered with a higher dose per fraction, over a shorter time, compared to conventional fractionation. Moderate hypofractionation refers to treatment with 2.5-3.1 Gy per fraction and typically 20-28 fractions total over a 4-to-6-week period. Several landmark randomized clinical trials have established that moderate hypofractionation provides long-term outcomes equivalent to conventional fractionation for curative treatment in patients with localized prostate cancer. Moderate hypofractionation is more cost effective and convenient for the patient than conventional fractionation. Ultra-hypofractionation refers to treatment with >6 Gy delivered per fraction and typically 3-7 fractions total. When ultra-hypofractionation is delivered in 5 or fewer fractions with **ablative** radiation doses to highly conformal targets and modern image guidance techniques, it is referred to as Stereotactic Body Radiation Therapy (SBRT) or Stereotactic Ablative Body Radiotherapy (SABR). At UCSF, prostate SBRT is delivered on either the Varian TrueBeam (requiring 10-20 minutes of treatment time per fraction) or the Accuray Cyberknife (requiring 30-60 minutes of treatment time per fraction).

With hypofractionation delivering higher dose per fraction, accurate targeting of the prostate is essential, as each fraction delivered comprises a higher percentage of the prescribed radiation dose.

Brachytherapy

Brachytherapy involves the implantation of radioactive sources directly into the radiation target, thereby maximizing radiation dose to the tumor while minimizing radiation exposure to normal healthy tissues. In patients with low-risk or favorable intermediate-risk prostate cancer, prostate brachytherapy may be used alone (monotherapy). In patients with unfavorable intermediate-risk or high-risk prostate cancer, brachytherapy may be used to boost radiation dose to the prostate in combination with EBRT, which is used to target pelvic lymph nodes and/or seminal vesicles. Prostate brachytherapy boost has been shown in randomized clinical trials to improve disease control rates over EBRT alone, with a modest increase in risk of side effects, primarily in the urinary domain.

There are two types of prostate brachytherapy.

Low Dose Rate (LDR or permanent seeds) brachytherapy involves the permanent placement of multiple radioactive seeds the size of a small grain of rice through the perineum (the area between the scrotum and the anus) into the prostate, using thin hollow needles guided by transrectal ultrasound. Depending on the radioactive isotope implanted, the seeds deliver most of their radiation energy to the prostate over weeks to months, eventually becoming inert. They stay in place for life. Careful brachytherapy planning and seed placement result in ablative radiation dose delivery to the prostate.

The entire prostate gland is implanted with radioactive seeds, not just the prostate tumor. This is because the entire prostate gland is considered to be at risk, even if prostate biopsy or imaging suggests a focal area of tumor. The exception to this rule is for those who are receiving brachytherapy due to focally recurrent tumor in the prostate after prior radiation. In that specific scenario, some brachytherapists will implant only the area of the recurrence. The implant procedure takes 45 minutes to 1 hour.

After permanent brachytherapy seed implantation, prostate cancer patients will emit radioactivity until the seeds become inert. Although the reach of such radioactivity is very limited, there are some precautions patients are advised to take immediately after the implant, particularly around those who are pregnant as well as young children. The duration precautions needed will depend on the type of radioactive seeds used. Patients interested in LDR brachytherapy should discuss these issues at length with their radiation oncologist.

High Dose Rate (HDR or temporary seeds) brachytherapy involves the temporary placement of 14-20 hollow needles called catheters through the perineum into the prostate. After appropriate catheter placement, a very ‘hot’ radioactive seed mounted on a wire and controlled by a computerized robot called an afterloader, is inserted into one catheter at a time. The radiation dose can be precisely shaped by controlling how long and where the seed dwells inside the prostate. The afterloader systematically moves the seed through the catheters to safely deliver a very high dose to the prostate. As in LDR brachytherapy, the entire prostate is targeted, except in cases of salvage brachytherapy re-irradiation. No radioactive material is left behind.

The feasibility of prostate brachytherapy depends on many factors, including the stage of the disease, baseline urinary symptoms, prostate anatomy, and prior surgical procedures such as transurethral resection of the prostate (TURP). In patients with significantly enlarged prostates, gland reduction using 5-alpha reductase inhibitors (e.g., finasteride or dutasteride) or androgen deprivation therapy may be recommended by the radiation oncologist prior to brachytherapy.

