MEDICAL X-RAY EXPOSURES IN THE UK

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ABSTRACT

Recent studies in the UK show that substantial savings could be made in the collective radiation dose to the population from medical x-rays without detriment to patient care. One significant area of potential dose reduction is to reduce the very wide ranges in the doses delivered to different patients for nominally the same diagnostic procedure. National protocols for measuring patient doses and comparing them with guideline reference doses for common x-ray examinations are described. They will help to identify those operating at the top end of these ranges and encourage them to reduce their doses towards the norm.

POTENTIAL FOR PATIENT DOSE REDUCTION

According to figures published by UNSCEAR (1), the UK carries out only about one half of the number of medical x-ray examinations per head of population than the average figure for all other developed countries for which recent data are available. In spite of this, a document published last year by the Royal College of Radiologists and the National Radiological Protection Board (2) on the extent of unjustified and non-optimised x-ray examinations in the UK, indicates that a reduction of nearly one half in the collective dose to the population from medical x-rays might be possible without detriment to patient care.

Clinically unjustified x-ray examinations have been addressed by the Royal College of Radiologists in a booklet providing guidelines for doctors on referral criteria (3). It identifies the uninformed or uncritical use of x-ray examinations in screening tests or as part of routine practice as the greatest source of unnecessary referrals. Indeed, representatives of the College felt that it would not be unreasonable to suggest that at least 20% of x-ray examinations carried out in the UK are clinically unhelpful in the sense that the probability of obtaining information useful for patient management is extremely low (2).

Once medical exposures have been correctly justified, the optimisation of patient protection, i.e. ensuring that radiation exposures are kept as low as reasonably achievable (ALARA) consistent with obtaining the desired diagnostic result, provides another fruitful area for beneficial dose reduction. Exposures can be kept ALARA by critical examination of both examination procedures and imaging equipment. To assess the potential for such dose reduction both locally and nationally requires measurement of the doses typically delivered by each x-ray facility and their national variation. Suitable measurements and control procedures are being encouraged in the UK by the development and publication of a nationally agreed protocol.

NATIONAL PROTOCOL FOR MONITORING PATIENT DOSE

A National Protocol for Patient Dose Measurements in Diagnostic Radiology (4) has been developed by representatives of NRPB, the Institute of Physical Sciences in Medicine

(IPSM) and the College of Radiographers and will soon be published. The most important features are described below.

1 Quantities to be measured

The recommended dose quantities have been selected to meet the following objectives:-

(a) To be capable of unambiguous definition so that everyone can clearly understand exactly what is to be measured.
(b) To be capable of simple direct measurement with readily available dosemeters of sufficient precision and accuracy. Valid comparisons can then be made with previous measurements at the same facility, with measurements in other facilities and with national norms.
(c) To provide a measurement of the typical dose received by adult patients examined in a particular facility from either:-

(i) a particular type of radiograph
or (ii) a particular type of complete examination.

To meet these objectives the following two dose quantities are recommended:-

(i) **Entrance Surface Dose** (including backscattered radiation) for individual radiographs.
(ii) **Dose-Area Product** for complete examinations.

Other dose quantities exist which may be more closely related to the radiation risk to the patient, eg. organ doses, effective dose or the total energy imparted to the patient. They cannot however be measured directly and have to be inferred. Methods for deriving such quantities from the directly measurable quantities recommended in this protocol have been developed by NRPB and are being extended. These will increase the utility of the two recommended directly-measurable quantities which still, however, remain more practicable for periodic checks and comparisons of patient dose.

2 Choice of dosemeters

Thermoluminescent dosemeters are preferred to ionisation chambers for entrance surface dose measurements because they are small, unobtrusive and, if stuck directly to the skin, fully measure backscattered radiation. Ionisation chamber measurements in free air (without a patient or phantom) are not ruled out in suitable circumstances, but such measurements must be corrected using appropriate backscatter factors.

Specially designed large-area, transparent ionisation chambers are available for attaching to the diaphragm housing of x-ray sets to measure dose-area product, and are the recommended dosemeter for this purpose. They do not interfere with the examination and will integrate the dose both over the area of the x-ray beam and over complete examinations involving radiography and fluoroscopy.

