19BME308 - Medical Radiation Safety

UNIT II - RADIATION SAFETY IN NUCLEAR MEDICINE AND RADIOTHERAPY

2.6 Radiation Protection in Brachytherapy

Potential Radiation Hazards in Brachytherapy

In all brachytherapy techniques there are radiation hazards to the patient, the hospital staff, and the public. The following section identifies these hazards and suggests appropriate measures for their reduction.

Patients

Patients are the direct beneficiaries of the treatment procedures, but exposure to other tissues at risk close to the tumor or organ of interest should be minimized. This is achieved by proper planning of the procedure, insertion of applicators with image guidance, post procedure imaging, and optimized treatment dosimetry. Over the years, more than five hundred incidents have occurred in which patients received minor to fatal injuries. These accidents can be attributed to human errors, mechanical failures, and lack of training and supervision. Examples of human errors include:

- Use of wrong source strength resulting in higher dose
- Wrong patient
- Wrong treatment site
- Wrong catheter connection

Radiation Safety Measures in Brachytherapy

Brachytherapy Facilities

Basic radiation safety in the use of brachytherapy sources starts with the design of the facility. For LDR techniques, the room housing the patient or, in an HDR facility, the room in which the HDR unit is housed for the treatment should have an appropriate design to reduce the annual dose to staff and public below the permissible levels at all accessible sites. The basic concepts of time, distance, and shielding are to be applied judiciously to calculate the annual doses. Achieving distance by housing brachytherapy units in large rooms can be difficult where space is at a premium, and hence reducing the occupancy in the vicinity and having adequate shielding are often the best ways to reduce the annual dose.

When selecting the location of the room, it is not advisable for it to be located close to an obstetrics or pediatric ward. Shielding should be considered not only for the walls, but also to the floor and ceiling, depending upon the utility and occupancy of the areas below and above the room, with due attention to load bearing of the structure. Any windows planned for a ground floor room need to have an area cordoned off to restrict access.

Low-Dose-Rate Brachytherapy Treatment Rooms

An LDR brachytherapy room will generally be part of a patient ward, and the layout should allow for the safety of the nursing staff and other staff in the ward and of the public visiting the ward. Further, the layout should provide for efficient nursing. In this context, the discussion will be limited to remote afterloading facilities. In addition to the general requirements for a patient-nursing room, there must be provision for the safe appropriate storage of the manual afterloading sources (if used), the afterloading unit, any source trains not incorporated in the unit, the source transfer or coupling tubes, and the emergency kit. An appropriate radiation detector should be installed in the room to detect any low activity source either in or outside the patient. Warning lights controlled by this detector should be displayed outside the room and at the nurse’s station. The access door/chain to the room should have an

interlock with the treatment unit. There must be provision for remote monitoring of the patient with CCTV and an intercom system.

Treatment Planning

Treatment planning comprises not only the dose calculation and optimization, but also the entire process of selection of the patient, patient preparation, the source/catheter implantation (image guided or otherwise), imaging for dosimetry, and treatment with appropriate source(s). In terms of radiation protection, good treatment planning fulfills two roles: it ensures the correct dose is given to the target while minimizing the dose to normal structures, and it reduces the likelihood of accidents. The institution protocols should be strictly followed in the selection of the patient. Otherwise, the patient will be unnecessarily irradiated or given the wrong dose.

Catheter Placement

Prior to placement, appropriate steps should be in place to identify and check the patient's name, site of application, and so on. If working with a preplanned catheter placement, as for 125I implant for prostate, the patient should be positioned the same way as that done for preimplant imaging. Image-guided placement should achieve more accurate results and improved dose distribution. Many computer programs can generate optimized plans, but no computer can compensate for a poorly placed implant. When multiple fractions are planned, all catheters must be anchored to a device attached to the body/ treatment area such as templates and buttons. For intraluminal applications, it is better to use catheters that have provisions to anchor the catheter to the wall of the lumen or cavity. It should be ensured that enough of the catheters project outside the skin, to make connections to the afterloading unit or for easy introduction of the source trains. Except during imaging and treatment all catheters should be capped to avoid any blockage or contamination by foreign material.

Imaging

All imaging for dosimetry should be done with the patient in the same position as for treatment. The personnel conducting the dose planning may not be the people executing the treatment. There should not be any ambiguity or errors in the order in which the catheters are numbered for planning and for treatment. Therefore, there must be an accepted norm to number the catheters. For example, for prostate implants, the numbering might start from the most anterior catheter on the patient's right and sequentially to the left in the same row. Then continue with the next row from the patient's right, the last number being the catheter on the posterior row most lateral on the left. Lack of such norms has resulted in wrong catheter connections to the HDR unit. Appropriate x-ray, CT, or MR markers should be placed correctly in the catheters to identify the extent to which the catheter is positioned in the organ of interest.

Dosimetry

It should be ensured that in the planning software the correct menu is selected for dosimetry and the patient's demography data are correctly entered. The operator should check that the image file/radiograph selected is for the correct patient. In the case of radiographs, the magnification factor should be checked and verified. Selection of source configuration data and other parameters must be independently verified by another person. All catheters should be identified sequentially and source positions decided based on organ delineation and cover. In the case of HDR/PDR applications, the indexer length used for the catheters should be verified and input. The prescription sheet should be checked before inputting the dose points and the prescription dose. All the above should be checked independently by another qualified person. Once a satisfactory plan is generated and approved by the radiation oncologist (RO), the plan and relevant data should be printed out and the RO should check and sign

Reference: *Jamie V. Trapp, "An Introduction to Radiation Protection in Medicine".*