At UCSF, prostate brachytherapy is usually performed under spinal or epidural anesthesia. Most cases are performed using temporary implants (HDR brachytherapy).

Testosterone Reducing Hormone Therapy (HT)

Hormone therapy, also known as androgen deprivation therapy (ADT), improves cancer cure rates and reduces risk of death related to prostate cancer in otherwise healthy patients with unfavorable intermediate-risk or high-risk prostate cancer treated with radiation therapy. ADT may be given before, during, and/or after radiation therapy. For more on ADT see Hormone Therapy for Prostate Cancer – A Patient Guide at https://urology.ucsf.edu/prostate-cancer-education-documents.

What happens before and during external beam radiation therapy?

Patients preparing for prostate cancer radiation therapy will have 1-2 radiation planning appointments prior to starting treatment. At the first appointment, which may be omitted in some circumstances, non-radioactive gold seed markers may be implanted in the prostate or prostate bed to help the radiation therapist accurately position your body during treatment. These gold seeds are placed via transrectal ultrasound (TRUS) guidance in a procedure similar to prostate biopsy, but it typically is much less uncomfortable or painful because it is done with fewer needle pokes and a thinner needle.

Your radiation oncologist may discuss with you the option of having a rectal hydrogel spacer placed, usually at the time of the gold seed marker procedure. The purpose of the hydrogel spacer is to create physical distance between the prostate and the rectum, thereby reducing radiation dose to the rectum during treatment. Placement of the hydrogel spacer is performed under local anesthetic with TRUS-guided needle insertion through the perineum. The hydrogel is injected into the space between the rectum and the prostate as a liquid which then solidifies after a few minutes. This hydrogel remains intact for approximately 3 months after placement and is subsequently absorbed by the body and excreted in the urine 6 months after placement. The major potential benefit is reduction in low grade radiation-related side effects. Potential risks include temporary pelvic discomfort or pain after hydrogel placement, or, rarely, infections such as peri-rectal abscesses or rectal wall perforation requiring antibiotics or surgery. There is controversy within the radiation oncology community regarding whether the benefits of rectal hydrogel spacers outweigh the risks. You should discuss the role of rectal hydrogel spacer in your case with your radiation oncologist and urologist.

At the second appointment you will have a radiation planning session called a “simulation,” at which time a scan of the pelvis will be obtained in the treatment position. You may be asked to do an enema prior to the simulation. You may also be asked to drink 20-24 oz of fluid 30-60 minutes prior to the simulation scan, after the enema, to fill your bladder. Alternatively, you may be asked to empty the rectum and bladder immediately prior to the simulation scan. Discuss the optimal preparation instructions for this appointment with your radiation oncologist. In most cases, the simulation scan will be done with computed tomography (CT), but sometimes magnetic resonance imaging (MRI) will be obtained as well. During the appointment, a series of ink marks may be drawn on your skin to help position your body for each treatment. These marks may be temporary, or you may have three permanent pinhead-sized black dots tattooed--one on the left hip, one on the right hip, and one in the area between belly button and the pubic bone.

Radiation Treatment Plan

After the simulation. your radiation oncologist and dosimetrist will create a radiation treatment plan customized for your anatomy using a sophisticated computer program. In this treatment planning process, the radiation beam arrangements, shape/energy of each radiation beam, along with the dose delivered, will be optimized to ensure that the prescription radiation dose is delivered to the target and that surrounding normal tissue including the bladder, rectum, and bowel is protected.

After your radiation oncologist approves your treatment plan, radiation treatment will begin. The first day of treatment may be longer than other sessions because additional imaging is performed on the first day as part of quality assurance. In most cases, radiation therapy will be scheduled each day Monday through Friday. SBRT, mentioned earlier, may be scheduled every other day instead of daily. You will be assigned a time slot to be treated, typically but not necessarily, at the same time each day. A specifically trained **radiation therapist** will administer your treatment. The total prescribed radiation dose is divided into equal daily doses (fractions) and delivered to the treatment area each day.

This strategy allows your healthy, non-cancerous tissue to repair itself between treatments. The cancer cells are not as efficient at DNA damage repair as normal tissues. Fractionation (dividing the total radiation dose into many treatment sessions) also allows different populations of cancer cells to be irradiated. During your treatment, your treatment plan may be modified (but this is not very common). For example, the size of the treatment field may be changed. If your radiation oncologist makes changes, any modifications will be planned and discussed with you.

