# RADIATION THERAPY

Most of the cancer patients need radiation therapy as a part of their overall treatment plan at some point in their illness. It is often recommended as a primary treatment, but can also be used along with chemotherapy or surgery.

Radiotherapy uses high-energy X-rays, electron beams, or radioactive isotopes to kill cancer cells without exceeding safe doses to normal tissue. It accomplishes its purpose by killing cancer cells through a process called ionization. Some cells die immediately after radiation because of direct effect, though most die because the radiation damages the chromosomes and DNA so much that they can no longer divide.
There are several technical ways of giving radiation. The most common way is by ***external radiation*** in which a radiation beam is directed at the tumor from a machine. ***Internal or systemic radiotherapy*** delivers radiation by giving a radioactive source intravenously or by injection, for e.g. intravenous radioactive iodine or radioactive gold into abdominal cavity. With ***intracavitory radiotherapy***, an applicator containing radiation seeds is placed in an organ such as uterus. In ***interstitial radiotherapy***, the sources are placed directly in the tumor. Radiation can also be administered during surgery in a technique termed ***intraoperative radiation therapy (IORT).*** These methods are usually used in combination with external radiation.

## PLANNING THE THERAPY

**The Stimulation:** If external radiation is going to be used, the first step is called stimulation, performed on a special x-ray machine built to resemble the machine that ultimately will be used. Certain contrast agents or probes may be used to aid in stimulation. It is done to make all the necessary measurements to fix the precise location of the tumor. Marks will be made on your skin with a colored ink to outline the target the radiation oncologist will be aiming for- the "radiation port"- which has to be the same everyday.

**The dosage:** The term used to measure in units the amount of radiation received is *centigray (cGy)*, but since one gray equals 100 rads, the two terms are interchangeable.
Careful planning allows the radiation oncologist to deliver the maximum effective dose to the visible tumor and any invisible tumor cells that might be nearby while protecting the surrounding normal tissue as much as possible. Calculating a dosage figure that balances these two goals can be complex, since the size and stage of the tumor have to be taken into account and since different tissues tolerate different levels of radiation. The liver will tolerate 3,000 cGY, the lung 2,000, and the kidney 1,800. Higher doses can be delivered to small parts of one of these organs, but if the entire organ is given higher doses than these, normal tissues can be harmed.
The oncologist prescribes the total dose necessary to destroy the tumor, and then calculates a daily dose over a specific period. This is called the fraction schedule. Throughout, the radiation oncologist works with a figure called the therapeutic ratio, defined as a comparison of the damage to the tumor cells compared with normal cells. The therapeutic ratio can be enhanced in a number of ways- by using altered time fraction schedules, careful treatment planning, selection of the optimum radiation energy for the specific problem, and by the use of experimental techniques such as high linear energy transfer (LET) radiation or chemical modifiers that either make the tumor cells more sensitive to radiation or better protect normal tissues.

**The Number Of Treatment:** Radiation is usually given daily 5 days a week. That schedule can continue for two to eight weeks depending on the tumor, the kind of the treatment being used, and the dosage required. The point of using multiple treatments instead of single treatment is to give normal cells a chance to recover and repair themselves.

**The Delivery Method:** The method to be used to deliver radiation is base on many factors, including the biology of the tumor involved, the possibility of the side effects or complications, the physical characteristics of the various sources of radiation, and how these different sources affect the body's many different cells, tissues, and organ systems. The method can be divided into external and internal radiation.

**TYPES OF EXTERNAL RADIATION**
The delivery of the dosage from the source outside the body- can vary according to the photon energy of the machines involved, the type of beams produced (electrons, X rays, gamma rays), when the treatment is given, and the number of beams involved in the treatment procedure.

- ***High-and Low-Energy Radiation*** External beam treatment uses special equipment that uses either low energy (orthovoltage machines) or high energy (megavoltage machines). All the machines used today are quite precise about where they deliver the radiation dose.
- ***Intraoperative Radiation Therapy (IORT)*** People with localized tumors that can't be completely removed or have a high risk for local recurrence may be candidates for IORT, a treatment carried out during surgery. The organ containing the tumor is localized and the surgeon removes as much of the tumor as possible. Then the normal tissue is moved out of the path of the radiation beam. A treatment cone connected to a Linear Accelerator is placed directly over the tumor, which is then treated with a single high dose. Normal tissues are spared, since they are outside of the beam.

