DOSE TO SOME SELECTED ORGANS FROM INTAKE OF RADIONUCLIDES IN INDIAN POPULATION

S C Jain [*], M M Gupta [*], A Nagaratnam [**] & A R Reddy [***]

[*] Institute of Nuclear Medicine & Allied Sciences, Lucknow Road, Delhi - 110 054, India

[**] Defence Metallurgical Research Laboratory, Kanchanbagh, Hyderabad - 500 258, India

[***] Defence Laboratory, Ratanada Palace, Jodhpur - 342 001, India

ABSTRACT

The dose to some selected organs has been estimated from intake of radionuclides taking into consideration the organ weights in Indian Man and Child of various age groups using dose coefficients as given by ICRP-56. The effective dose computed as per new tissue weighting factors given by ICRP-60 increased by 40-75 % from the old values from the ingestion of ^{131}I and ^{144}Ce. However, only marginal change was found in the case of ^{137}Cs. In Indian Population, there was a further increase upto 20 %.

INTRODUCTION

ICRP-56 (1990) has computed age-dependent dose coefficients (also called dose equivalents) for various organs and tissues to members of the public from intake of most radiologically significant radionuclides that might be released to the environment due to various human activities. These dose coefficients have been estimated for ICRP Reference Man, Child and Infant. However, Indian population differs significantly from their ICRP counterpart as regards anatomical and physiological characteristics as shown by Venkatraman et al (1963) and Jain et al (1991, 1992). In the present study, efforts are made to estimate dose to some selected organs for different ages taking into account dose transformation factors as estimated by the method suggested by Yamaguchi (1978). Further the revised effective dose was computed using revised tissue weighting factors as recommended by ICRP-60 (1991) from intake of some radionuclides and compared the same with the corresponding estimated values for Indian Population.

METHODOLOGY

The weight of five organs, namely, brain, kidney, liver, lungs and spleen was obtained from extended study of 2000 postmortem records in Indian population (Jain et al, 1992) of various age groups. These organ weights being

different from ICRP counterpart and hence the dose coefficients will be different in these subjects than their ICRP counterpart. The dose coefficients in Indian population of various age groups namely 1yr, 5yr, 10yr, 15yr and adult was computed by computing the dose transformation factors (DTF) for different organs using the method suggested by Yamaguchi (1978). These transformation factors are multiplied by the corresponding organ dose coefficients to give the revised dose estimates to the organs. In the present study, only three radionuclides ^{131}I, ^{137}Cs and ^{144}Ce were considered. The transformation factors for various organs were worked out for the principal gamma energy emitted by these radionuclides. The effective dose, E was also computed for ingestion of these radionuclides utilising the new tissue weighting factors as given by ICRP-60. Thymus is taken as surrogate to oesophagus and colon is considered to be the same as ULI (Phipps et al, 1991). However, the dose coefficients for all the remainder organs were not available in ICRP-56 and it is considered that the dose to these organs is the same as the average dose to 8 remainder organs for which information is available. Further the effective dose was also computed for Indians of different age groups utilising the transformation factors as calculated for selected organs above. For the other organs, if the weight of the organ is less than 20 g, DTF is taken as 1 and for the others, DTF has been computed considering the organ masses to be proportional to the body weight.

RESULTS & DISCUSSION

Table 1 gives the mean DTF for various organs in the Indian population for the photon energy 133-662 keV, the variation being negligible for different gamma energies considered.

Table 1. Mean dose transformation factors

Age	Brain	Kidney	Liver	Lung	Spleen	Others <20 g
1 yr	1.01	1.05	0.88	0.82	0.82	1.09
5 yr	1.12	1.12	0.96	0.82	0.83	1.12
10 yr	1.08	1.14	1.00	0.93	0.90	1.17
15 yr	1.09	1.16	1.12	0.89	0.98	1.20
Adult	1.06	1.25	1.21	1.01	1.09	1.16

Table 2 gives the effective dose (E_1) as given by ICRP-56, the revised value of ICRP-56 (E_2) and the revised estimated value of E for Indian population (E_3) from the ingestion of ^{131}I, ^{137}Cs and ^{144}Ce. The revised effective dose, E_2 to ICRP Reference population was found to be increased by 64-75 % for ^{131}I and did not differ in Indian population as more than 99 % contribution to effective

dose comes from dose to thyroid whose weight did not differ in Indians. In case of ^{137}Cs, E_2 was found to differ marginally from old values due to near uniform distributiion of the radionuclide in the body. In Indian population, E_3 values were marginally higher than for ICRP counterpart due to increased organ doses proportional to change in DTF's. However, in case of ^{144}Ce, E_2 were found higher by 39-46 % than old values and increased further in Indian population for the reasons alike ^{137}Cs.

Table 2. Effective dose from ingested radionuclides

Effective dose(Sv/Bq)	Age at intake				
	1 yr	5 yr	10 yr	15 yr	Adult
^{131}I					
E_1	1.1E-7	6.3E-8	3.2E-8	2.1E-8	1.3E-8
E_2	1.8E-7	1.1E-7	5.5E-8	3.5E-8	2.2E-8
E_3	1.8E-7	1.1E-7	5.5E-8	3.5E-8	2.2E-8
^{137}Cs					
E_1	1.1E-8	9.0E-9	9.8E-9	1.4E-8	1.3E-8
E_2	1.1E-8	8.9E-9	9.7E-9	1.3E-8	1.3E-8
E_3	1.1E-8	9.2E-9	1.0E-8	1.5E-8	1.5E-8
^{144}Ce					
E_1	4.3E-8	2.1E-8	1.3E-8	7.2E-9	5.8E-9
E_2	6.2E-8	3.0E-8	1.9E-8	1.0E-8	8.4E-9
E_3	6.8E-8	3.4E-8	2.2E-8	1.2E-8	9.7E-9

CONCLUSION

The revised effective dose to the population from the ingestion of ^{131}I and ^{144}Ce was found to be increased by 40-75 % for various age groups. However, a marginal change was noted for ^{137}Cs. In Indian population, there was a further increase (upto 20 %) from the revised values.

REFERENCES

1. ICRP (1990) Age-dependent Doses to Members of the Public from Intake of Radionuclides. Part I. ICRP Publication 56, Pergamon, Oxford.

2. Venkataraman K, Somasundaram S and Soman S D (1963) An Evaluation of Radiation Protection Standards for Indian Conditions, Health Phys. 9, 647-652.

3. Jain S C, Mehta S C, Reddy A R and Nagaratnam A (1991) Dose Transformation Factors for Indian Physiques of different Age Groups, Proc. V Int. Radiopharmaceutical Dosimetry Symposium (In Press).

4. Jain S C, Mehta S C, Dogra T D, Chandrashekhar N, Reddy A R and Nagaratnam A (1992) Organ Weights in Autopsy cases from an Urban Apex Hospital. Ind. J. Med. Res., (In Press).

5. Yamaguchi, H (1978) Estimation of Internal Dose for various Physiques using MIRD Adult Absorbed Fractions. Acta Radiolog. Oncol. 17, 429-439.

6. ICRP (1991) 1990 Recommendations of the International Commission on Radiological Protection, ICRP Publication 60, Pergamon, Oxford.

7. Phipps A W, Kendall G M, Fell T P and Stather J W (1991) Revised Estimates of Dose from Internal Emitters and Implications for ALI's, Radiat. Prot. Bull. 123, 9-13.