THE EFFECT OF CHANGE IN TISSUE WEIGHTING FACTORS ON EFFECTIVE DOSE COMPUTATION DUE TO CERTAIN NEW RADIOPHARMACEUTICALS IN INDIAN PATIENTS

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ABSTRACT

Effective dose has been calculated for three technetium-99m labelled agents used for rCBF studies using 'W_T' values recommended by ICRP-1977 and ICRP-1991. The estimated values of effective doses are lower than the earlier one by 10 %. For an average Indian, administration of the same activity results in 9-12 % higher effective dose. It is suggested that amount of activity to be administered to a patient may be normalised to his/her weight.

INTRODUCTION

In India, the levels of activity used in the department of nuclear medicine for diagnostic purposes, have risen dramatically, mostly due to availability of a large variety of radiopharmaceuticals. A necessity has been felt in the department to carry out dosimetric investigations of some of the new radio-tracer agents that are used/are likely to be used for regional cerebral blood flow studies. These investigations are carried out using positron emission tomography (PET) that can provide quantitative images of tracer distribution with high spatial resolution and are able to employ radiotracers that participate in distinct and well defined biochemical/physiological processes. Despite of the recent developments in instrumentation and oxygen-15 dispensing unit, due to high cost, PET investigations may take considerable time to get established at least in developing countries. SPECT and employing technetium-99m labelled compounds that are more economical and are more widely available, is considered to be a system of choice for most of such studies in the country. Radiation dosimetry of such 'diagnostic probes' has become necessary due to: (i) the recommendations of International Commission on Radiological Protection (ICRP-1991) that have brought about significant changes in the methodology of effective dose (that indicates the radiation risk to which the patient is exposed as a result of a particular radiodiagnostic investigation) computation particularly in assigning new set of values to tissue weighting factors (that represent the relative radiation sensitivity of an organ or tissue) and (ii) the prospect that administration of the same amount of radio-tracer agent to a Reference Man (ICRP-1975) and to an average Indian patient may give rise to different effective doses (due to the difference in anatomical characteristics of the latter).

MATERIALS AND METHODS

Intensive efforts are being devoted to design new radiotracers that will cross the intact blood brain barrier and are capable of measuring regional cerebral blood flow. At present, three such radiopharmaceuticals that have significant potentiality are: technetium-99m hexamethylpropylene amine oxine (^{99m}Tc-d,l-HMPAO), technetium-99m ethylcysteinate dimer (^{99m}Tc-L,L-ECD) and ^{99m}Tc-MRP 2Ø or one of its derivatives, marketted by Amersham, DuPont and Medgenix respectively. These compounds are retained by brain to the similar extent and diffusion rather than metabolism is considered to be the rate limiting step. Table 1 gives the effective dose data of these agents considering the values of tissue weighting factor, 'W_T', as recommended by ICRP-1991. For comparison, the effective doses have also been computed taking into consideration 'W_T' values recommended earlier (ICRP, 1977).

Table 1. Effective dose (mSv) due to the adminstration of 74Ø MBq of the technetium labelled agents for rCBF studies considering 'W_T, values recommended by ICRP (1977) and ICRP (1991)

Radiopharmaceutical	Effective Dose	
	using 'W_T' of ICRP-1977	using 'W_T' of ICRP-1991
^{99m}Tc-d,l-HMPAO (Neirinekx et al 1989)	6.Ø2	5.48
^{99m}Tc-L,L-ECD (Holman et al 1989)	3.64	2.83
^{99m}Tc-MRP 2Ø** (Bossuyt et al 199Ø)	4.12	4.16

**In case of ^{99m}Tc-MRP 2Ø, the biodistribution data is still incomplete and as such the effective dose values are very approximate only.

For calculating the effective dose, a procedure that is slightly different from that of Smith (199Ø) has been adopted and has been outlined in another paper (Gupta and Nagaratnam).

The effective dose calculations have been carried out keeping in mind the anatomical, chemical and physiological characteristics of Reference Man (ICRP-1975). It has been reported that an average Indian differs significantly from the Reference Man (Venkataraman et al, 1966). Data on weight and

size of the body as well as that of the specific organ masses have also been compiled from postmortem records of 2000 cases (Jain et al, in press). Employing this data and computing Dose Transformation Factors (Yamaguchi, 1978) for Indian physiques, effective dose estimation due to the adminstration of same quantity of radiopharmaceutical has been carried out for an Indian adult and shown in Table 2.

Table 2. Effective dose (mSv/740 MBq) due to technetium-99m labelled agent to a Reference Man and to an average Indian adult using recent 'W_T' values

Radiopharmaceutical	Effective Dose	
	Reference Man	Average Indian Man
^{99m}Tc-d,l-HMPAO	5.48	6.02
^{99m}Tc-L,L-ECD	2.83	3.30
^{99m}Tc-MRP 2	4.16	4.86

RESULTS & DISCUSSION

All the three technetium-99m labelled agents are poorly retained by brain. The clearance from blood and excretion into urine are faster for ^{99m}Tc-ECD. Consequently, dosimetrically the compound is more favourable especially with respect to liver, kidney and intestine. This faster clearance from blood results also in brain images with enhanced contrast. The effective dose to a patient is lower for ^{99m}Tc-ECD. The recent change in 'W_T' values lowers down the estimated effective doses by about 10 % due to all the three compounds. In Indian subjects, adminstration of similar activities causes 9-12 % higher effective dose mostly due to the difference in their organ weights. Therefore, perhaps, a more rational approach in deciding the amount of radiopharmaceutical that is to be adminstered may be, to take cognizance of the patient weight.

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