



Glossary of Terms for Radiation Oncology

- **Abscopal Effect** A measurable response of tumor tissue definitely separate from the area treated; found in chronic leukemias or in lymphomas where irradiation of an enlarged spleen or lymph nodes causes a generalized disease remission in the former and relief of obstructive symptoms in the latter.
- **Absorbed Dose** A measure of the amount of energy absorbed from a radiation beam, by a medium in the path of the beam, described in units of rads. One rad is equivalent to 100 ergs of energy deposited per gram of absorbing material.
- **Absorption of Radiation** Any material placed in the path of radiation beam will absorb some of the radiation, that is, some of the energy of that beam. The amount of absorption will depend upon the type of radiation, the density of the absorbing material, and the atomic number of the absorbing material. This may result in ionization, heating, production of scattered radiation, and rearrangement of atomic bonds.
- **Accelerator (Particle)** A device that imparts kinetic energy to charged particles such as electrons, protons, deuterons, and helium ions. These particles may be used in medical irradiation either directly or indirectly (via the production of x-rays or neutrons). See Linear Accelerator, Van de Graaff Generator, Betatron, and Cyclotron.
- **Afterloading Techniques** In these techniques, hollow applicators (designed to carry a radioactive material) are implanted or inserted into the volume to be treated. These are checked by various methods (x-ray films or image intensifier) before the radioactive material is inserted, a step that is usually done when the patient has been transferred back to his room. Its main advantage is that it allows the operation to be carried out with little exposure of personnel to radiation. It also limits the radiation exposure to specified personnel who are closely monitored. The most commonly used afterloading technique is that used in the treatment of carcinoma of the cervix. See Brachytherapy and Internal Sources of Radiation.
- **Arc Therapy** External beam teletherapy in which the source of radiation is moved about the patient on an arc during treatment. Multiple areas may be used. In some cases, the beam is stationary and the patient rotated in a vertical plane.
- **Backpointer** An attachment to a therapy treatment machine used in conjunction with a frontpointer or front light beam to align the direction of the radiation beam. It consists of a curved arm, arcing over the patient with a pointer lying along the central axis, pointing to the exit point of the radiation beam.

- **Backscatter** Some of the radiation after entering the tissue will scatter back toward the surface. This portion of the radiation is called backscatter. Therefore, the surface or skin dose may be defined as the air dose plus the backscatter dose.
- **Beam Quality** The spectral-energy distribution of the radiation beam. Beam quality determines both the penetration of the beam through tissue and the relative absorption of the energy in different types of tissue.
- **Beam Shaping** The use of special blocks, wedges, compensators, and other devices to create a treatment beam of the geometric proportions required for a treatment plan that is beyond the capabilities of the machine collimator.
- **Beta Plaque** A flat plate or curved surface that is coated with a radioactive material and emits electrons. It is placed on the surface of the area to be treated. The depth of penetration is very small, in the order of millimeters. A common isotope used is strontium-90. An example of a beta plaque is an ophthalmological applicator, curved to conform to the surface of the eye.
- **Betatron** A megavoltage treatment machine capable of delivering high energy x-rays and, in some instances, an electron beam. The electrons are accelerated in a circular orbit.
- **Bolus** A material of density nearly equivalent to tissue placed within the treatment beam to compensate for unevenness of body contour or to enhance the buildup of electrons on the surface of the skin.
- **Brachytherapy** The administration of radiation therapy by applying a radioactive material inside or in close approximation to the patient. This material may be contained in various types of apparatus, may be on the surface of plaques, or may be enclosed in tubes, needles, wire, seeds, or other small containers. Common materials for the administration of brachytherapy are radium, cobalt-60, cesium-137, iodine-125, and iridium-192. Brachytherapy is sometimes called plesiotherapy.
- **Brachytherapy-Intracavitary Application** The radioactive material, usually in the form of sealed sources, is placed into various types of applicators, which are then (or have been previously) inserted directly into a cavity in the patient through natural or surgically produced apertures. See Internal Sources of Radiation.
- **Brachytherapy-Surface Application** The radioactive material is usually contained on the surface of a plaque or mold, which is applied directly or close to the surface of the patient.
- **Bragg Peak** The region near the end of a charged particle track in matter, in which the rate of energy loss is maximum.
- **Breast Bridge** A jig used to set up tangential fields, in particular, for treatment of the breast or a remaining skin flap.
- **Bremsstrahlung** X-rays produced when energetic electrons are deflected in the field of an atomic nucleus; they may have any energy up to the energy of the electrons producing them.
- **Cast** A shell, usually of plastic, individually formed to fit the outer shape of the patient. All relevant external radiation field markings are placed on the cast. During treatment, the cast holds the patient in one position and ensures that the tumor volume is treated exactly.
- **Central Axis Depth-Dose** Depth-dose (defined below) along the central axis of a radiation beam.

