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Evaluation of Absorbed Dose in Renal Function Studies Due al I^{123}/I^{131}(hippuran) e In^{111}(DTPA)

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ABSTRACT:*The estimated absorbed dose to the kidneys for renal function studies of adult patients, can be performed through the analysis of the biokinetics of radiopharmaceuticals used, containing the I-123 / I-132 (Hippuran) or In-111 (DPTA). The study is to determine whether the dosimetric contributions biokinetics organs (kidneys, whole body and your bladder) of I-123 / I-131 (Hippuran) and In-111 (DTPA), are significant in the calculation of the absorbed dose for renal function studies. To determine the dosimetric contribution of the bladder and the entire body in the kidneys of adult patients, were used MIRD formalism Cristy and Eckerman representation. The results show that the total absorbed dose due to I^{123}, I^{131} and In^{111} are given by 0.0071 mGy / MBq, 0.032 mGy / MBq and 0.0168 mGy / MBq, respectively. While corresponding dosimetric contributions because their bodiesbiokinetics are given by 11.90%, 4.97% and 28.32%. In all cases, the dosimetric contribution of organs that are part of the biokinetics of radiopharmaceuticals (except kidneys) are very significant to be ignored, and are mainly due to the photons emitted by the entire body.*

Keywords:*Cristy-Eckermanphantom, DPTA, Hippuran, MIRDdosimetry,renal function*

I. INTRODUCTION

The estimated absorbed dose to the kidneys, for renal function studies of adult patients, can be performedthrough the analysis of the biokinetics of radiopharmaceuticals used, containing the I^{123} / I^{131} (Hippuran) or In^{111} (DTPA).

II. MATERIAL AND METHODS

To estimate the dose due to the dosimetric contribution of the bladder and the entire body in the kidneys of adult patients, were used MIRD formalism Cristy and Eckerman representation for these bodies. Medical Internal Radiation Dosimetry considered equations [1]:

$$\frac{D_{fotones}(riñones)}{A_0} = \sum_{i=1}^{3}\left[\sum_k \Delta_k\, \Phi_k\,(riñones \leftarrow i)\right]\tau_i \qquad rad / \mu Ci$$

$$\frac{D_{particle}(riñones \leftarrow riñones)}{A_0} = [\bar{E}_{particle}\frac{\tau_{riñones}}{m_{riñones}} + \bar{E}_{particle}\frac{\tau_{TB}}{m_{TB}}]\, x\, 2{,}13 \qquad rad / \mu Ci$$

τ_{TB}=Total residence time of the body
$m_{TB=}$ Total body mass

The absorbed fractions, Φ_k (thyroid ← i) g^{-1}, of "i" analyzed organs (kidneys,whole body and your bladder), for photon energies "k" ofI^{123} / I^{131} and In^{111} were obtained from M. Cristy and K. Eckerman[2].

Residence times of radiopharmaceuticals mentioned in each organ biokinetics, given in Table 1, were obtained from the website [3].

Table 1: Residence times (hours)andbiokinetics of I-123/I-131 (hippuran) andI-111(DTPA)[3]

Órgans / RFM	Kidneys	Bladder content.	Rest of body
I-123(hippuran)	0.07	2.62	0.58
I-131(hippuran)	0.07	2.89	0.6
In-111(DPTA)	0.093	2.07	3.0

$\Delta_k = 2{,}13\ n_k\ E_k \quad (\frac{rad-gm}{\mu Ci-hr})$, representsaverage energy of the "k" photons emitted inthe decay of I-123, I-131 and In-111, given in Table 2, were obtained from web page [4]

Table 2: Data for nuclear emitted photons (MeV) of I-123/I-131 and In-111 most significant[4]

RFM	Photons	E_k (Me V)	n_k/des	$\Delta_k = 2{,}13\ n_k\ E_k$ $(\frac{rad-gm}{\mu Ci-hr})$
I^{123}	Gamma	0,159	0,833	0,2821
		0,529	0,0139	0,0157
	CharacteristicRadiation	0,0272|	0,246	0,01415
		0,0275	0,460	0,0269
		0,0310	0,160	0,01056
I^{131}	Gamma	0,080	0,026	0,044
		0,284	0,06	0,037
		0,364	0,817	0,6334
		0,637	0,0717	0,097
		0,723	0,0177	0,027
	CharacteristicRadiation	0,0295	0,0138	0,00088
		0,0298	0,0256	0,0016
		0,0336	0,009	0,0006
In^{111}	Gamma	0,1713	0,902	0,33
		0,2454	0,94	0,49
	CharacteristicRadiation	0,0230	0,235	0,012
		0,0232	0,443	0,022
		0,0261	0,145	0,0081

$E_{particle}$(MeV/des.), represents the average energy ofparticles emitted by the I-123 , I-131 and In-111 , i.e., representsthe electrons appearing in the decay processes forcapturing and Auger electrons are given in Table 3 andwere obtained from web page [4]

