

mird / DOSE ESTIMATE REPORT NO. 1

SUMMARY OF CURRENT RADIATION DOSE ESTIMATES TO HUMANS FROM ⁷⁵Se-L-SELENOMETHIONINE

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SUMMARY OF ESTIMATED ABSORBED DOSES FROM A SINGLE INTRAVENOUS ADMINISTRATION OF ⁷⁵Se-L-SELENOMETHIONINE (1)

Tissue	Absorbed dose* (mrad/ μ Ci ⁷⁵ Se injected)
Blood (whole)	9 \pm 1
Kidney (left)	21 \pm 3
Kidney (right)	23 \pm 3
Liver	25 \pm 4
Ovaries	5 \pm 1
Pancreas	12 \pm 2
Spleen	16 \pm 2
Testes	11 \pm 2
Thyroid	6 \pm 1
Total body	8 \pm 1

* Calculated value \pm 1 s.d. The standard deviation was computed from standard deviations of the cumulated activities and the coefficients of variation of the absorbed fractions.

This report summarizes the contents of MIRD Pamphlet 9 entitled "Radiation Dose to Humans from ⁷⁵Se-L-Selenomethionine" (1).

RADIOPHARMACEUTICAL

Selenium-75-L-selenomethionine can be produced by chemical or biological synthesis. When intravenously administered, the method of preparing the compound does not influence the total-body retention of ⁷⁵Se administered as L-selenomethionine.

NUCLEAR DATA

The nuclear data are given in Table 1.

TABLE 1. NUCLEAR DATA

Radionuclide	⁷⁵ Se	
Physical half-life	120 days	
Decay constant	0.000240 hr ⁻¹	
Mode of decay	Electron capture	
Principal photons:	E _i (MeV)	n _i
E ₁ , energy	0.0106	0.541
n ₁ , mean number/dis	0.1211	0.164
	0.1359	0.555
	0.2645	0.586
	0.2795	0.252
	0.4005	0.130

* Photons with a mean number of photons per disintegration of greater than 0.05 are listed. See Ref. 2, p. 20 for complete compilation.

BIOLOGICAL DATA

Six institutions contributed data collected from 40 subjects of whom ten were normal controls, seven had parathyroid adenoma, twelve had various types of carcinoma, and eleven had miscellaneous or unspecified diseases.

Of the total administered ⁷⁵Se, corrected for radioactive decay, the excretion is estimated to be 80% in the urine, 15% in the feces, 4% via hair, nails, and skin, and 1% via expired air. These estimates are based on measurements of these substances as well as on total-body counting measurements. Quantitative urinary and fecal excretion recoveries were obtained in five patients for periods up to 12 days. Total-body retention data obtained from measurements of 24 patients in total-body counters were supplied by four institutions. Three of the 24 subjects were counted for less than 3 days, and the

TABLE 2. BIOLOGICAL PARAMETERS DESCRIBING THE DISTRIBUTION FOR ⁷⁵Se FROM A SINGLE INTRAVENOUS ADMINISTRATION OF ⁷⁵Se-L-SELENOMETHIONINE*

Tissue	Biological disappearance constants, λ_j (hr ⁻¹)		
	$\lambda_1 = 0.0523$ $\lambda_2 = 0.00063$ $\lambda_3 = 0.00013$		
	Fraction of administered ⁷⁵ Se activity per organ†		
	f ₁	f ₂	f ₃
Blood‡	0.065	0.086	0.035
Fat	0.	0.020	0.024
Renal cortices (2)	0.	0.021	0.00078
Renal medullae (2)	0.010	0.0054	0.00074
Liver	0.092	0.14	0.0099
Lungs (2)	0.0040	0.029	0.0027
Muscle	0.20	0.	0.25
Ovaries (2)	0.	0.00018	0.00004
Pancreas	0.0060	0.00067	0.00021
Skin	0.031	0.055	0.0067
Spleen	0.0048	0.0093	0.00048
Testes (2)	0.	0.00076	0.00016
Thyroid	0.	0.00040	0.00026
Total body	0.14	0.44	0.42

* Adapted from Table B-1, p. 25 of Ref. 1.

† The organ masses of MIRD Pamphlet No. 5 were used (3).