During your treatment you will be asked to lay motionless on the treatment table. The area that is being treated is exposed (you may choose to wear a hospital gown) and positioned beneath the treatment machine (linear accelerator). The head of the treatment machine will move around your body to different angles, determined by the treatment plan, to deliver the radiation. On a gantry-based LINAC such as a Varian TrueBeam, each treatment may take from 5-20 minutes. On the Cyberknife, each treatment is typically 30-60 minutes. After each daily treatment, you will be able to perform your regular activities. You can expect to be in the Department of Radiation Oncology for approximately 30-60 minutes each day (or 60-90 minutes for Cyberknife treatments).

Please note that many people will be involved in your treatment (your doctor, residents, nurses, therapists, dosimetrists, physicists) but your radiation oncologist will supervise your treatment and will make sure all steps are being performed accurately

How should I expect to feel during radiation therapy?

Undergoing external beam radiation therapy is like having a routine x-ray and is no more uncomfortable. Radiation cannot be seen, smelled, or felt. You may, however, experience side effects from the treatment. Generally, side effects do not appear until the 2nd or 3rd week in conventional treatments but may occur earlier with prostate SBRT or HDR brachytherapy.

Radiation therapy is a local treatment, and any side effects will primarily involve the area of the body where the radiation is directed. For prostate cancer, patients may experience some or all the following:

- An increase in the frequency of urination
- Urinary urgency
- Weak urinary stream
- Difficulty starting urination
- Mild burning or tingling with urination
- Loose stools, and less often, diarrhea

- Softer and smaller volume bowel movements
- Increased frequency of bowel movements
- Worsening of existing hemorrhoids or, rarely, rectal irritation with occasional scant blood
- Generalized fatigue of varying severity may also be experienced. However, patients receiving radiation therapy are usually able to continue to work or function normally. Many studies have shown that exercise during radiation therapy can ease side effects, including fatigue.

Depending on the severity of these side effects, you may be prescribed medications for symptom relief such as an anti-diarrhea medication (i.e., Imodium AD or Lomotil) or a medication to decrease the frequency of urination (i.e., Flomax or Uroxatral). You may also be advised to adjust your dietary habits or take a daily fiber supplement such as psyllium (Metamucil). Most of these symptoms are short-term (acute) and will go away a few weeks after radiation treatment ends. The time for full "recovery" depends upon the patient and the type and severity of urinary or bowel symptoms the patient had (if any) before treatment.

As part of your treatment planning, you will be asked to fill out questionnaires to evaluate your urinary, bowel and sexual health. It is important to discuss the nature and severity of your symptoms in detail with your healthcare provider, as this may influence your treatment course. Patients typically continue with their normal daily activities during treatment.

How should I expect to feel after radiation therapy?

After completion of external beam radiation therapy, you may have urinary and bowel side effects that may continue for 2-6 weeks. These side effects will lessen as time passes, and most patients recover to baseline urinary and bowel habits by 3-6 months. You may need to continue taking medications prescribed during treatment. Some patients report continued but lessening fatigue for several weeks or months after treatment ends. Patients usually continue with their normal daily activities.

After brachytherapy, you may experience burning with urination, increased daytime and nighttime frequency of urination, slow or weak urinary stream, incomplete emptying of the bladder, a brief period of blood in the urine (usually in the immediate post procedure period), perineal pain or soreness, scrotal bruising and/or swelling, blood spotting from the perineum, nausea from anesthesia, and fatigue.

Most patients continue with their normal daily activities soon after brachytherapy. Limiting heavy lifting and strenuous physical activity for 2-3 days after the implant is recommended. In less than 5 % of patients, swelling of the prostate may cause obstruction of outflow from the bladder. If this happens, you may go home from the brachytherapy procedure with an inserted urinary (Foley) catheter and will be prescribed a medication to help reduce the swelling and inflammation. In the rare case that you experience delayed urinary obstruction after discharge from the hospital without a catheter, you should go to the nearest emergency room so that a Foley catheter can be inserted. The catheter is usually removed within 1 week. Rectal symptoms are not common after brachytherapy. Patients may experience some rectal discomfort after the procedure, but rectal bleeding is uncommon.

