OCCUPATIONAL X-RAY EXPOSURE OF ANAESTHETISTS

C. McGOWAN, B. HEATON AND R. N. STEPHENSON

Summary

Lithium fluoride thermoluminescent dosimeter chips were used to measure the radiation dose received by anaesthetists caused by the use of image intensification during a typical 4-week period in an orthopaedic theatre. These were used to estimate an annual dose, for comparison with dose limits, to ascertain if anaesthetists should be included in personnel monitoring services. Doses proved to be below detectable limits; hence anaesthetists are at minimal risk from occupational exposure to radiation. The orthopaedic theatre is believed to use more x-rays than other theatres, so exposure elsewhere should also be undetectable.

Key words

Anaesthetist, risks. Operating rooms, contamination.

Although anaesthetists can frequently be exposed to ionizing radiation, in the form of scatter from diagnostic x-rays used during some theatre procedures, little work has been done to determine the level of exposure and whether or not they might be at risk. It is generally assumed that the doses are very low, and consequently anaesthetists are often not included in radiation protection personnel monitoring services. In this study we tested this assumption of negligible exposure.

Previous studies [1–3] relating to dose measurements in anaesthetists have tended to address the issue as incidental to measurements on the patient and other theatre staff, often examining exposures incurred during specific procedures only, rather than obtaining an assessment of total annual exposures caused by all work. Such an assessment could then be used as a basis for the decision as to whether or not anaesthetists should be included in personnel monitoring services.

Methods and results

Careful consideration was given to the best way in which to obtain a reasonable estimate of the annual dose. To this end, advice was sought from anaesthetists, radiographers and theatre staff as to the operating theatres in which most x-rays were used. The conclusion reached was that orthopaedic theatres used the most x-rays, and it was decided to measure the doses received in the orthopaedic trauma theatre. If these doses proved to be low, it was felt that it could be concluded that doses in other theatres would also be low, and hence no anaesthetist would be at risk.

A period of 4 weeks was devoted to the initial measurements in the trauma theatre. The total number of operations performed during this time and the number using x-rays were noted, and compared with the same values (obtained from theatre records) for the 4 months before the start of the study. It was possible to show that the period of study was typical in terms of the use of x-rays, and thus the doses measured could be extrapolated to provide a reasonable estimate of the annual dose received by anaesthetists in theatre.

All dose measurements were made using lithium fluoride thermoluminescent dosimeter (TLD) chips (TLD 100, Harshaw Chemical Company). These were selected for their low dose threshold, reasonable tissue equivalence, and small size, so that the wearers would not be unduly inconvenienced. These chips had a minimum detectable dose of 0.1 mSv.

It was suspected that the dose received by the anaesthetist during a single operation or even during a single working session would be too low to measure, and hence it was decided to conduct the measurement continuously over 4 individual weeks and also for the 4 weeks together, in the event that the weekly dose was below the detection limit. This was achieved by transferring the dosimeters between anaesthetists, to obtain cumulative weekly and monthly dose measurements. Doses were monitored only during the day, from Monday to Friday; the weekend and evening operations were excluded. In reality, an individual anaesthetist would only work a maximum of about two sessions per week in the trauma theatre at Aberdeen Royal Infirmary (excluding emergency hours) and therefore an estimate of the annual dose from the above would be a “worst case scenario” value for the hypothetical situation of a single anaesthetist working in theatre all of the time.

Six positions were selected at which the doses would be measured. These were the forehead, to obtain an estimate of the eye dose as the lens of the eye is vulnerable to ionizing radiation; thyroid;
torso, to provide a measure of the whole body dose, both under and outside the protective lead rubber aprons worn when x-rays are used in theatre; and on the left and right sides of the body, where the lead apron does not always fasten securely. Thus at any one time the anaesthetist wore 12 TLD; six to measure the weekly dose and six to measure the monthly dose.

All TLD used for the experiment were initially read out at the same time and all started accumulating a background dose from that time. After completion of the individual exposure periods, the TLD were read after an interval of 24 h rather than waiting until the end of the experiment and reading all at the same time. (In the latter case background TLD are normally kept for the full duration of the experiment and on reading out a constant background dose rate is assumed.) This readout method was adopted, partly because time constraints implied that any procedural changes had to be implemented rapidly but also to reduce variations in signal fading which may have occurred if low doses were received. In order to measure the background, a group of 21 TLD was selected, kept initially for 7 days, and every 3 days, three were read out and the average value calculated. Thus it was possible to determine approximately by the way in which the background signal built up with time, and hence calculate the expected number of background counts on a TLD that had been used for a measurement. The calculated value is only an estimate as the total background level consists of counts produced by background radiation, and a signal inherent in the TLD which varies slightly between chips, so real background count values fluctuate around the estimated level.

Figure 1 shows the counts detected by each of the TLD during each week and for the whole month. These values are inclusive of the background counts, and each is shown normalized to the estimated background count value for that particular group of TLD. The background value is represented by the horizontal line.

As can be seen from the histogram, the recorded counts fluctuated approximately equally above and below the background level, as would occur if no doses were recorded, because of the variation in the inherent signals on the chips. Thus the dose received by the anaesthetists, even over the course of a month, was below or approximately equal to the limit of detection of the TLD.

Comment

As it was shown that the 4 weeks of the study had a typical distribution of operations involving x-rays, the doses recorded in those 4 weeks could be used to estimate an annual dose. However, as the measured dose was below the detection limit, it was effectively zero, and therefore this estimate cannot be made accurately. But even though the monthly dose was undetectable, the annual dose may reach detectable levels, and a more extended study would be needed to determine if this is the case. However, such a study would not be necessary as if the monthly dose is undetectable, the annual dose must be extremely small, and negligible compared with the recommended dose limit of the Ionizing Radiations Regulations of 15 mSv year\(^{-1}\) for a non-classified radiation worker [4], and also to future recommendations of the International Commission on Radiological Protection [5]. Moreover, because it is generally agreed that trauma theatres use more x-rays than any other operating theatre, the dose received in other theatres should be even smaller. Over the course of a year an anaesthetist moving between theatres should receive a negligible dose of ionizing radiation and thus is not at risk. Hence it is not necessary to include anaesthetists in personnel monitoring services.

References