- **Cesium-137 Tubes** Used instead of radium for intracavitary insertions, especially in the treatment of carcinoma of the cervix. They are cylinders two centimeters in length and approximately four millimeters in diameter, usually calibrated as milligram equivalent of radium.
- **Cobalt-60 Teletherapy** The administration of external beam radiation therapy by means of Cobalt-60 gamma-rays: energies 1.17 and 1.33 MeV.
- **Compensator** A specially measured slab of material placed in the treatment beam to allow selective transmission of areas of the treatment beam to compensate for unevenness of machine output or body contour. Compensators vary greatly in complexity depending upon use requirements.
- **Contour Preparation** The utilization of some means of transferring a sectional shape of the patient's body onto a suitable surface for the purpose of dosimetry calculations. Normally followed by location of consequential internal structures and the suspected tumor volume.
- **Contact Therapy** Treatment by an x-ray machine designed for use at very small TSD (target-to-skin distance) of one to five centimeters at relatively low energy (approximately 60 kv.). Useful for small skin lesions.
- **Conventional Therapy** Treatment by x-ray beams, not in the supervoltage range.
- **Curie** Special unit of (radio) activity, equal to 3.70×10^{10} disintegrations per second. Historically, the curie (Ci) was based on the disintegration rate of one gram of radium.
- **Cyclotron** A circular accelerator used to produce high energy protons, deuterons, and other relatively heavy charged particles. Energies over 100 million volts may be achieved. Such particles may be used for basic physics research and to produce radionuclides for medical applications. They are sometimes used directly for experimental therapy or to produce neutron beams for therapy.
- **Depth-Dose** Radiation dose at some specified depth or depths in tissue relative to the dose at a fixed reference point on the beam axis. Depth-dose is usually expressed as a percentage.
- **Diaphragm (or Collimator)** The part of a radiation beam therapy machine that limits the field to the desired size. The thickness of the metal required increases with the energy of the beam.
- **Dosimetrist** An individual who has training and knowledge in treatment planning and who, under the supervision of a qualified radiological physicist or radiation therapist, is capable of performing dose calculations and of assisting in calibration and verification of dose distribution within the patient. A dosimetrist shall have a Bachelor's degree in physical science with at least one year of additional experience in radiation physics, or be a registered radiation therapy technologist with at least two years of additional experience in radiation physics and treatment planning.
- **Dosimetry Strictly**, the measurement of dose. In practice, calculations, measurements, and other activities required for determining the radiation dose delivered.
- **Electromagnetic Radiation** Electromagnetic radiation consists of a transport of energy through space as a combination of an electric and magnetic field both of which change in magnitude as a function of time and space. (Examples: visible light, infrared and ultraviolet, x- and gamma-rays).
- **Electron Beam Therapy** Treatment by electrons accelerated to high energies by a machine such as the betatron. Used mainly for lesions situated at or near the surface. The advantage is that, unlike x-

rays, electrons deliver the maximum dose to the first few centimeters of tissue, with rapidly decreasing dose as depth increases. The depth of the high-dose region can be varied by varying the electron energy.

