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WHOLE-BODY MEASUREMENTS AT IPEN, BRAZIL

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Abstract – The intake of radioactive material by workers can occur in the radiopharmaceuticals production or during the handling of these in the medical fields (nuclear medicine). The workers who work in areas where exposures are significant are routinely monitored to demonstrate that the workers are receiving adequate protection from internal contamination. Direct measurements of whole-body and thyroid contents provide an estimate of the activity value of these radionuclides in the potentially exposed workers. The whole-body measurements of the workers, trainees and visitors are routinely performed by the In Vivo Monitoring Laboratory (LMIV) of the Energy and Nuclear Research Institute (IPEN/CNEN-SP). The frequency of measurements is defined by the Radioprotection Service (SRP) and the Dose Calculation Group of IPEN. During the period 2006-2007, 2500 measurements had been carried in workers who develop tasks related to the production of radiopharmaceuticals. The activity value of the radionuclides and the workers' tasks relationship had been evaluated.

Key words: Radiopharmaceuticals, whole-body measurements, internal dosimetry

INTRODUCTION

The workers who work in areas where radioactive materials are handled, processed or produced require a monitoring programme to allow the estimate of the exposure dose, an evaluation of the total body or organ deposition and the assessment of dose from this measurements, beyond a comparison of this dose with the legal constraints (1,6,7). The International Commission on Radiological Protection (ICRP) provides general recommendations for the individual monitoring programmes and the interpretation of results of estimates of intakes of radionuclides by workers (3).

The direct measurement of body or organ activity is commonly used for radionuclides that emit radiation with energies greater than 100 keV. The application of bioassay data for dose calculation is valid normally for radionuclides distributed uniformly in the organism (6).

At the *In Vivo* Monitoring Laboratory (LMIV) of the Energy and Nuclear Research Institute (IPEN/CNEN-SP) whole-body measurements are routinely carried out in workers of the IPEN, visitors, trainees and contract workers. The frequency of measurements is established by the Radioprotection Service (SRP) and the Dose Calculation Group of IPEN.

Between 2002 and 2004 an average of 845 measurements were performed per year considering whole-body and thyroid measurements. In 2006 the number of 1320 measurements was reached by the adoption of a new invitation methodology of people to be monitored, involving the installations' managers and SPR. In the year 2007, 1184 measurements were carried out.

MATERIALS AND METHODS

The detection system consists of one NaI (Tl) detector (8 x 4 in) for whole-body measurements, connected to a Ortec 556 high-voltage supply, a Canberra 2022 amplifier and an Ortec 920 Ethernim 16-imput multichannel buffer.

The walls of the shielded room consist of 130 mm-thick steel sheet lined with 5 mm of lead and 5 mm of copper. The internal dimensions are 2.6 m x 1.7 m x 1.85 m, with air filtration and maintained at a temperature of 25ºC.

The counting time was 15 min. Minimum detectable activity (MDA) values for some radionuclides typically measured with the whole-body counter were calculated as follows: 10 Bq for ^{131}I, 40 Bq for ^{123}I and 70 Bq for ^{99m}Tc (5).

A total of 1274 results of whole-body measurements obtained in 2006 and 2007 were evaluated. The most frequent radionuclides were assessed as well the general tasks of workers who had presented activity values greater than the minimum detection limit (MDL) and smoking habits these workers.

RESULTS AND DISCUSSION

The general tasks of workers were: 61% in production, 17% in maintenance, 11% in radioprotection, 9% in research and 2% in operation of systems. As expected, the great majority of the workers who had results above the detection limit was in group involved in radiopharmaceuticals' production (Fig. 1). In the same way, we have in sequence the maintenance and radioprotection groups, i.e. groups compound by the workers that directly support production's tasks. It's important to remember that the number of workers who had results above the detection limit was around 4% of the total of evaluated measurements.

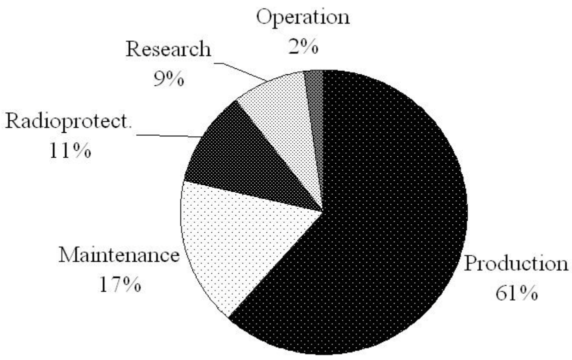

Figure 1. General tasks of workers.

