SEVEN YEARS OF INDIVIDUAL MONITORING SERVICE IN CUBA

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ABSTRACT

The Center for Radiation Protection and Hygiene (CPHR) has been carrying out from 1987 the individual monitoring of workers occupationally exposed to the ionizing radiations in the Republic of Cuba, excepting those that employ X rays in diagnostic radiology. In this paper the results of the individual monitoring services during the period 1987-1993 are discussed. For all occupational practices the current system of dose limitation established in the country with 50 mSv as limit of annual dose is satisfied. The distribution in all occupational practices other than Nuclear Medicine and Gammatherapy is characterized by having more than 95% of the controlled personnel with an effective dose lower than 5 mSv. In the case of Nuclear Medicine and Gammatherapy, more than 80% of the workers were below that dose value. For the practices evaluated in this paper the possibility of assuming the system of dose limitation recommended by ICRP is evident. The evaluations carried out for the introduction of operational quantities Hp(0.07) and Hp(10) in dose assessment procedure are presented. The expressions obtained during the characterization of the film badge dosimeter, in terms of operational quantities guarantees a deviation of response of the dosimeter with depending upon energies, lower than 20 %.

INTRODUCTION

The Center for Radiation Protection and Hygiene (CPHR) has been carrying out from 1987 the individual monitoring of workers occupationally exposed to the ionizing radiations in the Republic of Cuba, excepting those that employ X rays in diagnostic radiology. The services offered refer to the control of external exposure by employment of film badge dosimeters for whole-body irradiation and TLD rings for the control of the dose in hands. "In vivo" and "in vitro" internal contamination monitoring for different radionuclides (^{131}I, ^{125}I, ^{32}P, ^{3}H, ^{14}C, ^{35}S) is also included.

MATERIALS AND METHODS

The individual monitoring of external exposure was carried out by using film badge dosimeters. The characteristics of the commercial "whole-body" dosimeters utilized, such as the procedures of calibration and methods for dose assessment are presented in [1]. Until 1991 the radiation monitoring film used in the service was the ORWO RD3-4 made in German Democratic Republic. That model was substituted by the AGFA-GEVAERT film "Personal Monitoring". The Service included individuals occupationally exposed to external radiation , who worked in following practices : Nuclear Medicine, Gammatherapy, Roentgentherapy, Research with ray X, Customs Control, Unsealed Sources, High Activity Sources, Geological Prospection, Industrial Radiography with ray X and gamma radiation. The monitoring period was for one month until 1990. Starting from 1991 the monitoring period was extended to three months.

In 1990 the individual monitoring of exposure in hands with TLD (LiF) given by the IAEA was established. That Service was limited to 50 users. For selection of workers to be controlled was kept in mind the dose received for the whole body in practices Nuclear Medicine and Unsealed Sources.

For the internal contamination monitoring, the effective dose calculation was carried out by applying the metabolic models, recommended by the ICRP in their publications [2]. The procedures of calibration and methods for dose assessment are presented in [1].

As a consequence of the recommendations of the ICRP [3], the response of the film badge dosimeter was characterized per unit of personal dose equivalent at both depths of 10 mm and 0.07 mm, (Hp(10) and Hp(0.07) respectively) [4]. Two reference methods for determination of the dose were applied, one in which dosimeters for calibration, irradiated with ^{137}Cs are used, and another in which two sets of dosimeters were employed for

calibration, one irradiated with a ^{137}Cs source and the other one with a ^{241}Am source. As a procedure for dose assessment the linear combination of the dose calculated for the different sectors of the dosimeter are analyzed.

RESULTS AND DISCUSSION

In the Film Dosimetry Service, values of mean annual effective dose per occupational practice (Table 1) evidence that practices with largest mean doses for external irradiation are those of Nuclear Medicine and Gammatherapy. The total mean dose in these years oscillates from 1.2 to 2.6 mSv (Table 2). Only 42 workers had exceeded the 15 mSv (three tenths of permissible limits of annual dose). Practices of Nuclear Medicine (17) and Gammatherapy (16) had the major number of workers involved.

Table 1: Mean annual doses for practices. Period 1987-1993. Film dosimetry service.