- **Entrance Port** The area on the surface of a patient or phantom on which a radiation beam is incident.
- **Exit Dose** The dose at the point where the axis of the beam emerges from the patient.
- **External Irradiation** A method of irradiation in which the source of radiation is outside the body. The radiation beam must always traverse the skin and some normal tissue except with a superficial lesion.
- **Field Block** A quantity of attenuating material utilized to shape a treatment beam, especially to produce a beam of complex shape.
- **Field Size** The measure of an area irradiated by a given beam. There are two most useful conventions. The first is the geometric field size; the geometric projection on a plane perpendicular to the central ray of the distal end of the collimator as seen from the center of the front surface of the source. The second is the physical field size, defined as the area included within the 50 percent maximum dose isodose curve at the depth of maximum dose.
- **Filter** An insert, composed of various layers of different metals (aluminum, copper, lead) put in the x-ray beam to filter out the lower energy rays of the beam.
- **Fractionation** A technique of administering radiation therapy in multiple doses over a number of days or weeks to achieve a maximum therapeutic ratio.
- **Gamma-Ray** A photon emitted from the nucleus of a radioactive atom, different from an x-ray photon only with respect to origin. A photon may be thought of as a moving electromagnetic disturbance which behaves sometimes as a wave and sometimes as a particle.
- **Gold-198** A radioactive isotope used in interstitial therapy in the form of seeds or wire, or in intracavitary therapy in the form of a colloidal solution. The isotope has a half-life of 2.7 days and emits photons at 0.41 MeV, as well as electrons.
- **Half-Life** The time during which half the atoms initially present in a sample of radioactive material will have decayed.
- **Half-Value Layer (Thickness) (HVL)** A measure of the quality of the radiation. Indicates the thickness of the specified material required to reduce the flux density of the radiation beam to one half of its initial value. For example, the HVL of ^{60}Co is 11 mm. of lead.
- **High LET Radiation** Energetic charged particles, or other radiation capable of liberating secondary charged particles, for which the spatial rate of energy loss (linear energy transfer or LET) is greater than about 10 kilo electron volts per micron of particle path, i.e. a significantly higher rate than that for electrons. Examples are protons, pions, alpha particles, and neutrons. Neutrons are uncharged but liberate protons and other charged particles in tissue.
- **Immobilization Device** A mechanical device to maintain the patient in a fixed position during treatment. This may take the form of a plaster cast, a vacuum pillow, or some other holding device.
- **Internal Sources of Radiation** (See Brachytherapy)

- **Removable Implant** The radioactive material is enclosed in needles, seeds, or tubes, which can be removed after the desired dose is given. Examples are radium-226 or cesium-137 needles and iridium-192 seeds or wire. The sources may be inserted directly into tissue or inside an applicator of some kind.
- **Permanent Interstitial Implant Seeds** containing the radionuclide are inserted directly into tissue, either individually or in ribbons of absorbable suture material, and left indefinitely. The technique is used to treat intrathoracic and intra-abdominal tumors (lung, pancreas, bladder, prostate) and in the palliative treatment of accessible tumors. Radionuclides used include iodine-125 (60 day half-life) and radon-222 (3.8 day half-life). The seeds are inert after total decay and do not cause any foreign body reaction.
- **Distributed Internal Source** Intracavitary application of radiocolloids, such as Au-198, or P-32 (chromic phosphate), allows uniform distribution of radioactivity over serosal surfaces.
- **Metabolically Located Sources** Administered radionuclide is transported and concentrated by normal metabolic activity, e.g. I-131 in thyroid.
- **Inverse-Square Law** A physical law describing the intensity of radiation at various distances from a point source. The flux density or radiation is inversely proportional to the square of the distance from a point source.
- **Ion Chamber** A special radiation measuring device in which the collected electrical charge from ionization in a gas-filled cavity is taken to be the proportion to some parameter (e.g. dose or exposure) of radiation field.
- **Isodose Curve** A curve on which all points receive an equal radiation dose. A series of them will map out the relative intensities of a radiation field in a phantom or patient.
- **Isodose Distribution** In a selected plan intersecting the treatment region, a representation of dose distribution by a set of curved lines, each line tracing the locations of points at which a specified dose is delivered. Its calculation is very time consuming unless performed with the aid of a computer. The dose at each point is the sum of doses from all intersecting beams (in teletherapy) or from all implanted sources (in brachytherapy).
- **Isotopes** Atoms of identical chemical properties (same configuration of orbital electrons) but with a different atomic weight (different number of neutrons contained in the nucleus of the atom).
- **LD 50/30** A term that represents a single total-body irradiation lethal in 30 days to 50 percent of a group of animals. For man it is about 350 to 450 rads.
- **Linear Accelerator** Essentially a pipe in which charged particles may be accelerated by applying a high frequency potential difference during the particle transit along the pipe. In electron accelerators for radiotherapy, the pipe becomes a "wave-guide", which may be a corrugated tube with continually increasing spacing between corrugations. Microwave frequency electromagnetic fields generated at one end travel down the wave-guide in a wave of increasing velocity. A "bunch" of electrons injected at precisely the right time is accelerated by "riding the crest" of this wave. The electrons produce x-rays by striking a target at the far end of the tube.