It is expected that both types of measurements will usually be carried out by radiographers with the active assistance of medical physicists particularly in providing suitably

calibrated dosemeters. The protocol describes how both TLD systems and Dose-Area Product Meters should be calibrated and specifies desirable levels of accuracy.

3 Sample selection

Advice is given on how to select an appropriate measurement sample so that valid comparisons can be made between facilities and with national norms. The objective of the measurements is to obtain an indication of the typical dose that is being delivered to an average adult patient by the procedures and equipment used in a particular facility for the types of radiograph or examination under study. To meet this objective measurements should preferably be made on a representative sample of at least 10 adult patients rather than on phantoms or in free air.

It is recommended that dose measurements should concentrate on those types of radiograph and examination that make a significant contribution to the collective dose from medical x-ray examinations. These are indicated in Table 1 where reference dose values are also given. Measurements on other types of radiograph or examination which would provide useful information on the performance of a particular x-ray facility are not to be excluded, but for the majority of standard radiographic or fluoroscopic facilities, patient dose monitoring should be initially concentrated in the above areas. Computed Tomography and mammography are deliberately not covered by the protocol.

4 National collation of dose data and Reference Dose Levels

Important features of the Protocol are that it provides guideline reference doses based on earlier national surveys and it recommends a system for the continual national collation of patient doses. Users of the Protocol are encouraged to send their results to NRPB so that trends in patient dose can be analysed and reference doses based on national norms can be revised if necessary. At present, reference doses are based on the 3rd quartile values of the mean doses delivered by x-ray departments in a national patient dose survey conducted by NRPB in the mid 1980s.

Table 1. Reference dose values

Entrance Surface Dose per radiograph		(mGy)	Dose-Area Product per examination	(Gy.cm2)
Lumbar spine	**AP**	**10**	**Lumbar spine**	**15**
	Lat	**30**	**Barium enema**	**60**
	LSJ	**40**	**Barium meal**	**20**
Abdomen	**AP**	**10**	**Intravenous**	
Pelvis	**AP**	**10**	**urography**	**40**
Chest	**PA**	**0.3**	**Abdomen**	**8**
	Lat	**1.5**	**Pelvis**	**5**
Skull	**AP**	**5.0**		
	PA	**5.0**		
	Lat	**3.0**		

Since 75% of radiology departments can operate satisfactorily with mean doses below the third quartile values, it is recommended that those departments that are found to exceed this level should conduct thorough and immediate investigations into the reasons for their excessively high doses. The investigations either should lead to revisions in techniques or equipment to bring the doses into line with the majority or, exceptionally, should lead to a thorough justification of the need for high doses in that particular clinical circumstance. We believe that the reference levels correspond to the ICRP 60 (5) concept of a "dose constraint" for medical exposures.

The achievement of mean doses below the reference (3rd quartile) level should not be construed as an indication of satisfactory or optimum performance per se. It may well be possible to reduce doses further without loss to the diagnostic value of the examination and such reductions should always be pursued in line with the ALARA principle. However, particular attention should be paid to checking image quality if mean doses fall significantly below the 1st quartile values. Simple methods for checking image quality are outlined in the protocol.

CONCLUSIONS

Adherence to the procedures recommended in this protocol will ensure that radiologists and radiographers are kept aware of how the doses that they currently deliver to their patients compare with national norms so that they can bring them into line with modern accepted practice. The national collation of patient dose data will enable the impact of patient protection measures and trends in medical exposures in the UK to be assessed and the guideline reference doses to be revised if necessary.

REFERENCES

1 UNSCEAR, 1988. Sources, Effects and Risks of Ionising Radiation. 1988 Report to the General Assembly, with annexes. (United Nations, New York)

2 NRPB/RCR, 1990. Patient Dose Reduction in Diagnostic Radiology, Docs of the NRPB, Vol 1, No 3. (HMSO, London)

3 RCR, 1990. Making the Best Use of a Department of Radiology: Guidelines for Doctors. (RCR, London)

4 NRPB/IPSM/CoR, 1992. National Protocol for Patient Dose Measurements in Diagnostic Radiology. (NRPB, Chilton)

5 ICRP, 1991. 1990 Recommendations of the International Commission on Radiological Protection. (Pergamon Press, Oxford)