Radiation safety is a common concern for patients undergoing external beam radiation therapy and brachytherapy. Patients are given detailed written instructions before going home. After discharge, there are no radiation safety issues for EBRT and HDR brachytherapy patients, and there is no need for patients to isolate themselves from family and friends because the treatments are not dangerous to others. Once a patient's daily treatment is completed, there is no radiation remaining in the body.

For patients treated with LDR (permanent seed) brachytherapy, most of the radiation from the implant is absorbed by the patient's body tissues. However, for the first 1-2 months after permanent seed implantation, patients should maintain a distance of six feet or more from any pregnant person if they will be in the patient's company for a prolonged period of time. In addition, it is recommended that young children and pets not be allowed to rest on the patient's lap for prolonged time periods. Sexual intercourse may be resumed at any time after the seed implant; however, a condom should be worn for at least the first two weeks after the procedure and at least the three episodes of ejaculation, due to the very small risk of seed migration leading to radioactive material in the ejaculate.

Sexual function

Some patients may experience a decline in their erectile function (**erectile dysfunction** or **impotence**) after radiation therapy. The likelihood of impaired potency is also influenced by patient age (the primary risk factor), the use and duration of HT, smoking history and other medical conditions such as hypertension, diabetes and the medicines used for their treatment.

For some patients, erectile function declines slowly over the first five years after radiation treatment. The effects of short-term HT (4-6 months) appear to be largely reversible. Similar levels of sexual function are reported 4 years after treatment by patients who received HT and by patients who did not receive HT. Patients may develop some degree of erectile dysfunction after brachytherapy; however, treatment-related erectile dysfunction may be less likely after brachytherapy than other forms of treatment. Most patients who are not taking **nitrate-containing medications** will be able to use any of the oral impotence medications on the market. These medications improve erectile quality with excellent success.

Most patients will be able to achieve orgasms after radiotherapy, but some may experience a change in their orgasm. Some patients who have had RT but have not had their prostate removed experience a change in their ejaculate (thicker, less fluid) and a decrease in the quantity or an absence of ejaculate after radiation treatment. This is usually more common with EBRT than brachytherapy.

Following brachytherapy, the ejaculate may be discolored (dark-brown or even black). The discoloration is due to "old" blood that is residual from the procedure. It is harmless and of no risk to the patient or their sexual partners. The ejaculate will become clear over time. Sexual function is discussed in detail in the Your Health Matters Managing Erectile Dysfunction – A Patient Guide. https://urology.ucsf.edu/prostate-cancer-education-documents.

Sperm production

Sperm are produced in germinal cells in the testicles. During prostate radiation, low levels of **scatter radiation** scattered inside the body from the treatment beam can reach the testicles and decrease sperm production. The dose of radiation that reaches the testicles usually leads to a temporary reduction (months to years) in the sperm count. It is possible, however, to have a permanent reduction in the sperm count (sterility). If you are considering fathering children, you may wish to seek medical advice regarding your fertility and the need to bank sperm prior to treatment.

Testosterone production

Testosterone is secreted by Leydig cells in the testicles. The large majority of patients experience no change in testosterone levels from prostate radiation therapy alone. Depending on the radiation technique used, prostate radiation may uncommonly cause modest, temporary decline in testosterone levels due to scatter dose to the testicles. It is very unlikely that radiation alone would lead to permanent alterations in testosterone levels.

What else do I need to know?

On occasion, the EBRT treatment machines “go down” and treatment cannot be delivered. This occurs unexpectedly for a variety of reasons. If any aspect of the machine’s normal function is irregular, a safety feature stops the machine from working and treatments cannot be given. When this happens, you will have treatment on another machine, wait until the problem is resolved, or skip treatment that day. You will be asked to skip a treatment only when a longer evaluation and repair time are needed. If you miss a treatment, it will be made-up, so you receive the dose of total radiation for the course of treatment prescribed by your healthcare providers.

Many questions may arise during radiation therapy treatment, not all of which can be anticipated or answered here. Your healthcare providers will be available to answer questions throughout your treatment.

Troubleshooting

Mild fatigue may occur during EBRT treatment. If this happens, daily exercise may be helpful for increasing energy levels. Most patients will be able to continue their full-time jobs while on treatment if they are working. If you are working, consider decreasing your work hours or taking a leave, but that is rarely needed. However, do try to remain physically active and eat a well-balanced diet. Nutritionists are available at the UCSF Cancer Resource Center to provide dietary assistance. Contact your healthcare provider if your fatigue becomes severe.