A total of 12 radionuclides were assessed. The five most frequent were ^{131}I, ^{99m}Tc, ^{67}Ga, ^{123}I and ^{18}F. These radionuclides were observed respectively in 60%, 13% 9%, 9% and 4% of the workers who had results above of the detection limit (Fig. 2).

The values of activity detected are considerably low. The detected maximum activity for each radionuclide and the estimated dose resultant of this incorporated activity considering the dose coefficients adopted by the ICRP (4) are showed in Tab. I.

The smoking habits were of no significance to the internal contamination of the workers because around 90% of the workers who had results above of the detection limit were nonsmokers.

Table I. Maximum activity detected by radionuclide.

Radionuclide	Activity (kBq)	Effective Dose (µSv)
^{131}I	119 ± 5	6.2
^{99m}Tc	28 ± 1	0.1
^{67}Ga	174 ± 8	20
^{123}I	42 ± 2	0.5
^{18}F	8.2 ± 0.4	0.2

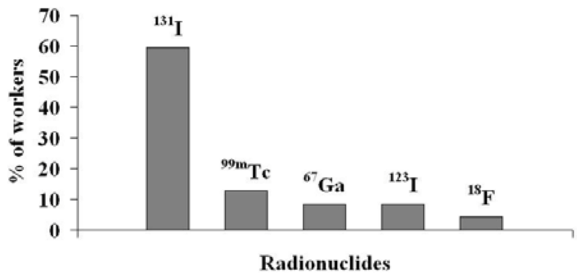

Figure 2. Most frequently requested radionuclides.

REFERENCES

1. Castro, M.C., Interpretação de resultados de monitoring individual interna de trabalhadores da Fábrica de Combustível Nuclear - FCN. Dissertação (Mestrado) – Instituto de Radioproteção e Dosimetria (IRD). Rio de Janeiro, 2005.
2. Dantas, B.M., Bertelli, L. and Lipsztein, J.L., Evaluation of whole-body counting capabilities based on ICRP limits. *Radiat Prot. Dosim*. 2000, **89**(3-4):255-258.
3. International Commission on Radiological Protection, Individual Monitoring for Internal Exposure of Workers. Publication 78. *Annals of the ICRP*, 27, No. 3-4, Pergamon Press, Oxford and New York, 1997.
4. International Commission on Radiological Protection, Radiation Dose to Patients from Radiopharmaceuticals. Publication 80. *Annals of the ICRP*, 28, No. 3, Pergamon Press, Oxford and New York, 1998.
5. Lima, I.B, Vivaldini, T.C., Xavier, M., Berti, E. A. R. and Cardoso, J. C. S., in *Proceedings of the International Nuclear Atlantic Conference*, Santos, 2007, edited by Brazilian Association for Nuclear Energy - ABEN, n. E02-1429.
6. Potter, C.A., Internal dosimetry: a review. *Health Phys.* 2005, **88**(6):565-578).
7. Shoji, M., Kondo, T., Honoki, H., Nakajima, T., Muragushi, A. and Saito, M., A case study of the estimation of occupational internal dose using urinary excretion data obtained in a biomedical research facility. *Health Phys.* 2005, **89**(6):618-627.

8. Araujo F., Rebelo A. M. O., Pereira A. C., Moura M. B., Lucena E. A., Dantas A. L. A., Dantas B. M. and Corbo R., Optimization of ^{131}I doses for the treatment of hyperthyroidism. *Cell. Mol. Biol.* 2009, **55**: 1-6.

9. Santos A. M. and Vieira J. W., ‘Voxelization’ of alderson-rando phantom for use in numerical dose measuring. *Cell. Mol. Biol*. 2009, **55**: 7-12.
10. Vieira J. W. and Lima F. R. A., a software to digital image processing to be used in the voxel phantom development. *Cell. Mol. Biol*. 2009, **55**: 16-22.
11. Holanda C. M. C. X., Silva-Júnior m. F., Alves R. C., Barbosa V. S. A., Silva R. P., Rocha L. G. and Medeiros A. C., The effect of the rochagan™ on radiolabeling with ^{99m}Tc. *Cell. Mol. Biol*. 2009, **55**: 23-28.
12. Oliveira C. M., Dantas A. L. A. and Dantas B. M., A methodology to evaluate occupational internal exposure to fluorine-18. *Cell. Mol. Biol*. 2009, **55**: 29-33.