Health problem addressed

Linear accelerators (linacs) and cobalt radiotherapy units are used in external-beam radiation therapy to treat cancer. Cobalt units and low-energy linacs are used primarily to treat bone cancer and tumors of the head, neck, and breast. High-energy linacs are used to treat deep-seated neoplasms and tumors of the pelvis and thorax. Radiation is used to treat at least 50% of all cancer cases. It can be either curative or palliative, depending on the stage and prognosis of the disease.

Product description

Linacs emit a well-defined beam of uniformly intense x-ray photon radiation of different energies, depending on the accelerator. Some linacs also produce electron beams. Cobalt radiotherapy units use a man-made radioisotope, cobalt-60, to produce gamma-ray photons. Linacs consist of four major components—a modulator, an electron gun, a radio-frequency (RF) power source, and an accelerator guide. The electron beam produced by a linac can be used for treatment or can be directed toward a metallic target to produce x-rays. Linacs are classified according to their energy levels, low, medium, and high.

Principles of operation

Linear accelerators accelerate electrons that collide with a heavy metal target, scattering high-energy x-rays. A portion of these x-rays is collected and shaped to form a beam that matches the patient’s tumor. The beam comes out of a gantry which rotates around the patient. The patient lies on a moveable treatment couch and lasers are used to make sure the patient is in the proper position. Radiation can be delivered to the tumor from any angle by rotating the gantry and moving the treatment couch.

Operating steps

A radiation therapist positions the patient on the unit’s table and carefully aligns the patient with positioning lasers and fiducial tattoos. Additional beam shaping elements are attached to the collimator or are adjusted on the collimator. The therapist then leaves the room and controls the delivery of radiation from a separate control room.

Reported problems

Most radiation therapy-related errors and incidents have been reported to be caused by use error. This can result in significant under-dose or over-dose in the delivery of radiation. Errors can also occur at the planning stage or in equipment calibration. Missed clinical information at the planning stage has caused severe (even fatal) radiation injury, and poor calibration can lead to serious medical errors. Also, in several reported cases, electromagnetic interference from a linear accelerator caused infusion-pump failure when the pumps were being used on patients undergoing radiation therapy.

Use and maintenance

User(s): Medical physicists; radiation therapy technicians
Maintenance: Medical physicists; radiation therapy staff; technicians; biomedical or clinical engineer
Training: Initial training by manufacturer and manuals

Environment of use

Settings of use: Radiation therapy department or centers
Requirements: Stable power source; shielded room and control room

Product specifications

Approx. dimensions (mm): 6500 x 7000 x 3200 (room size); 2500 x 500 (treatment couch)
Approx. weight (kg): Variable
Consumables: NA
Price range (USD): 1,500,000-4,500,000
Typical product life time (years): 8-10
Shelf life (consumables): NA

Types and variations

Linear accelerators; Cobalt radiotherapy units