Dealing with staff radiation safety

F. Roberts, London (UK)

It has long been recognised that the radiation doses received by staff working in PET or PET/CT departments are higher than those in Nuclear Medicine (1, 2). With many PET facilities being installed within existing Nuclear Medicine departments, it has been necessary for staff to modify their working practises in order to minimise radiation exposure.

The physical characteristics of positron emitting isotopes such as $^{18}$F, $^{11}$C, $^{13}$N and $^{15}$O result in a high radiation risk for staff. The annihilation reaction that occurs when a positron and electron collide produces two 511KeV gamma rays emitted at 180 (degrees). These high energy photons have a much greater penetrating ability than those used in most Nuclear Medicine procedures. The half value layer for $^{18}$F is 4.1mm in lead, which is substantially greater than the 0.17mm for the 140KeV emissions from $^{99m}$Tc (3). With a specific gamma ray constant (dose rate in air for 1MBq of isotope at 1m) being 6 times greater for $^{18}$F than that of $^{99m}$Tc (2), staff in a PET facility are more likely to receive a higher radiation dose than those working in Nuclear Medicine only.

There have been many studies investigating the doses received by PET staff, with values received per patient examination varying considerably depending on different practises, department layouts and injected activities. Chiesa et.al (1) reported an average whole body dose per PET examination of 11.5uSv, while Benetar et.al (4) measured a much lower dose of 5.5 uSv per examination.

Specific techniques have been adopted to reduce PET staff doses. The principles of time, distance and shielding can be utilised to ensure that ALARA/ALARP are maintained.

As with any procedure involving radioactive isotopes, time with the patient should be minimised after injection. Techniques such as ensuring the patient has stable intravenous access (eg cannula) prior to transporting the dose to the injection area will enable exposure during this high dose rate task to be minimised. A thorough explanation of the procedure and allowing time for patient questions will also help reduce the time spent with the patient after they are injected.

Careful planning of PET departments is required to ensure adequate shielding in the walls, doors and lead glass windows. Larger scanner and injection rooms will reduce the amount of shielding required in the walls and allow staff to optimise their distance from the patient whilst interacting with them. Dose dispensing areas should utilise 511KeV specific shielding such as syringe shields, lead safes and bench shields. A secondary shield for dose transportation such as a lead carry box or rolling lead carrier should be a standard part of a PET facility.

With the increasing use of mobile PET scanners throughout Europe, further radiation considerations are required. Increasing distance is not always possible to help reduce staff dose and more shielding is required lower staff exposure in these confined spaces. Where the toilet or injection facilities are located off the mobile vehicle, careful assessment is required to ensure the distances travelled are minimised.

Radiotherapy planning also introduces new radiation safety considerations. Due to the precise nature of positioning patients for these scans, the radiotherapy staff may be exposed to a higher radiation dose than anticipated. Many centres perform a “cold set-up” on the PET/CT scanner prior to the injection of $^{18}$FDG which can help minimise the time staff need to spend with the patient while they are radioactive.

Staff radiation doses in PET facilities can be minimised by applying the techniques of time, distance and shielding. Analysis of work practises and implementation of standard operating procedures will ensure radiation safety best practice is maintained.
References


