A PROGRAM TO MONITOR WORKER FACTORS AND EXTERNAL EXTREMITY AND WHOLE BODY OCCUPATIONAL RADIATION EXPOSURES IN A ACADEMIC SETTING

Ralph A. Fobair
Health Protection Office, University of Iowa, Iowa City, IA 52242

INTRODUCTION

Since 1982 a formal ALARA program has been in place at the University of Iowa. ALARA is the recognized acronym for "As Low As Reasonably Achievable." The University of Iowa is required, by its Radioactive Materials License, to conduct all activities involving licensed radioactive materials and radiation producing devices in a manner designed to maintain personnel exposure to radiation at ALARA levels. (1) The initial goal of this program was to reduce all whole body quarterly personnel exposures to less than 3.75mSv (375mrem). The primary means of evaluating the effectiveness of the ALARA program, up through early 1986 was the careful review of printed radiation dosimetry reports. To accomplish this more than 2500 personnel dosimetry records printed on approximately 100 pages were reviewed individually on a monthly basis. This did not allow for easy comparison of personnel radiation exposures from one individual to another.

During the latter part of 1985 it was determined that a computerized system would be helpful in the management of the ALARA program, and aid in the distribution of personnel radiation monitoring devices. In order to be useful, a computer based data management system needs to meet several criteria:

(i) Allow for identification of workers by job classification, and work location.
(ii) Identification of all types and levels of radiation exposure.
(iii) The ability to quickly contact a worker should the need arise.
(iv) The use of a small personal computer that could keep track of one year of dosimetry data, (30,000 records and occuping 3.75 Mbytes of hard disk storage.)
(v) Locating a datatbase management system that could handle 30,000 records and run on an IBM-PC.

The commercial badge vendor (2) was contacted, and it was determined that such accounts would have to be set up in series codes. Each series code would specify a unique department within the teaching hospital, or a unique research group in the medical school or bio-science area. The supplier indicated that dosimetery data would become available on 5.25 inch diskettes for use with the IBM PC-DOS type personal computers. Metafile (3) an integrated information management system was selected for use with the IBM PC-DOS series computers.

---

(1) Iowa State Department of Health Radioactive Radioactive Materials License, (1986)

(2) R.S. Landauer, Jr. & Co., 2 Science Road, Glenwood, IL 60425 , USA

Metafile is a free-form, relational database management system combined with text editing and a fourth generation programming language that allows for development of user-specified applications. The system requires 256k bytes of internal RAM when running under PC-DOS or MS-DOS version 2.1 or later; 2 disk drives, one of which may be a hard disk or a RAM disk device; a monochrome or color monitor, and a serial (asynchronous) RS-232C communications port. Initial development required 2 months for the program in distributing and accounting of personnel radiation-monitoring devices (PMDs). During this time each person wearing a PMD was assinged a series code. A series code is a three letter code for identifying the department and investigator. For example series code RRL, represents Radiation Research Laboratory. The first goal of the new system would be relating MBq of P-32 used per month vs. millirems per month exposure to the hands.

MATERIALS AND METHODS

In order to be included in the study a investigator must meet three criteria:

(i) The wearing of a finger ring TLD (4) with the detector facing in towards the palm of the hand. Also each participant needed to wear a whole body dosimeter (5).

(ii) Using P-32 on a regular basis, a minimum of 9.25 MBq (0.25 mCi) used per calendar month.

(iii) Within the laboratory there could be no other source of radiation, i.e. gamma-emitters or machine produced radiation.

In the initial study 55 P-32 users were identified. Of the 55 only 31 of the users ordered 9.25 MBq (0.25 mCi) or more per month. Only 15 investigators met the criteria for inclusion in the study. The study took place from March 1986, through May of 1987. Each investigator was placed into one of four groups based on the amount of P-32 used per month. During the course of the study the correct use of the PMDs was verified by observation. The volume of data generated by this report is presented in table format.

RESULTS

The minimum measurable exposure was 100uSv (10mrem) whole body, and 300uSv (30mrem) for beta exposure to the ring TLD. The linearity of the system was found to be excellent. The correlation coefficient, r , between MBq P-32 used per month and exposure was 0.94.

---

(3) Version 9.2 Metafile, Metafile Information Systems, Inc., 15 East Second Street, Chatfield, MN 55923, USA

(4) Model U3 dosimeter, R.S. Landauer, Jr. & Co.., 2 Science Road, Glenwood, IL 60425, USA

(5) Model G1 dosimeter, R.S. Landauer, Jr. & Co.., 2 Science Road, Glenwood, IL 60425, USA

Table 1. Monthly exposure to personnel using P-32

Participant Id Number	P-32 used per month	Average exposure per month in uSv Whole body Deep	Whole body Shallow	Right Hand Shallow
1.	0 to 37 MBq	6.7 ± 26 *	33.3 ± 62 *	160.0 ± 155 *
2.	0 to 37 MBq	221.4 ± 185	300.0 ± 180	285.7 ± 280
3.	0 to 37 MBq	14.3 ± 36	35.7 ± 50	321.4 ± 272
4.	37 to 148 MBq	33.3 ± 51	33.3 ± 51	460.0 ± 318
5.	37 to 148 MBq	0.0 ± 0	66.7 ± 72	500.0 ± 290
6.	37 to 148 MBq	0.0 ± 0	6.7 ± 26	613.3 ± 245
7.	37 to 148 MBq	13.3 ± 35	140.0 ± 99	673.3 ± 284
8.	148 to 370 MBq	21.4 ± 43	85.7 ± 66	792.9 ± 144
9.	148 to 370 MBq	26.7 ± 59	80.0 ± 86	840.0 ± 235
10.	148 to 370 MBq	415.4 ± 99	515.4 ± 31	1061.5 ± 480
11.	148 to 370 MBq	20.0 ± 41	93.3 ± 88	1113.3 ± 479
12.	148 to 370 MBq	14.3 ± 38	42.9 ± 54	1171.4 ± 1382
13.	148 to 370 MBq	0.0 ± 0	20.0 ± 41	1186.7 ± 536
14.	370 to 925 MBq	26.7 ± 46	126.7 ± 134	1520.0 ± 1187
15.	370 to 925 MBq	80.0 ± 41	146.7 ± 64	2026.7 ± 406

* One standard deviation. Minimum exposures were set equal to zero, therefore average whole body exposures less than 100 uSv are minimal, and added as zero. The deep dose should be considered equivalent to the whole body dose. The deep dose is the dose equivalent from all radiation at a depth of 1.0 cm (1000 mg/cm sq.) in soft tissue. The effects of buildup and attenuation of radiation in the body are considered in accord with the International Commission on Radiation Units and Measurements Specifications. The shallow dose should be considered as the dose to the skin of the whole body. The shallow dose is the dose equivalent from all radiations at approximately 0.007 cm (7 mg/cm sq.) in soft tissue. The shallow dose equivalent takes into consideration scattered radiation within body.

SUMMARY

Several factors must be taken into account before drawing any conclusions from this data. The field gradient from a pure beta source is more dependent on distance, than the shape or size. (Th87) The data indicates that special attention should be given to situations where the chance of beta exposure exist, because significant exposure to the hands may occur. The use of a computerized isotope inventory system along with the ability to effectivley identify, as well as corelate dosimetry, has the potential to reduce unwarranted exposure to the hand and other extremities. This program has the potential to be applied to other isotope manipulations.

REFERENCES

Th87 Thind K. S., 1987 "Extremity Dose: Its Definition, Standards and Regulatory Limits, Radiobiological Significance, Measurement and Practical Considerations" Health Phys. 52, 695-705.