- **Linear Energy Transfer (LET)** The spatial rate of energy loss by a charged particle along its path, often expressed in units of kilo electron volts per micron.
- **Loading (Field Weighting)** Among several beams in a treatment plan, the relative distribution of radiation exposures to the individual beams may be expressed in percentage of radiations applied, one field to another or total dose, centering on the same tumor volume. May also be expressed as a ratio (one to one, one to three, etc.).
- **Localization Films** X-ray films taken with various radiopaque markers in order to localize the position of the tumor relative to the external markings.
- **Low LET Radiation** Radiation that delivers most of its dose by way of charged particles having spatial rates of energy loss (linear energy transfer or LET) less than about 10 kilo electron volts per micron of particle path. Low LET values are associated mainly with electrons and with x- or gamma-rays (which liberate electrons in tissue).
- **Nuclide** A species of atom having specified numbers of neutrons and protons in its nucleus.
- **Orthovoltage X-Ray Therapy** X-ray therapy applied with a machine producing x-rays having a peak energy of 140 to 680 kVp.
- **Oxygen Enhancement Ratio (OER)** The ratio between the dose required to produce a given biological effect under hypoxic conditions and the dose required to produce the same effect under well-oxygenated conditions. The OER for x-rays typically has a value of 2.6 as compared to a value of 1.6 for neutrons.
- **Penumbra** The region at the edge of an irradiated volume that receives some radiation, but not the full dose of the beam. It exists because of the finite source size and because of scattered radiation.
- **Phosphorus-32** A radioactive isotope that emits beta rays and has a half-life of 14.3 days. It is administered internally, in solution, and tends to concentrate in the bone marrow, spleen, liver, and lymph nodes. Useful in treatment of polycythemia vera. Phosphorus-32 is also used in colloidal form by injection into the serous cavities (pleural and peritoneal) in order to control the malignant accumulation of fluid.
- **Pin and Arc** An attachment for a therapy unit used to position the beam at a specific angle and aimed toward a specific point in the patient.
- **Point A** An imaginary point described by Todd and Meredith as being two centimeters lateral to the cervical canal and two centimeters above the cervical os. The point is supposed to lie in the paracervical tissues.
- **Point B** A reference point that lies three centimeters lateral to Point A and is used as a means of evaluating pelvic wall dosage.
- **Port Film** A radiograph taken with the patient interposed between the treatment machine portal and an x-ray film. The purpose of this film is to demonstrate radiographically that the treatment field, as externally set on the patient, adequately encompasses the desired treatment volume and at the same time avoids adjacent critical structures.

- **Primary Beam** The direct radiation beam emanating from the head of the irradiating unit. Scattered radiations result when this beam collides with any object (patient, treatment table, walls)
- **Quality** The penetrating power of a photon beam, described in terms of half-value layer.
- **Rad** Unit of the radiation quantity "absorbed dose". One rad is equal to an energy absorption of 0.01 joule per kilogram of any material.
- **Radioactivity** The property of certain nuclides of spontaneously emitting particles or gamma radiation or of emitting x-radiation following orbital electron capture or of undergoing spontaneous fission.
- **Radiation** The propagation of energy through space or matter. In radiology, it can be divided into two main groups: charged particles (e.g. electrons, protons, alpha particles) and electromagnetic (x-rays, gamma-rays).
- **Radiation Beam** The flow of therapeutically useful radiation energy through a defined area: includes x-rays, gamma-rays, electrons, and other radiation from a treatment machine.
- **Radioactive Half-Life** The time during which half the atoms initially present in a sample of radioactive material will have decayed.
- **Radium-226** A radioactive isotope commonly used for radiotherapy. It has historical importance in that it was the first isotope to be used medically and is used as a radiation standard. The half-life is about 1,620 years and photons of many discrete energies are emitted up to a maximum of 2.2 MeV. It is used in the form of needles and tubes for interstitial and intracavitary insertions.
- **Radon** It is available in the form of sealed gold seeds and is widely used for permanent implants.
- **Relative Biological Effect (RBE)** The ratio between the dose required to produce a given biological effect using a reference radiation (of specified type and energy) and the dose required to produce the same effect using the radiation in question.
- **REM (Roentgen-Equivalent-Man)** Special unit of the radiation protection quantity "dose equivalent". Dose equivalent is obtained by multiplying absorbed dose by a "quality factor", which has higher values for higher LET radiations. When dose is expressed in rads, dose equivalent is in rems.
- **Roentgen (R)** Special unit of the radiation quantity "exposure", equal to an electrical charge (produced by ionization) of 2.58×10^{-4} coulomb per kilogram of air.
- **Rotation Therapy** External beam teletherapy in which the source of radiation moves circumferentially around the patient while being centered in the volume of interest. Some devices allow the patient to rotate in the vertical plane within a stationary beam.
- **Scatter** When a material is in the path of a radiation beam, the material not only absorbs some of the radiation, it also scatters some in all directions, usually reducing the quality of the beam at the same time. Therefore, the radiation received at a point has two components: scattered and primary. It follows that the exposure rate at a point in air will be increased if a patient or phantom is placed behind it. This is caused by "backscattered" radiation.
- **Simulation** The use of a simulator to determine the various treatment field outlines and orientations to be used in the course of radiation therapy.