- ***Stereotaxic (Stereotactic) Radiosurgery*** *also called as* ***Gamma knife:*** Here a number of cobalt sources are used to treat deep-seated blood vessel malformations within the brain. Technical information from the CT, MRIscan or angiogram is fed into treatment planning computer, and a dose distribution is calculated for the Linear Accelerator. The computer revolution and the availability of Linear Accelerators have made this form of treatment especially useful for vascular malformation, meningiomas, acoustic neuromas, and some malignant brain tumors.

**TYPES OF INTERNAL (SYSTEMIC) RADIATION THERAPY**
In this method of treatment, radiation to cancer cells is delivered by being inserted directly into or around the tumor. Radioactive sources can be injected, housed in special applicators, or implanted in the form of needles or seeds.

- ***Treatment with radioactive compounds:*** The use of radioactive tracers to treat tumors are unique in their ability to target specific tumors by being incorporated into their metabolism (e.g., thyroid cancer), finding antibody sites on tumor sites (e.g., lymphoma), localizing to tumor receptor sites (e.g., neuroendocrine tumors), or body's own response to the tumor to deliver a treatment dose (e.g., strontium 89). The membrane of tumors may have specific antibody sites where antibodies (monoclonal antibodies) can react or may have nonspecific receptors (neuroendocrine tumors).

- ***Interstitial radiation therapy:*** also called brachytherapy, places the sources of radiation directly in the tumor and surrounding structures. It's most commonly used in tumors of the head and neck, the prostate, and the breast. It is also usually used in combination with external radiation.
- ***Intracavitary radiation:*** The most common use of this method is in gynecologic tumors, such as carcinoma of the uterus. Specially designed hollow applicators are placed in the uterus under general or spinal anesthesia. A small plastic tube containing the required number of sources of radioactive isotope of a specific strength are inserted into the hollow applicators. The sources and applicators are left in place for forty-eight to seventy-two hours. The seeds deliver the dose over the specified time, and once the dose is reached, the applicators and the sources are removed. The advantage of this method is that a very high dose of radiation can be delivered to the tumor, while the rapid falloff in the dose gives maximum protection to the surrounding structures.
- ***Intraluminal radiation therapy:*** This method has limited use with some tumors in hollow organs like the esophagus and biliary tract. In esophagus carcinoma, for example, a specially designed tube is placed into the opening (lumen) of the esophagus. Then under X-ray visualization- fluoroscopy-several small radioactive sources are placed into the tube opposite the tumor. The tumor receives a high dose of radiation, while the dose to the surrounding structures is minimized.

SIDE EFFECTS OF RADIOTHERAPY

The common side effects of radiotherapy are divided into *Generalized(Systemic)* and *Local* effects. The type of effect and how severe they become generally depends on the area treated, the size of the radiation port, the daily dose rate, and the total dosage delivered. Not everyone taking radiotherapy suffers side effects.

1. **Systemic Effects**: One of the most common systemic side effects is fatigue or malaise. This is especially common among patients receiving treatments to large areas, such as the whole abdomen and in total lymph node radiation. Nausea and vomiting may occur in patients receiving radiation to the upper abdomen, but it is rare in patients getting radiation to the head and neck, chest, or pelvis.
2. **Localized Side Effects**

- *SKIN:* Most skin reactions appear as redness called erythema. It is similar to sunburn and goes through the same stages- redness, gradual tanning, and then peeling. If the dose has been high, late skin changes may appear in the form of increased pigmentation.
- *HEAD AND NECK:* The most significant side effect is irritation of the membrane lining or mucosa of the mouth- the mucous surrounding the tumor may become red. As the treatment progresses, quite a few small superficial ulcers may develop. This can cause a lot of discomfort and will probably interfere with the swallowing and nutrition. The taste sensation may be affected if the tongue happens to be in the primary radiation beam. Also the amount of saliva produced can be significantly reduced if the salivary glands happen to be in the treatment beam.
- *CHEST:* The mucosal lining of the esophagus may get involved and the patient may develop heart- burn type symptoms.
- *ABDOMEN:* Radiation to the upper abdomen can cause nausea and vomiting, usually during the first few days of treatment. As the treatment progresses the symptoms often diminished.
- *PELVIS:* Treatment to the pelvis can bring about cramps, perhaps followed by diarrhea during the second and third week of treatment. Patient may have urine frequency, urgency

to urinate or dysuria. All these symptoms are temporary and will disappear soon after the treatment is completed.

- *HAIR LOSS:* Only hair within the radiation port will be affected by treatment. So a patient will loss his scalp hair only if he is receiving radiation to the head, usually for brain tumors. Whether the hair loss is temporary or permanent will depend on the dosage.