Diarrhea, flatulence, or painful defecation are not uncommon and may occur after the second or third week of conventionally fractionated radiotherapy or earlier with hypofractionated schedules. In most cases, these symptoms will go away after the treatment ends with no intervention. During radiation treatment, dietary modification usually helps reduce the frequency and severity of diarrhea. Try to avoid or reduce fried foods, greasy foods, and highly spiced foods. Cut down temporarily on foods with insoluble fiber (i.e., lettuce, cauliflower) and increase low-fiber and soluble-fiber foods (i.e., bananas, mashed potatoes, applesauce, white rice, canned or cooked fruits and vegetables). Some patients may find taking a daily soluble fiber supplement, such as psyllium (Metamucil), helpful.

Maintain your intake of lean proteins (i.e., turkey, chicken and fish) and increase your fluid intake to avoid dehydration. The use of moist toilet paper, baby wipes, or sitz baths may help relieve rectal irritation. Your healthcare provider may recommend the use of anti-diarrheal medications. Contact your healthcare provider if you see blood in your stool, if the diarrhea worsens, or if you become light-headed or dizzy.

Frequent urination, burning with urination, and difficulty urinating are the most common complaints of patients receiving radiation therapy for prostate cancer. Occasionally, the urinary stream will weaken. Generally, these symptoms are not severe and are managed with medications that help the bladder function better or eliminate burning. Rarely, your healthcare provider may order a urine test. These symptoms will go away after the end of treatment. Contact your healthcare provider if you see blood in your urine or if you are unable to urinate.

Swelling, bruising or tenderness of the scrotum may occur after brachytherapy. Swelling and tenderness usually go away on their own within 3-5 days. Bruising usually takes longer. Oral anti-inflammatory medications, such as ibuprofen, are usually sufficient for pain relief. You should avoid hot tubs and Jacuzzis for at least 2-3 days after the procedure. Do not go bike riding until tenderness has gone away.

Skin irritation is uncommon during prostate radiation therapy, but if it occurs do not rub or scratch the area. Try to avoid clothing that is too constrictive and avoid lotions or colognes containing alcohol. Your healthcare provider can recommend a skin care regimen and topical creams or lotions to relieve the symptoms. Contact your healthcare provider if you develop a rash all over your body.

Follow-up: How often will I need to see my healthcare provider?

Following EBRT, some patients may have an initial appointment to make sure that treatment-related side effects are diminishing or have gone away. The frequency of follow-up appointments will be determined by your risk of cancer recurrence. In general, serial PSA blood tests are obtained every 3-6 months during the first 2-3 years after completing treatment and then every 6 months thereafter until year 5, and then annually. Changes to this schedule may be made during your follow-up evaluations depending on your PSA behavior.

Patients receiving LDR brachytherapy will have an appointment for a CT scan of the prostate approximately 4 weeks after the procedure. This CT scan will be used to evaluate the "quality" of the implant. Generally, an appointment in the Department of Urology will also be scheduled for the same day.

How will I know if the treatment is working?

Serial PSA blood tests are how you will be monitored after definitive treatment of your prostate cancer. Following radiation therapy, your PSA should fall, but will not reach its lowest value PSA (nadir) immediately after treatment. It may take up to 2-4 years for the PSA to reach its nadir. Keep in mind that the PSA may not decline steadily.

Temporary increases, also called spikes or bounces, in PSA may occur during the first 12-36 months after completion of EBRT or brachytherapy. These bounces are not indications of treatment failure. The pattern of PSA decline may not be steadily downward.

There is much debate over the most accurate means to detect treatment failure after treatment with radiation therapy. A consensus definition was established several years ago to systematize the evaluation of treatment outcomes. This definition defines treatment failure as three consecutive increases in the PSA value after the nadir has been reached. In a more recent definition of treatment failure, a PSA level that rises to an absolute value of 2 above the nadir has been shown to strongly associate with subsequent disease progression, but often, further treatment is initiated before PSA levels rise to a level of 2 above nadir.

PSA testing remains an important monitoring tool and serial testing at regular intervals is critical to its effective use. Your healthcare provider will evaluate additional data in conjunction with PSA test results to effectively monitor your treatment outcome.

