

Basics of Radiation Treatment

Jayne Camporeale, MS, RN, OCN®, APN-C

Cancer is the second-leading cause of death in the United States, exceeded only by heart disease (American Cancer Society, 2008). Approximately 1.43 million non-skin cancer cases will be diagnosed in 2008 (ACS) and three out of four patients with cancer are likely to receive radiation during the course of the illness (Belka & Camphausen, 2006). Understanding the basics of radiation and treatment goals are essential to provide the best possible patient care.

Radiation can be very effective for curative purposes, localized control, and palliation of pain and symptoms. It also can be used in the neoadjuvant setting to shrink a tumor before surgery.

What Is Radiation?

Radiation is any type of radiant energy that can impart energy to the medium through which it passes (Zeman, 2000). Radiation kills cancer cells by permanently damaging the cell DNA or by creating free radicals that damage cell DNA (Zeman). Accurate and precise delivery of radiation to the tumor can minimize damage to surrounding healthy tissue.

Radiation Delivery Methods

Radiation can be delivered using multiple techniques, but, in general, three are used for cancer treatment (see Figure 1). This article will focus on teletherapy or external beam radiation therapy.

Teletherapy or External Beam Radiation Therapy

External beam radiation therapy, the most common radiation delivery method, involves delivery of high-energy x-rays

or particles to a specific area to treat the disease (Watkins-Bruner, Haas, & Goslin-Acomb, 2005). The treatment area is determined by visible tumor, microscopic tumor, and positional boundaries. The boundaries create gross tumor, clinical tumor, and planning target volumes (see Table 1). Other patient-related positional uncertainties that should be accounted for include organ motion, digestion, excretion, weight, and ability to remain still.

What Is the Linear Accelerator?

The linear accelerator is the most commonly used treatment machine. Located a distance from the tumor site, the linear accelerator produces the radiation the patient will receive through high-energy x-rays and electrons (see Figure 2).

Through microwave technology, electrons either accelerate to a high-energy state and exit as an electron beam or are directed into a target to produce x-rays. X-rays collide inside the linear accelerator and scatter and bump into a heavy metal target in the machine, where a portion are collected and shaped into a beam equal in size to the area of the targeted tumor (Watkins-Bruner et al., 2005).

Treatment design and planning takes place within the physics and dosimetry rooms where beams are customized for each patient. Three-dimensional conformal and intensity-modulated radiation therapies have advanced cancer treatment by providing a more heterogeneous

dose to the treatment area and sparing healthy tissues as much as possible (Bourland, 2000). Treatment-planning techniques can more precisely define radiation delivery to an irregularly shaped tumor. Conformal treatment with a computer-controlled multileaf collimator helps reduce radiation exposure to at-risk organs (see Figure 3). Additional shielding or lead blocks may be used to minimize exposure of normal tissue near the treatment area (Bourland).

The desired treatment depth determines the type and amount of energy used. For example, many skin cancers are treated with electrons because they travel a finite distance before stopping. Photons, on the other hand, have wavelength, frequency, and energy ranges over an unlimited order of magnitude (Bourland, 2000) and, therefore, are used on deeper cancers such as lung tumors.

The linear accelerator's radiation beam is projected through a section known as the gantry, which can rotate 360° around the patient. The patient is positioned on a moveable table called the couch, which can move in vertical, longitudinal, lateral, or arc motions (Bourland, 2000). This setup allows the radiation to be delivered to the tumor from any angle (Radiologic Society of North America, Inc., 2007).

The linear accelerator is controlled by a radiation therapist (see Figure 4) who is responsible for ensuring that the dose is delivered to the correct area as prescribed. The therapist uses visual and

Jayne Camporeale, MS, RN, OCN®, APN-C, is an adult nurse practitioner in the Department of Radiation Oncology at the Cancer Institute of New Jersey in New Brunswick.

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