19BME308 - Medical Radiation Safety

UNIT II - RADIATION SAFETY IN NUCLEAR MEDICINE AND RADIOTHERAPY

2.4 Procedure for Safe Operation of Radiation Equipment

Protection of Occupationally Exposed Individuals and the Public

Recognition and Avoidance of Hazards:

It is important to recognize that the hazard to the occupationally exposed individual in radiology arises from three sources (Figure 1). These are the primary x-ray beam, x-ray tube leakage radiation and, most important of all, scatter from the patient. These latter two sources of hazard are collectively called secondary radiation. It should be rare for clinical staff to be exposed to the primary beam. However, in those instances where uncooperative patients are involved it may be necessary to hold or restrain those during a procedure, and restraining devices should be utilized whenever possible. In the case of children it is invariably good practice to allow a career to assist. In all instances leaded gloves should be worn if there is any chance of the hands being in the primary beam.

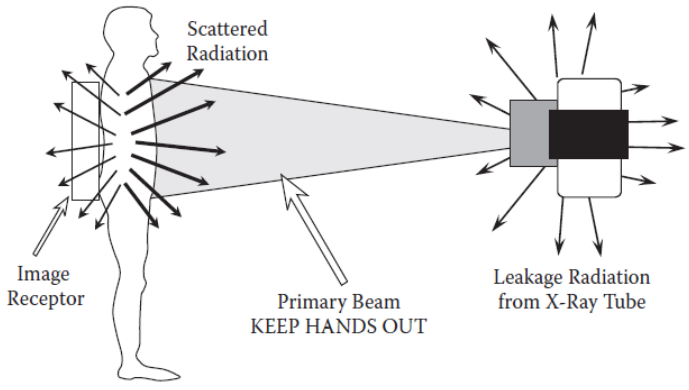

Figure 1 : Recognize the exposure hazards: leakage radiation, scatter radiation, and primary radiation.

Conventional fluoroscopic installations present no great hazard if the above precautions are adhered to. However, it is worth noting that the configuration employing an overtable x-ray tube and an undertable image intensifier is intrinsically less safe than the more traditional configuration (see Figure 2). Primarily this is because leakage and scatter radiation are significantly reduced by the image-intensifier housing and table in the case of the latter configuration. Accordingly, the use of the above table x-ray tube configuration should be discouraged unless it can be operated remotely.

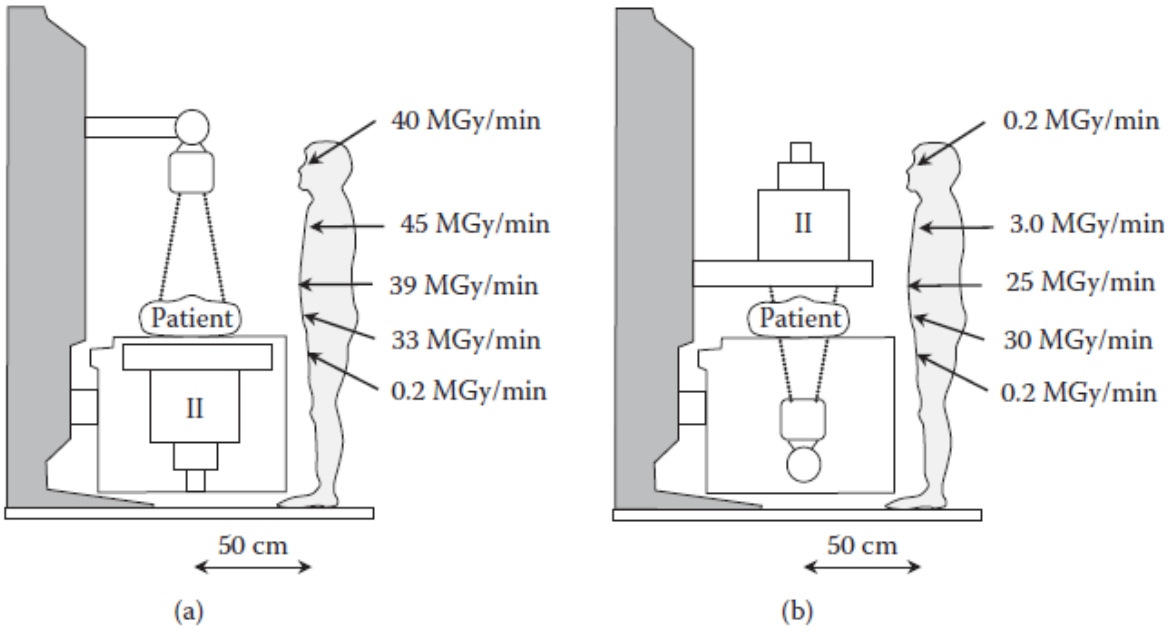

Figure 2: *Typical skin absorbed dose rates near fixed fluoroscopic equipment in the absence of protective aprons or drapes. (a) Overtable x-ray tube. Note elevated dose rates to trunk and head. (b) Undertable x-ray tube with relatively high dose rates only in region of lower trunk.*