Table 3: Data for nuclear emitted particles (MeV) of I-123/I-131 and In-111 most significanteRadionuclide **[4]**

RFM	Particles	E_k(MeV)	n_k/des	$n_k\ E_k$ (MeV/des)	$\bar{E}_{particle} = \sum n_k E_k$ (MeV/des)
I^{123}	ElectronsConversion	0,1272	0,136	0,0173	0,0205
		0,1540	0,0177	0,0027	
		0,1580	0,0035	0,00055	
	ElectronsAuger	0,0032	0,94	0,0030	0,0058
		0,0227	0,1235	0,0028	
I^{131}	Beta	0,0694	0,021	0,00145	0,1818
		0,0966	0,073	0,007	
		0,1916	0,899	0,1722	
		0,283	0,0048	0,00135	
	ElectronsConversion	0,0456	0,0354	0,0016	0,0076
		0,359	0,0025	0,00089	
		0,3299	0,0155	0,0051	
		0,2497	0,003	0,00075	
	ElectronsAuger	0,0034	0,051	0,00017	0,000317
		0,0246	0,006	0,000147	
In^{111}	ElectronsConversion	0,1446	0,078	0,0113	0,02559
		0,1673	0,010	0,00167	
		0,2187	0,049	0,01071	
		0,2414	0,0079	0,00191	
	ElectronsAuger	0,0027	0,980	0,00265	0,00566
		0,0193	0,156	0,00301	

Mass values of the kidneys, bladder content,and total body ,are given in Table 4, and were obtained from M. Cristy and K. Eckerman [5].

Table 4: Mass values (g) for adult kidney ,bladder ,andtotal body representing-Cristy -Eckerman representation [5]

Organs Adult	Mass (grams)
Riñones	299
Cuerpo total (TB)	73700
Contenido vejiga urinaria	211

Using the methodology MIRD and representation of Cristy-Eckerman in kidney of adults, bladder ,and whole-body , the study is to demonstrate whether the dosimetric contributions of the organs that are part of the biokinetics of I-123 /I-131 (hippuran) and In-111 (DTPA) , are significant in the estimated absorbed dose for renal function studies.

III. RESULTS AND DISCUSSIONS

Table 5: Absorbed dose in adult kidneys, due to I^{123}, I^{131} and In^{111}, in the representation Cristy – Eckerman and MIRD formalism (mGy / MBq) x 10^{-3}

RFM	emissions	D(riñ ← riñ)/A_o	D(riñ←i)/A_o*		Sub-total	TOTAL
			TB	bladder		
I^{123} (Hippuran)	Photons : γ X	1,32 1,33	0,27 0.36	0,22 0,0	3,50	7,1
	e^- conversion's e^-Auger	2,80 0,81	-		3,61	
I^{131} (Hippuran)	Photons : γ X	3,90 0,05	0,78 0,004	0,81 0,0	5,54	32,0
	Beta emitter e^-conversion's e^-Auger	25,36 1,06 0,04	-		26,4 6	
In^{111} (DPTA)	Photons : γ X	4,87 1,58	3,84 0.38	0,54 0,00	11,21	16,8
	e^- conversion's e^- Auger	4,47 1,13	-		5,6	

(*) i = all source organs except the thyroid

The results ofkidneys **absorbed dose**in adults**,**mGy / MBq ,they are given inTable 5 andshow that:

(1) I^{123} (hippuran): 0.0071 mGy / MBq: 88.16% correspond to the *self-dose* (37.3% gamma / photon radiation characteristic, and 50.84% to Auger electrons and internal conversion); and the remaining *11.96%*, the organs of the biokinetics.

(2) I^{131} (hippuran): 0.032 mGy / MBq: 95.03% of the dose corresponding to *self-dose* (12.34% to gamma / photon radiation characteristic, and 82.69% due to beta / Auger electron emission and internal conversion); and the remaining *4.97%*, the organs of the biokinetics.

(3) In^{111} (DTPA): 0.0168 mGy / MBq: 71.68% correspond to the *self-dose* (38.37% to gamma / photon radiation characteristic, and 33.31% to Augerelectrons and internal conversion); and the remaining *28.32%*, the organs of the biokinetics.

In all cases, the dosimetric contribution of organs that are part of the biokinetics of radiopharmaceuticals (except kidneys) are very significant to be ignored and must be mainly the photons emitted by theentire body.

Depending on the type of radiopharmaceutical used and biokinetics, shall the significance of his contributions to the absorbed dose estimated by the kidneys [6, 7]

IV. CONCLUSIONS

Using the MIRD formalism and representation Cristy-Eckerman in the kidneys of adults patients , demonstrated that during studies of renal function, the dosimetric contribution of organs that are part of the biokinetics of I^{123}/I^{131} (hippuran) and In^{111} (DTPA), are very significant in the estimated absorbed dose to the patient**.**

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