Relationship Between Blood Level Testosterone and PSA Level After Radiation + ADT

With androgen blockade (ADT), testosterone levels will fall. There should be a corresponding drop in PSA. After stopping ADT, typically several months up to a few years will be required for testosterone levels to recover to pre-ADT levels. More prolonged courses of ADT lead to longer testosterone recovery times. Because radiation therapy may not ablate all prostate cells (some non-cancerous cells may survive), as testosterone levels rise, a small amount of PSA may be produced, even in the absence of cancer. PSA levels should stabilize after testosterone recovery if cancer has been eradicated. The lower the PSA value after testosterone recovery, the more likely prostate cancer eradication has been achieved.

Will I need additional treatment?

Usually, no additional treatment is needed after radiation therapy. Any need for additional treatment is determined by PSA levels, Gleason score, stage of the prostate cancer and whether you had your daily treatments as scheduled, particularly for EBRT.

Regular post-treatment PSA evaluation is important in monitoring and evaluating the need, if any, for additional treatment. Should the cancer recur, the options for treatment will, in part, depend upon the initial treatment and the location of the recurrence (in the prostate itself, in the lymph nodes, or distantly such as in the bones). Additional alternative forms of radiation therapy, prostatectomy, cryotherapy, hormone therapy or new treatments under evaluation in **clinical trials** may be recommended. Your team of healthcare providers (radiation oncologist, urologist, and medical oncologist) will discuss appropriate treatment options and recommendations with you.

Risk of Secondary Malignancy

Radiation therapy will irradiate some healthy tissues in addition to the prostate. There is a very small extra risk of secondary malignancy caused by radiation therapy occurring >5 years after the treatment within the pelvis, most often in the bladder or rectum. The risk of secondary malignancies is most relevant in younger patients.

GLOSSARY

(The first usages of glossary terms are **bolded** in the text.)

Ablative – Ablation refers to any process that renders tissue non-viable.

Adjuvant – Assisting or aiding. Used to describe additional treatments administered in addition to a definitive therapy. For EBRT, this usually refers to androgen deprivation given after EBRT is finished.

Androgen – A hormone with masculinizing properties, i.e., testosterone. Androgens stimulate growth of both normal prostate and most malignant prostatic cells.

Androgen deprivation – A therapeutic strategy designed to decrease circulating levels of the male androgen testosterone and its related compounds. Androgen deprivation can be done by removing the organs that produce testosterone (i.e., removing the testicles; orchiectomy) or by giving medication (see hormone therapy).

Anti-androgen – Oral agents flutamide (Eulexin) and bicalutamide (Casodex) that block the action of testosterone and its active metabolite dihydrotestosterone (DHT) at the cellular level by interfering with androgen receptor interactions.

Applicator – A device used to deliver or hold a radioactive source during brachytherapy.

Benign prostatic hyperplasia (BPH) – Non-cancerous enlargement of the prostate gland, which often results in difficulty with urination. The incidence increases with age.

Biopsy – Sampling of tissue.

Blocks – Pieces of metal alloy that can be used to shape the EBRT beam.

Bone scan – A nuclear medicine imaging study that utilizes a radioactive compound injected into a vein to identify areas of increased bone cell activity in the skeleton; used to screen for the presence of bone metastases or prostate cancer in the bones.

Boost – An additional dose of radiation that is given after an initial course of treatment to enhance tumor control.

Brachytherapy – In radiation therapy, treatment with ionizing radiation that is applied directly into an organ that has cancer. For prostate cancer, this consists of implantation of radioactive material into the prostate. Also called implants or seeds.

Cancer – A group of diseases characterized by uncontrolled cell growth. Cancer cells, unlike benign cells, exhibit the properties of invasion and metastasis.

Catheter – A general term for a tube that is inserted to drain fluids from or instill fluid into the body.

Cell – The fundamental structural and functional unit of living organisms.

Centi-gray (cGy) – The measurement of radiation delivered to a tumor. A gray (Gy) is a unit of absorbed energy dose.

Clinical trial, Phase 1 – A clinical trial designed to determine the appropriate dose and toxicities of an investigational agent or treatment.

Clinical trial, Phase 2 – A clinical trial designed to determine the effectiveness and side effects of an investigational agent or regimen.

Clinical trial, Phase 3 – A clinical trial designed to test the effectiveness of a given treatment as compared to existing treatments.