Specific Issues for Cardiology and Interventional Radiology:

The practice of using C-arms in cardiac and interventional angiography suites does increase the potential radiation hazard compared with using conventional fixed fluoroscopic equipment. There are two reasons for this. First, there are frequently no lead drapes or built-in shielding to

minimize scatter and leakage at the operator's position. Second, as angioplasty, stenting, and radio frequency ablation procedures become more common, there has been a dramatic increase in fluoroscopic screening times. It has been reported that substantial occupational exposure may arise during cardiology and interventional procedures as a result of inappropriate equipment and inadequate personnel protection. As previously noted, the major radiation hazard is scatter radiation emanating from the patient, and in general, occupational doses will scale with patient doses so that occupational doses can be lowered by reducing unnecessary patient dose and also by the procurement and use of appropriate equipment, including shielding devices

While some general recommendations about good geometry have already been made in the context of patient dose reduction, some preferred orientations of C-arm x-ray equipment are indicated in Figure 3. For lateral and oblique projections the operator should stand on the side of the patient where the imaging device is located.

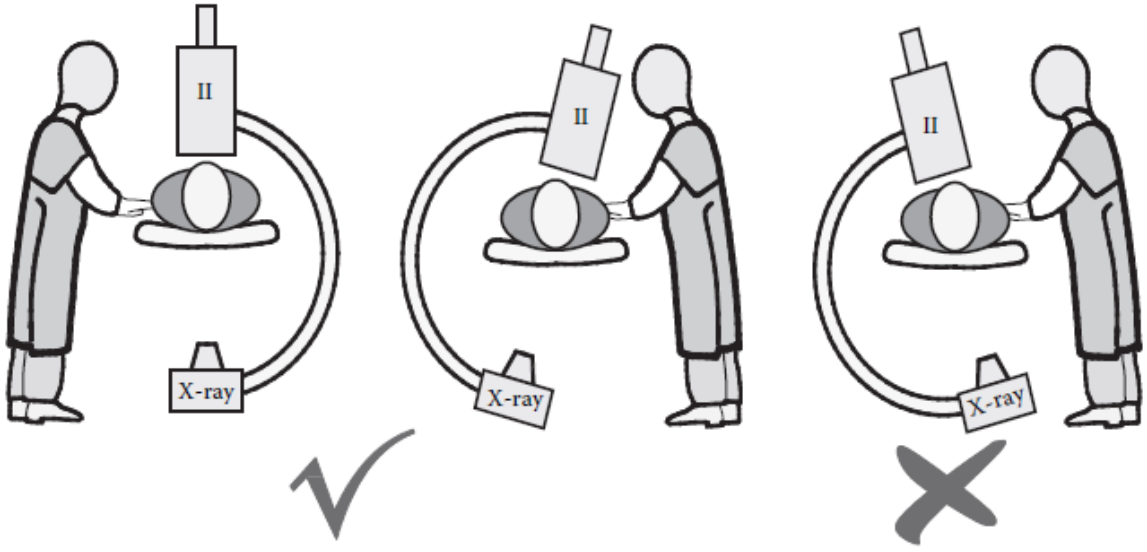

Figure 3: Preferred geometries from the occupational perspective when using C-arm imaging equipment are shown schematically at left and middle. The orientation on the right suffers from the operator being subjected to more leakage and scatter radiation.

Specific Issues for CT Fluoroscopy (Finger Doses):

The issue of radiation protection during CT fluoroscopy needs to be considered carefully since CT fluoroscopy has the potential to result in high doses to the hands of the radiologist performing these procedures. In fact, the dose limits for the extremities may easily be exceeded for a realistic case load.

The recent implementation by some manufacturers of technology that allows the x-ray tube to be switched off as it rotates above the patient represents a commendable step forward in terms of reducing dose to the operator. Since the wearing of leaded gloves may result in a loss of dexterity, this option may be untenable in some CT fluoroscopy procedures. Accordingly, radiologists should consider using specially designed forceps or needle holders to aid in dose minimization to their fingers.

One practical measure that may be implemented is the use of lead drapes placed approximately 2 cm caudal to the scan plane, as significant dose reductions to both the hands and abdomen of radiologists have been demonstrated. It is highly recommended that this dose reduction technique be implemented during CT fluoroscopy. This in no way absolves the radiologist from the need to wear protective clothing.

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