- **Simulation Films** X-ray films taken with the same field size, source-to-skin distance, and orientation as a therapy beam in order to mimic the beam and for visualization of the treated volume on an x-ray film.
- **Simulator** A radiation generator operating in the diagnostic x-ray range with the mechanical capability to orient a radiation beam toward a patient with parameters imitating that proposed for therapy, and affording direct x-ray fluoroscopic visualization and roentgenographic images of the area. Machine not capable of delivering radiation therapy.
- **Skin Sparring** Because of the buildup of the absorbed dose in supervoltage radiation deep to the skin, the skin surface does not receive the maximum dose delivered. The skin reaction is therefore much less than would be expected from conventional radiation.
- **Source Axis Distance** The distance from the source of radiations to the center of rotation in the case of rotational or arc therapy.
- **Source-to-Skin (SSD)** The distance from the radiating isotopic source to the skin of the patient.
- **Split-Course** A course of radiotherapy delivered in two or more parts separated by planned rest periods.
- **Strontium-90 Applicator** A beta-ray source used for contact therapy, usually for eye lesions. Most of the dose is delivered by beta-rays (maximum energy of 2.3 MeV) from the equilibrium activity of the yttrium-90 daughter product.
- **Superficial Therapy** Treatment with an x-ray machine of relatively low energy, approximately 100 kv. Penetration is not large.
- **Supervoltage Therapy** 680 kVp to two MeV and above including cobalt-60 and cesium-137.
- **Teletherapy** The delivery of radiation treatments to the patient from a source located far (usually more than 50 cm.) from the region to be treated.
- **Thermoluminescent Dosimetry** The use of radiation-sensitive materials to determine dose at selected locations by measuring light emitted when materials are heated, i.e. thermoluminescence. Frequently placed in the path of the treatment beam to verify radiation exposures comprising a treatment plan. The action of radiation on certain crystalline materials, e.g. lithium fluoride, is to "trap" some electrons at higher energy levels, in the crystal lattice. These electrons may be released from their traps by heating of the material, and the light that they emit in returning to their former energy levels is directly proportional to the absorbed dose.<
- **Tolerance Dose** The maximum radiation dose which may be delivered to a given biological tissue at a specified dose rate and throughout a specified volume without producing an unacceptable change in the tissue.
- **Treatment Beam Parameters** The data required for the complete specification of an individual treatment beam. Includes: radiation energy, field size, use of wedges, blocks, bolus, etc., orientation with respect to patient and prescribed exposure time, dose, and distance, etc.
- **Treatment Field** A plane section of a beam, perpendicular to the beam axis, as defined by the collimator of the treatment machine. Term often used synonymously with treatment port.

- **Treatment Plan** An ensemble of radiation beams or sources designed to produce a prescribed dose pattern in and for the patient; includes spatial and temporal distributions.
- **Treatment Planning** A complex process carried out prior to the administration of radiation therapy. Usually includes such items as tumor localization, treatment volume determination, contour preparation, and treatment dose determination to prescribe the dosage pattern required; also, composition of radiation exposure spatially and their time distribution to effect the prescribed dose pattern.
- **Treatment Port** The machine opening through which the radiation beam is delivered. See Treatment Field.
- **Tumor Localization** The various studies and procedures to determine the volume of tumor involvement, e.g. simulation, tomography, computerized transaxial scanning, ultrasonic scanning, and radionuclide scanning.
- **Tumor Volume** That volume encompassing all known or presumed tumor.
- **Van de Graaff Generator** An electrostatic machine that utilizes a moving belt to carry electrons to a high-voltage collector or terminal and then accelerates these charged particles to high energies.
- **Verification Field** The radiograph taken with the patient interposed between the treatment machine portal and an x-ray film. The film is left in place for the entire course of treatment and its purpose is to verify the area treated by the original portal film.
- **Wedge Filter** A tapered block of attenuating material, designed to produce a differential distribution of radiation exposures over the area of a radiation beam.
- **X-Rays or X-Radiation** Electromagnetic radiation of energy greater than 100 electron volts, emitted when electrons (or other charged particles) experience a sudden loss of energy, either falling into a vacant orbital energy level of an atom (in which case "characteristic" x-rays are produced) or being sharply deflected in the field of an atomic nucleus (in which case "bremsstrahlung" x-rays are produced).