RADIATION PROTECTION OF WORKERS
Radiotherapy

IAEA

Radiation doses to staff must be kept: As Low As Reasonably Achievable: ALARA

Radiotherapy is the use of ionizing radiation to kill diseased tissue. Radiation sources used for radiotherapy may be external to the tissue (external beam therapy) or in contact with the tissue (brachytherapy). Radiotherapy sources are designed to deliver very high radiation doses to the treatment area. However, from an occupational exposure point of view:

if safety features are installed and maintained

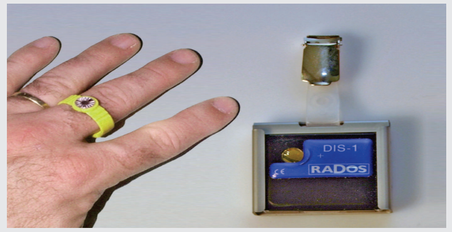
and staff are trained to follow procedures

then staff doses will be low, typically 1 mSv per year or less

but doses can be very high if there are accidents.

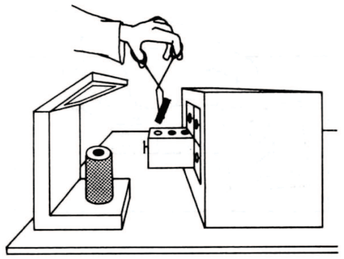
Dosimeters: If dosimeter badges are provided, they should be worn between the shoulders and the hips. Small dosimeters, worn on a finger, can monitor the dose to the hand. Dosimeters must be returned to the provider so that the dose information can be read. Dosimeters must not be shared.

Dosimeters do not provide protection from exposure to ionizing radiation, they are a means of assessing the dose that the wearer has received.



Manipulating sources

Radioactive brachytherapy sources are unsafe to handle directly with the fingers. Long-handled tongs or tweezers must be used.



BRACHYTHERAPY

Brachytherapy

Brachytherapy treatments may involve placing the source directly against the diseased tissue (direct loading) or placing a source into applicators or tubes for a prescribed time (after loading). Brachytherapy using high dose rate sources must be carried out in a controlled environment where:

- ☑ Staff must remain outside the room during the treatments.
- ☑ The treatment room must be fitted with interlocked doors and warning signs.
- ☑ The patient must be supervised via a shielded window or a closed circuit TV (CCTV).
- ☑ A radiation monitor of scattered radiation must be present inside the room to show when the source is in use.

The requirements for using low dose rate sources are not as stringent as those listed above.

Brachytherapy patients must be monitored immediately after treatment and before being discharged.

Care of sources

Radioactive sources must be:

- ☑ Stored in a secure, shielded and labelled storage facility.
- ☑ Labelled with the radionuclide name, activity and serial number.
- ☑ Checked each day, and whenever a source is moved; a record of these checks must be kept.

EXTERNAL BEAM THERAPY

External beam therapy treatment requires very high dose rates which may be delivered by radioactive sources (e.g. cobalt-60) or radiation generators (e.g. linear accelerators).

'Defence in depth'

Defence in depth means safety in many layers so that if a single safety feature fails, protection will still be provided.

In external beam therapy, this means:

- ☑ A treatment room that offers good shielding.
- ☑ A maze entrance to the treatment room.
- ☑ Interlocked access points.
- ☑ Signals in the room and at the entrance when dose rates are high.
- ☑ Emergency off switches in the room.

The safety features must be designed such that a component failure will cause the device to attain rest in a safe condition.

The safety features must be regularly serviced.

Radioactive sources emit radiation all the time, but are shielded when not in use.

Radiation generators do not emit radiation when they are switched off. However, generators can sometimes induce activity that will normally take a very short time to decay.

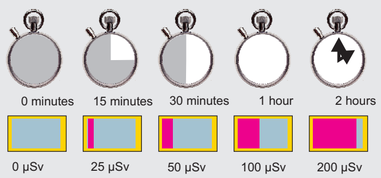
RADIATION PROTECTION FROM EXTERNAL EXPOSURE

Exposure to gamma and X rays can be controlled by consideration of time, distance and shielding:

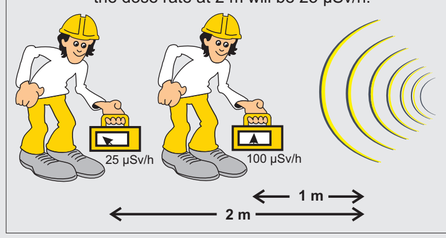
Time

To reduce radiation doses, the time spent in radiation areas must be kept as short as possible. The longer the time spent in an area, the higher the dose received.

In an area where the dose rate is 100 µSv/h, the dose received will be:



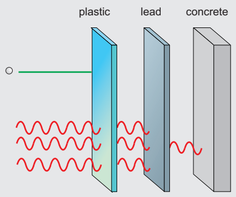
Distance If the dose rate at 1 m from a source is 100 µSv/h, the dose rate at 2 m will be 25 µSv/h.



Shielding Shielding material must be appropriate for the type of radiation. For example:

1 cm of plastic will totally shield all beta radiation.

Lead and concrete can be used to shield against gamma and X radiations.



BRACHYTHERAPY

DO

- ☑ Wear your personal dosimeter if you have been issued with one.
- ☑ Ensure, for high dose rate sources, that the scattered radiation detector is operational.
- ☑ Use local shielding, gloves and long forceps when handling brachytherapy sources.
- ☑ Monitor the patient and the treatment area after each patient has been treated.
- ☑ Use a survey meter to check that the source is fully shielded or the exposure has terminated.

DO NOT

- ☑ Leave a source unattended at any time.
- ☑ Discharge a patient who has not been monitored, or who has implanted radioisotopes above the activity discharge limits.

EXTERNAL BEAM THERAPY

DO

- ☑ Check the operation of safety features daily.
- ☑ Service interlocks and warning systems as recommended by the manufacturer.
- ☑ Always wear a dosimeter if you have been given one.

DO NOT

- ☑ Enter the room if the “radiation on” warning light is illuminated.
- ☑ Use the room if any of the safety features are damaged.
- ☑ Use the room unless you are sure that it is safe.

DOSE AND EFFECTS

Units of dose

The unit of absorbed dose is the gray (Gy).

The unit used to quantify the dose in radiation protection is the sievert (Sv).

One millisievert (mSv) is 1/1000 of a sievert.

- ▶ Annual doses from natural background radiation vary on average between 1 mSv and 5 mSv worldwide.
- ▶ One microsievert (µSv) is 1/1000 of a millisievert. The typical dose from a chest X ray is 20 µSv.

Dose rate

Dose rate is the dose received in a given time. The unit used is microsieverts per hour (µSv/h).

- ▶ If a person spends two hours in an area where the dose rate is 10 µSv/h, then they will receive a dose of 20 µSv.

Health effects of radiation exposure

If radiation doses are very high, the effect on the body will appear relatively soon after the exposure. These acute injuries will occur if the absorbed dose is higher than a threshold value; the sources and equipment used in radiotherapy are capable of delivering such doses. It is therefore essential that procedures for work are followed.

Even if the dose is not high enough to cause serious injury, there is still the possibility of incurring other health effects. These effects, e.g. radiation induced cancer, are risk based, i.e. the higher the dose received, the greater the chance of developing the effect. To reduce the possibility of developing late effects, radiation doses must be kept:

AS LOW AS REASONABLY ACHIEVABLE (ALARA)