SOME RADIATION PROTECTION PROBLEMS IN A CANCER HOSPITAL AND ASSOCIATED RESEARCH INSTITUTE

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The Royal Marsden Hospital and the Institute of Cancer Research both derive from the original Cancer Hospital (Free) founded in 1851 by Dr. William Marsden at a site in Chelsea. From the beginning the hospital had a dual role - care of the patient and research. This has now become a large multidisciplinary organisation, comprising a postgraduate teaching hospital within the National Health Service, and an independent Research Institute which is part of the University of London. Different branches of the organisation are located in three sites many miles apart. Both Hospital and Institute make extensive use of ionizing radiation in therapy and diagnosis, and in clinical and laboratory investigations in radionuclide work. Four linear accelerators, and several telecobalt, telecaesium and orthovoltage sets are used in beam therapy and there is a wide range of X-ray diagnostic equipment, including a computed tomography whole body scanner. Brachytherapy involves an annual turnover of about 3.7 TBq (100 Ci) (Cs-137, Ir-192, Au-198) administered as small sealed sources to some 450 patients, while the annual administration of unsealed sources, in diagnosis (Tc-99m, etc) and therapy (I-131, etc) is about 3.0 TBq (80 Ci) involving some 10,000 patients. In the Institute, a range of radionuclides, notably H3, C14 and I-125, are used at tracer and higher level, and there are irradiation facilities with high activity ($\sim$50 TBq, $\sim$1.4 kCi) Co-60 sources.

In this paper we first identify some of the problems we face in ensuring that our protection organisation responds appropriately to the latest recommendations and legal requirements in radiological protection, against a background of steady increase in the scope of our radiation work. In recent years there have been sharp increases in the volume of work with unsealed sources, and we draw special attention to our experience in these areas.

RESPONSE TO RADIOLOGICAL PROTECTION RECOMMENDATIONS

For over 20 years we have imposed upon female staff of reproductive capacity, an annual whole-body dose-equivalent limit of 15mSv, to be accumulated so far as possible, at a uniform rate. This limit was imposed in the context of a wide range of brachytherapy procedures, including associated nursing of patients, the primary aim being to ensure a good standard in limitation of foetal dose if any of the exposed staff become pregnant. In our experience, with constant attention to protection procedures, including the control of dose accumulation by personnel monitoring

such limitations appeared to be readily achievable in all our radiation practice. From about 1970 we had moved towards imposing a 15 mSv limit for all staff and only a very small group have been allowed even to approach that limit. Our response to ICRP26 has been to confirm our position but to focus even more attention on the ALARA (as low as reasonably attainable) principle. For our establishment we now regard the breaking of a 15mSv limit as evidence of inadequate control rather than of need for worker classification. Nevertheless, it is administratively valuable to us, particularly against the possibility of an incident, to recognise that occasional dose accumulation up to the ICRP recommended limit (50mSv/annum) might still be regarded as acceptable.

To reduce the attention required to dose control in brachytherapy procedures, we have supported within our hospital the introduction of significant changes in radiotherapy technique over the years, such as total replacement of Ra-226 by Cs-137 and Ir-192, the development of convenient small-source dispensing equipment, the use of after-loading techniques, and the provision of a special brachytherapy nursing unit equipped with inter-bed and mobile shielding structures plus television and intercommunication systems for observation-nursing. We have also developed our teaching programmes in radiological protection, including special instruction for nursing staff within our Nursing School (1).

Despite these efforts, the pressure on our protection organisation continues to increase markedly, but only in part through our rising work-load in radiation procedures. Our attention to control of dose to patient has been much increased, especially in relation to our important commitment to mammography (2), the '10-day rule', quality control procedures in diagnostic radiology and new safety requirements in radiotherapy installations. Additionally, we are beginning to encounter new administrative requirements stemming from European and National Regulations on Health and Safety, and the demands for attention from Trades Union representatives through powers granted by such regulations.

WORK WITH UNSEALED SOURCES

Control of external radiation exposure is exercised by our own film monitoring service which has maintained records of staff-dose within our establishment for more than thirty years. We regard the constant use of the information derived from this service as a crucial element of our protection arrangements, not only as a means of meeting our self-imposed limit on staff-dose accumulation, but also as a way of identifying at an early stage any significant changes in the collective dose-equivalents for different groups of staff. Additionally, inspection of films provides a useful check on any looseness in contamination control. Within our many departments surveillance of procedures is exercised by departmental radiological safety officers, and primary control of contamination is by routine contamination monitoring. A low background whole-body counter and a thyroid I-125 assembly are also used for countercheck measurements.

NUCLEAR MEDICINE

From somewhat primitive beginnings some 30 years ago (using open bench procedures and a spirit lamp to sterilise the air!) we have progressed to air-conditioned radiopharmaceutical clean rooms housing laminar flow cabinets, at both branches of our hospital (3). During early periods of low work-load our chief concern was contamination control. However, in the late 1960's our work-load increased sharply; in 1969 a total activity of 630 GBq (17 Ci) in a wide range of radiopharmaceuticals was administered to some 3000 patients. The accumulation of external dose by a small group of staff was then evident but still relatively small. The work-load has, however, continued to increase with the 1979 total of activity administered exceeding 3 TBq (80 Ci) chiefly Tc-99m in various forms, to some 10,000 patients for a wide range of diagnostic examinations. External dose accumulations by staff also continued to increase and by the mid-1970's the annual collective dose-equivalent for our nuclear medicine group ($\sim$20 staff - medical, radiography and nursing) had risen to some 40mSv.

In considering the problems of external dose, we note particularly the gain resulting from the use of more sensitive equipment (in reducing patient measurement time) and from attention to techniques of administration.

We have made detailed investigations into the control of dose to the hands (4), (5), (6).

RESEARCH

We have given much attention to procedures involving I-125, and have noted the problems reported elsewhere (7). In one pathology laboratory here some 20 members of staff are involved in labelling techniques, using up to 74 MBq (2 mCi) in each procedure and over 11 GBq (300 mCi) per year. A Class B laboratory with high grade fume cupboard is used for this work. Staff are instructed to self-monitor, including the thyroid, by contamination meter, and counter-check measurements are made periodically by Physics Staff using a thin crystal NaI detector. Under these conditions during two years we have only detected I-125 in about one third of these workers, at levels generally of 370 - 740 Bq (10 - 20 nCi).

One traumatic experience with tritium deserves mention. In spite of our centralised control on radionuclide acquisition, a member of our staff acquired, by an unusual method of requisition, an aqueous solution of an organic compound supposedly labelled at high specific activity with 92.5 GBq (2.5 Ci) T and supposedly free of labile tritium. In spite of our Instruction Manual, our local rules, our B-laboratory facility and our safety officer, an open bench evaporation of the solution was conducted. Later analysis showed that virtually none of the tritium had ever been associated with the compound. As a result of the evaporation procedure, the laboratory and its equipment were substantially contaminated and body burdens reached the ICRP investigation level in several staff. The decontamination procedures were lengthy and the interruption of important work programmes was severe.

SUMMARY

By giving steady attention to the design of facilities and the arrangement of procedures, and with an active personnel monitoring policy, relatively large scale radiation commitments within medical and research organisations can proceed with individual whole-body doses to staff being held well below 15mSv/annum. Such control generally relies heavily on the experience of a small group of staff within the organisation, who now face increased problematical administrative commitments from recent legislation.

In spite of detailed attention to control of radiation work, traumatic radiation incidents may still occur.

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