The British Journal of Radiology, *70* (1997), 325–326

Commentary

Radiation protection in interventional radiology

K FAULKNER

Regional Medical Physics Department, Newcastle General Hospital, Westgate Road, Newcastle upon Tyne NE4 6BE, UK

Introduction

In recent years there has been an increase in the number, type and complexity of interventional radiology procedures. The impetus behind this rapid and continuing expansion has been the desire for improved, more cost-effective medicine, in which the patient can look forward to an improved prognosis. Often patients having interventional radiology procedures are treated as either out-patients or day cases, whereas the alternative surgical technique would require hospitalization. This expansion in interventional radiology has occurred in many countries worldwide, irrespective of the type of system for health care delivery, because of the many benefits.

In the main, interventional procedures are characterized by having extended fluoroscopy times, and sometimes requiring many radiographic images to be taken. As a consequence, developments in interventional radiology have a number of profound radiation protection implications for both patients and staff. In particular, the application of the concept of justification to these procedures is different than to other radiological examinations, as both deterministic and non-deterministic effects on the patient have to be considered.

Patient dose

For the patient, long fluoroscopy times lead to higher radiation doses, sometimes limited to a small area of the patient's skin surface. This in turn leads to the potential for deterministic effects, such as skin erythema, to be seen in patients who have had interventional radiology procedures. Physicians treating patients who have had an interventional radiology procedure need to be aware of this possibility.

The potential induction of deterministic effects in the skin is compounded by the lack of appropriate patient dosimetry information available to the interventionalist during the procedure. At present, fluoroscopy units used for interventional radiology are only required to be fitted with an indication of total elapsed fluoroscopy time. Furthermore, this information is usually displayed at the operator's console where it cannot be seen by the interventionalist undertaking the examination. Unfortunately, total elapsed fluoroscopy time does not correlate very well with maximum skin entrance dose. The latter quantity being dependent on the automatic dose-rate control setting selected, patient's size, focus–skin distance and the period of time that the area of skin was irradiated. Equipment developments are required to enable the interventionalist to be provided with an on-line display which provides a better indication of the potential onset of deterministic effects.

Extended fluoroscopy times, sometimes coupled with higher than average fluoroscopy currents can lead to an increased risk of non-deterministic effects such as leukaemia in which the probability of the effect is proportional to the dose. The risk of inducing a hypothetical cancer at some time in the future from interventional radiology correlates reasonably well with dose–area product. Dose–area product is a quantity which may be measured using a large area ionization chamber placed at the output port of the X-ray tube or inferred from a knowledge of X-ray technique factors and the field size. Measurement of dose–area product is also recommended in the National Patient Dosimetry Protocol [1].

The maximum skin entrance dose can be deduced from the dose–area product if the field size and focus–skin distance are known. Instrumentation that is able to accomplish this is in an early developmental stage. The display of total dose–area product and the estimated maximum skin entrance dose on the interventionalist's television monitor would provide information about the two types of radiation effect.

It is also important to minimize patient doses whenever possible. One method of trying to achieve patient dose reductions would be to provide the interventionalist with online dose rate information. The interventionalist could then select techniques which resulted in a lower patient dose, if desired.

Staff dose

Occupational exposures from interventional procedures tend to be higher than other

Received 21 November 1996 and in revised form 16 December 1996, accepted 8 January 1997.

fluoroscopy examinations. The factors leading to higher patient doses also lead to higher staff doses. Moreover, interventional patients usually require more staff to be present in the X-ray room than for other examinations. Some of these individuals may not usually enter a radiology department. Consequently, the minimization of staff doses is particularly important during interventional radiology procedures. All groups of staff associated with interventional radiology should be aware of practical radiation protection procedures. Measures which reduce patient doses will, in general, also reduce occupational exposures.

Staff associated with interventional radiology procedures should wear appropriate protective clothing. A wrap around protective apron equivalent to 0.35 mm lead provides a reasonable degree of shielding to the trunk. This may be supplemented by wearing a protective thyroid shield around the neck as this reduces the dose to the thyroid and oesophagus, as well as reducing effective dose.

If the interventionalist has a high patient workload and uses an overcouch X-ray tube or L-U arm fluoroscopy unit then there is a potential for eye doses to approach the appropriate dose limit. In these circumstances measures to reduce the interventionalist's eye dose should be instigated. This may involve wearing protective glasses or the use of a ceiling suspended protective viewing window possibly with lead curtains attached.

The International Commission on Radiological Protection (ICRP) [2] has recommended a change in dose limits for occupationally exposed workers. These changes in dose limits will be reflected in the United Kingdom's radiation protection legislation in due course. The general lowering of dose limits coupled with the increase in frequency of interventional radiology will mean that more interventionalists will approach dose levels at which they will need to become classified workers. Some may even approach an annual dose limit, though this is perhaps unlikely judging by present personal monitoring results. Female interventionalists may require special monitoring arrangements when pregnant as the dose limit to the surface of the abdomen, once pregnancy has been declared, is 2 mSv for the remainder of the pregnancy. This limit could be exceeded at relatively low interventional workloads. The development of dose constraints for occupational exposures in interventional radiology may assist in the process of reducing the radiation dose received by individuals.

Conclusion

In summary, interventional radiology is here to stay and it is likely to increase in prevalence in the future. It is important that the radiation protection implications to both patients and staff are not lost in the drive for improved, more cost effective medicine. A number of equipment developments may be required to support these developments.

This commentary is based on some of the discussions and recommendations arising from a meeting on radiation protection in interventional radiology organized jointly by the World Health Organisation and the Institut fur Strahlenhygiene, Munich. It is anticipated that a report on radiation safety in interventional radiology will be published by the World Health Organisation in the near future.

Reference

1. IPEMB, NRPB, COR. National Protocol for Patient Dose Measurements in Diagnostic Radiology. Didcot: NRPB, 1992.
2. International Commission on Radiological Protection. 1990 recommendations of the International Commission on Radiological Protection. Oxford: Pergammon Press, 1991.