EFFECT OF NEW ICRP RECOMMENDATIONS ON THE EFFECTIVE DOSE OF SOME NEW RADIOPHARMACEUTICALS

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ABSTRACT

ICRP (1991) has recommended new values to tissue weighting factor W_T . The effect of changes in 'W_T' values on effective dose 'E' for two technetium-99m based agents used for myocardial perfusion studies, have been investigated. Due to different biological behavior, the effective dose due to one compound is higher by 12% than the other for the same administered activity. Using the new values of W_T, the effective doses are found to be lower for technetium based agents in comparison to ^{201} TlCl.

INTRODUCTION

The concept of effective dose equivalent 'H_E (now effective dose E) introduced by the International Commission on Radiological Protection (ICRP-1977) for radiation workers, has been successfully applied for patients undergoing radiodiagnostic investigations. In nuclear medicine, the concept is utilised to indicate approximate risk to which the patient is exposed as a result of the investigation and comparing this risk with the possible diagnostic benefits. The effective dose is represented by $E=\Sigma W_T H_T$ where H_T is the mean absorbed dose in the organ or tissue 'T' (for the emission of most of the nuclides used in diagnostic nuclear medicine mean absorbed dose and equivalent dose are similar) and W_T is the tissue weighting factor representing the relative radiation sensitivity of organ or tissue 'T'. Using the general equation of Coffey and Watson (1979) for biodistribution of the radionuclides in the body and methodology of absorbed dose estimation by Snyder et al (1975), absorbed dose and subsequently using the tissue weighting factors recommended by ICRP(1977), effective dose due to a large number of radiopharmaceutical preparations were compiled (ICRP-1987).

New biological information related to the detriment associated with radiation exposure, is now available. That has necessitated the revision of ICRP recommendations made earlier. The new ICRP recommendations (1991) have brought about significant changes in the methodology of computation of effective dose, particularly regarding the numerical values of 'W_T' assigned to different tissues or organs. These developments have made it necessary to examine the effect of recent ICRP recommendations on the computation of effective dose due to some new radiopharmaceuticals and comparing the same with conventionally used radionuclide preparations. The

discussion is restricted to pharmaceuticals used for myocardiac perfusion studies.

MATERIALS AND METHODS

Nuclear cardiology has helped to predict and to assess the effect of revascularisation procedures, to avoid needless angiography and to improve the diagnosis of coronary artery diseases. Recently two technetium based radiopharmaceuticals have become available for myocardial perfusion studies - Technetium-99m $[MIBI]_6$ where MIBI is 2-methoxy isobutyl isonitrile and Tc 99m - Teboroxime marketed by Du Pont Pharma and Squibb Diagnostics respectively. These preparations have very different pharmacokinetics in the body probably because of their charges and different oxidation states of technetium. Table 1 gives the effective dose received due to the administration of 1110 MBq of the radiopharmaceuticals and assuming 2 hour urinary bladder voiding intervals. considering tissue weighting factors recommended by ICRP (1977) and ICRP (1991).

Table 1. Effective Dose (mSv) due to administration of 1110 MBq of technetium-99m MIBI and Teboroxime considering W_T values recommended by ICRP (1971) and ICRP (1991)

Radiopharmaceutical	Effective dose W_T of ICRP-1977	W_T of ICRP-1991
Technetium-99m MIBI	13.95	10.17
Technetium-99m Teboroxime	14.21	11.76

Based on data of Stabin (1990) and McSherry (1991)

In absence of complete data on mean absorbed doses to all organs or tissues of interest, the following procedure for approximation has been adopted:

(i) Mean absorbed dose to LLI wall has been used to approximate the dose to colon (Phipps et al 1991).

(ii) Whenever the mean absorbed dose to an organ or tissue and the explicit value of W_T assigned to it are available, the contribution of the organ or tissue to the effective dose to the body has been computed as per standard procedures recommended by ICRP-1977 and ICRP-1991.

(iii) In other cases after carrying out the procedure (ii), the remaining residual value of W_T is equally divided between the remaining organs or tissues of group 1 and group 2 as specified by ICRP (1987). In carrying out these calculations, the provisions of ICRP (1991) recommendations have been kept in mind. This is a

slightly modified approach of that suggested by Smith (1990).

Calculating in the similar fashion, the effective dose due to ^{201} TlCl has also been computed and compared with these technetium based agents in Table 2.

Table 2. Comparison of effective dose due to three radiopharmaceuticals used currently for cardiac perfusion studies

Radiopharmaceuticals	Effective Dose (as per recent W_T values)
MIBI	6.78 mSv/740 MBq
Teboroxime	7.80 mSv/740 MBq
^{201} TlCl	8.70 mSv/111 MBq

Discussion and Conclusion

MIBI is cleared more rapidly from the blood and liver than Teboroxime. Therefore the radiation dose of the BATO complex is higher to the liver but lower to the intestine and kidney and its effective dose is also higher than MIBI by about 12%. However, the effectiuve dose of both the technetium labelled agents is favourable compared with that of ^{201}TlCl.

REFERENCES:

1. Coffey J L, Watson E E (1979) Calculating dose from remaining body activity. A comparison of two methods. Med. Phys. 6: 307-308

2. ICRP (1977) Recommendations of the International Commission on Radiological Protection, ICRP Publication 26, Pergamon, Oxford.

3. ICRP (1987) Protection of the patients in Nuclear Medicine, ICRP Publication 52, Pergamon, Oxford.

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

5. McSherry B A (1991) Technetium -99m-Teboroxime: A new agent for myocardical perfusion imaging. J. Nucl. Med. Tech. 19: 22-26.

6. 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.

7. Smith T (1990) On an alternative method of estimating effective dose equivalent. Eur. J. Nucl. Med. 16: 53-54.

8. Stabin M (1990) Oak Ridge Associated Universities, Oak Ridge, TN 37831 (615) 576-3449.

9. Snyder W S, Ford M R, Warner G G and Watson S B (1975) 'S' Absorbed dose per unit cumulative activity for selected radionuclides and organs. MIRD Pamphlet No. 11.