Clinical trial, Randomized – A clinical trial in which the effectiveness of two or more treatments are compared. Random assignment of patients to one treatment or another ensures that clinical features are balanced.

Clinical trial controls – A standard against which experimental observations may be evaluated, as a procedure identical in all respects to the experimental procedure, except for absence of the one factor that is being studied.

Computerized tomography (CT scan or CAT scan) – Also called computer assisted tomography. A radiologic imaging study in which cross-sectional images of the body are obtained. For EBRT, CT scans are used for treatment planning.

Concurrent – Simultaneous. With EBRT usually refers to androgen deprivation that is given during the course of treatment.

Dihydrotestosterone (DHT) – A derivative of testosterone, which has a higher biologic activity within the prostate than testosterone; blocked by 5-alpha reductase blockers.

Electronic portal image (EPI) – an electronic image produced using a flat panel.

Epidural anesthesia – A catheter is inserted into the space surrounding the spinal cord to give medication to block pain. Used after radical prostatectomy or during HDR brachytherapy.

Epithelial cells – Cells that line body surfaces and cavities. These are the cells that produce secretions (such as PSA in the prostate) and are the cells from which (by definition) carcinomas are derived.

Erectile dysfunction (ED) – see impotence.

External beam radiation therapy (EBRT) – High-energy x-rays or protons used to kill cancerous tissue in the prostate, and elsewhere in the body.

5-alpha reductase blockers – A medicine that blocks conversion of testosterone to dihydrotestosterone inhibiting prostate growth.

Flat panel – a sensitive device that detects x-rays. The image produced is digital and can be immediately processed electronically. Image production requires less energy than x-ray film. May be used to position patients and/or detect organ motion.

Foley catheter – A tube that is placed into the bladder through the penis used to drain urine.

Fractionation – Dividing the total prescribed radiation dose into fractions typically delivered once a day. Conventionally fractionated courses of definitive EBRT typically involve 35-45 fractions over 7-9 weeks. **Moderate hypofractionation** delivers a biologically equivalent dose to conventional fractionation in 20-28 fractions over 4-6 weeks. **Ultra-hypofractionation** refers to treatment in 3-7 fractions (with the term SBRT/SABR reserved for ≤5 fractions using ablative radiation doses) over 1-2 weeks.

Gantry – The part of the linear accelerator that moves around the patient and functions in the delivery of EBRT.

Gleason grade and score – The **Gleason grade** is a numerical value given to prostate cancers that describes the level from which normal cell tissue has progressed from a low to an aggressive form of cancerous tissue within the prostate. Grades are assigned to the most common pattern of cancer as well as the second most common. Grades for each pattern range from 1 to 5. A grade of 1 denotes a cancer that closely resembles benign or normal tissue. A grade of 5 is assigned to cancers that appear most aggressive and differ significantly from benign tissue. The **Gleason score** is obtained by adding together the 2 Gleason grades and can range from 2 to10.

Gynecomastia – Enlargement of breast tissue in a patient. May occur with the use of androgen deprivation.

High dose rate (HDR) brachytherapy – A focal radiotherapy treatment involving temporary placement of a radioactive source in the prostate that is removed after each treatment. Small flexible tubes are inserted into the prostate through the perineum to deliver a high dose of radiation in a short period of time (5-20 minutes).

Hormone therapy (HT) – see androgen deprivation

Immobilization device – An external device used to help the patient remain in the same position for every treatment.

Implant – See brachytherapy

Impotence – Erectile dysfunction. The inability to achieve an unassisted erection sufficient for satisfactory sexual intercourse. This topic is covered in detail in Your Health Matters - Managing Impotence – a Patient's Guide.

Intensity modulated radiation therapy (IMRT) – An advanced form of EBRT (see above) that selectively raises doses at different places on the prostate and spares normal tissue with great precision.

Implant – A type of brachytherapy in which radioactive material (seeds) are implanted into the prostate.

Ionizing radiation – A general term for radiation beams that trigger ionization (excitation) of an atom or molecule. Ionizing radiation transfers energy into the tissues in which it is deposited.

Linear Accelerator (linac) – A machine used to deliver External Beam Radiation Therapy (EBRT).

Luteinizing hormone releasing hormone (LHRH) agonist – Synthetic analogs of natural gonadotropin-releasing factor that induce a temporary increase in testosterone secretion followed by fall of testosterone to castrate levels.