Occupational practices	Mean Annual Effective Doses [mSv]						
	1987	1988	1989	1990	1991	1992	1993
Nuclear Medicine	3.21	3.16	4.33	3.89	2.44	3.25	2.71
Gammatherapy	3.19	3.60	3.59	4.06	2.39	1.94	1.65
Roentgentherapy	2.49	1.28	1.42	0.72	2.55	1.34	1.15
Research with rays X	0.74	0.74	0.73	0.76	0.57	0.54	0.43
Customs Control	1.29	0.80	0.72	0.80	0.30	0.19	0.36
Unsealed Sources	2.51	2.44	2.58	2.71	1.07	1.21	0.84
High Activity Sources	2.40	2.41	2.56	2.41	1.00	0.82	0.57
Geological .Prospection	2.40	2.40	2.50	2.41	1.25	1.03	0.33
Industrial Radiography with rays X	0.82	0.73	0.98	0.75	0.26	0.36	0.48
Industrial Radiography with gamma radiation	2.80	2.60	2.80	2.81	1.14	0.75	0.67

Table 2: Results of the individual monitoring with film badge dosimeters

Year	Number of controlled workers	Mean effective dose [mSv]	Workers with doses above 15 mSv	Maximum Dose [mSv]
1987	1263	2.47	2	16.8
1988	1475	2.38	2	16.1
1989	1714	2.48	9	24.2
1990	1542	2.55	11	42.7
1991	1459	1.28	4	44.2
1992	1079	1.53	8	34.8
1993	1002	1.16	6	22.8

The variation of annual mean effective dose for different occupational practices, shows that in no case it exceeds the 5 mSv. The percentage of workers which received doses lower than that value, is in all practices over 95%. Practices of Nuclear Medicine and Gammatherapy where the accumulative frequency is over 80% are exceptions. No worker had exceeded the permissible dose limit of 50 mSv established for one year.

In the Individual Monitoring Service of exposure in hands, the maximum number of workers controlled during a year was 34. No worker had exceeded the annual limit of dose equivalent for a specific organ. The higher annual doses registered were: during 1990- 151 mSv, in the practice of Unsealed Sources in 1991- 86 mSv and in 1992- 96 mSv both in Nuclear Medicine.

In the Internal Contamination Monitoring Service the higher number of detected incorporations was found for radionuclides ^{131}I, ^{125}I and ^{32}P. In the case of Nuclear Medicine for the ^{131}I, values of committed dose equivalent oscillated between 2.50 - 28.76 mSv, the last being the largest committed dose equivalent detected throughout the control periods. The values of the mean committed effective dose for each occupational practice did not reach the level of 5 mSv.

During the last three years the lowest values of annual effective dose was registered for all practices. This situation could reflect the effectiveness of the radiation protection measures implemented in each practice and of the complete supervision system in Cuba.

As a result of the characterization of the film badge dosimeter in terms of operational quantities it was verified that the lowest deviation of the response of the dosimeter with the energy occurs when the 5 sectors of film badge dosimeter observed are combined [4]. Expressions that guarantee a deviation of the dosimeter response with depending upon energies lower than 20 % were gotten. Both methods of reference dose showed a comparable effect in the smoothing of the energetic dependence. It is observed that only for energies near 20 keV differentiated calculations of Hp(0.07) and Hp(10) make sense.

In order to evaluate the practical implications that the reduction of the dose limit to value lower than 50 mSv could have, the following analysis was performed. The frequency of cases above 20 mSv oscillate between 2 - 3 workers per year. This number represents a 0.2% of the total of the personnel controlled and it could be possible to reduce it with a more specific control of the practice where that is manifested [1]. Taking into account these aspects, it could be affirmed that is possible, in a practical situation, to reduce the current dose limit without great investments in order to guarantee compliance with the new dose limitation system, at least in those practices controlled by the CPHR.

CONCLUSIONS

For all occupational practices the current system of dose limitation established in the country with 50 mSv as limit of annual dose is satisfied. The workers receive annual mean effective dose that does not exceed three tenths of this limit. The distribution in all occupational practices except Nuclear Medicine and Gammatherapy is characterized by having more than 95% of the controlled personnel with an effective dose lower than 5 mSv. In the case of Nuclear Medicine and Gammatherapy, more than 80% of the workers were below that dose value.

The low value of mean effective dose evidences that the radiological protection requirements in our country guarantee the avoidance of significant doses for external and internal exposure. For the practices evaluated in this paper, the possibility of assuming the system of dose limitation recommended by ICRP is evident.

The expressions obtained during the characterization of the film badge dosimeter, in terms of operational quantities guarantees a deviation of response of the dosimeter with depending upon energies, lower than 20 %. Only for energies near 20 keV differentiated calculations of Hp(0.07) and Hp(10) make sense.

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