‡ Two additional components are required to describe the distribution of ⁷⁵Se in blood. These components are f₄ = 0.211, $\lambda_4 = 5.64$ hr⁻¹, and f₅ = -0.205, $\lambda_5 = 0.636$ hr⁻¹, p. 14, Ref. 1.

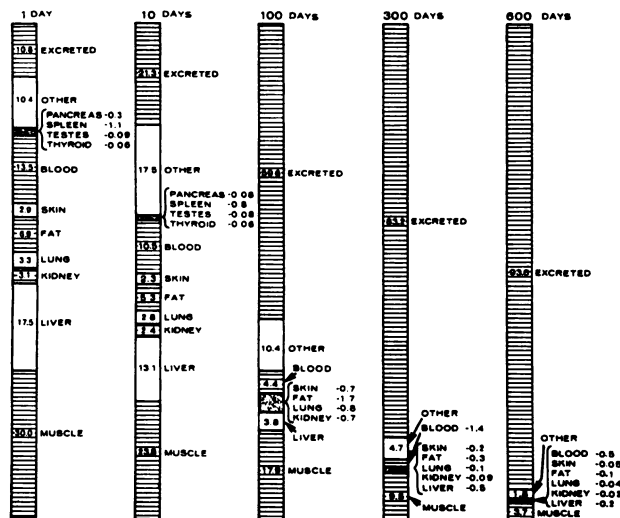


FIG. 1. Estimated percent of injected ^{75}Se , corrected for radioactive decay, in organs of body at various times after single intravenous injection of $^{75}\text{Se-L-selenomethionine}$ (1).

remaining subjects had the last count made between 64 and 923 days. Based on the total-body retention and excretion measurements, $13.1 \pm 2\%$ ("best fit" parameter \pm standard deviation) of the injected ^{75}Se has a biological half-time of 0.55 ± 0.12 days, $44.3 \pm 7\%$ has a biological half-time of 46 ± 11 days, and $41.9 \pm 8\%$ has a biological half-time of 220 ± 31 days.

Calculations based on ^{75}Se in whole blood, plasma, and red blood cells were made using data obtained from three patients studied up to 466 days which agreed well with previously published reports from several investigators. The concentration of ^{75}Se was determined in 128 specimens of tissues from 23 patients collected at four laboratories either at surgery or autopsy over an interval between 0.02 and 361 days. Figure 1 summarizes the estimated distribution of ^{75}Se in various organs of the body at 1, 10, 100, 300, and 600 days after the intravenous injection of $^{75}\text{Se-L-selenomethionine}$. The "other" category indicated in Fig. 1 represents approximately 20% of the body mass and consists of organs for which tissue samples were not taken.

ABSORBED-DOSE ESTIMATES

The cumulated activity used to calculate the doses to specific organs is based on the fraction of the administered ^{75}Se deposited in the organ, f_j , and the biological disappearance constants, λ_j , for the tissues listed in Table 2. The same three biological elimination constants were used for all tissues except blood. The organ masses of MIRD Pamphlet No. 5 were used (3).

The absorbed fractions used in these calculations

were obtained for the complete ^{75}Se photon spectrum instead of from interpolated values derived from MIRD Pamphlet No. 5. These are tabulated in Table B-3 of Ref. 1.

In Appendix B of Ref. 1, the calculations of the absorbed dose to the liver from different source tissues are given to illustrate the methods of calculation used by the MIRD Committee. In Appendix C of Ref. 1, the error considerations are given for these dose estimates.

REFERENCES

1. LATHROP KA, JOHNSTON RE, BLAU M, et al: Radiation dose to humans from $^{75}\text{Se-L-selenomethionine}$. MIRD Pamphlet No 9, *J Nucl Med* 13: Suppl No 6, 1972
2. DILLMAN LT: Radionuclide decay schemes and nuclear parameters for use in radiation dose estimation. MIRD Pamphlet No 4, *J Nucl Med* 10: Suppl No 2, p 20, 1969
3. SNYDER WS, FORD MR, WARNER GG, et al: Estimates of absorbed fractions for monoenergetic photon sources uniformly distributed in various organs of a heterogeneous phantom. MIRD Pamphlet No 5, *J Nucl Med* 10: Suppl No 3, p 8, 1969

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