Lymph node – Filter nodules that are part of the body's drainage system for fluids. Also serves as a component of the immune system by removing bacteria, foreign particles, cancer cells, etc. from the circulation. Often the site of tumor metastases.

Metastasis – Secondary growth of a cancer due to the spread of cancer cells away from the site of origin. The capacity to metastasize is a characteristic of malignant tumors.

Multi-leaf collimator (MLC) – A part of the linear accelerator that is used to shape the EBRT beam.

Neoadjuvant – A treatment that is given before definitive local therapy. For EBRT, this usually refers to androgen deprivation given before the start of treatment.

Nitrate Containing Medications – An example medication is nitroglycerin which is used by some patients with heart disease (angina).

Orchiectomy – Surgical removal of the testicles to eliminate testosterone; used to treat advanced prostate cancer. Not commonly used nowadays and replaced with hormone therapy.

Osteopenia – Decreased calcification or density of bone.

Osteoporosis – A reduction in the quantity or amount of bone; skeletal atrophy.

Perineum – The area of the body between the anus and the base of the scrotum. In brachytherapy, needles containing radioactive seeds or in HDR brachytherapy thin tubes are implanted in the prostate through the perineum. (Perineal is the adjectival form)

Prostate gland – A gland in the male that surrounds the neck of the bladder and urethra. Secretions produced in the prostate contribute to the seminal fluid.

Prostate specific antigen (PSA) – A protein produced by prostatic epithelial cells. The level of PSA often correlates with the likelihood and extent of prostate cancer and the size of benign prostatic enlargement (BPH).

PSA nadir – The lowest point to which a patient's PSA drops on a PSA blood test, following definitive treatment.

Peripheral zone (PZ) – The rear outer area of the prostate gland where over 80% of prostate cancers originate.

Primary treatment- The first, or only, treatment given for a disease. It is often part of a standard set of treatments, such as surgery followed by chemotherapy and radiation. When used by itself, primary treatment is the one accepted as the best treatment. If it does not cure the disease or causes severe side effects, other treatment may be added or used instead. Also referred to as first-line therapy, induction therapy or primary therapy.

Radiation oncologist – A physician who specializes in treating cancer with radiation therapy.

Radiation therapist – A person who is specifically trained to operate a linear accelerator and administer radiation therapy treatments.

Radical prostatectomy (RP) – A surgery in which the entire prostate gland and seminal vesicles are removed.

Rectal hydrogel spacer – A gel that injected between the prostate and the rectum prior to radiation therapy to reduce radiation dose to the rectum. The gel is injected with a fine needle through the perineum. It hardens within minutes and stays in place for 3 months, then is absorbed and excreted from the body by 6 months. A commonly used hydrogel is the Boston Scientific SpaceOAR.

Stereotactic body radiation therapy (SBRT)/Stereotactic ablative body radiation (SABR) – Highly conformal, ablative external beam radiation therapy delivered in 5 or fewer fractions. SBRT/SABR may be delivered via specialized machines such as the Accuray CyberKnife or gantry based LINACS such as the Varian TrueBeam.

Scatter radiation – Low levels of radiation scattered inside the body from the treatment beam during prostate radiation.

Seeds – See brachytherapy

Seminal vesicles – Paired glands located on either side of the prostate that secrete substances to nourish sperm.

Simulation and verification – The process of planning radiation therapy. For EBRT usually includes a CT scan.

Testosterone – The male sex hormone or androgen that causes characteristically male features; predominantly produced in the testicles.

Three-dimensional conformal radiation therapy (3DCRT) – A means of delivering external beam radiation therapy that results in high doses delivered to the target with less exposure to surrounding tissue.

Transrectal ultrasound (TRUS) – An imaging test in which an ultrasound probe is placed into the rectum to image the entire prostate. This test facilitates prostate cancer staging and prostate biopsy.

Treatment plan – A radiation oncologist's prescription that describes how a patient should be treated, including the dose of radiation to be delivered, and the organs to be treated and protected.

Urethra – A structure that drains urine from the bladder. It passes through the prostate gland (prostatic urethra) and through the penis (penile urethra).

For additional information about radiation therapy, please go to the following web site:

The UCSF Department of Radiation Oncology:
https://radonc.ucsf.edu/