mird / DOSE ESTIMATE REPORT NO. 4

SUMMARY OF CURRENT RADIATION DOSE ESTIMATES TO HUMANS WITH VARIOUS LIVER CONDITIONS FROM ^{198}Au-COLLOIDAL GOLD

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SUMMARY OF ESTIMATED ABSORBED DOSES PER mCi OF ^{198}Au FOR VARIOUS LIVER CONDITIONS FROM A SINGLE INTRAVENOUS ADMINISTRATION OF ^{198}Au-COLLOIDAL GOLD

	Absorbed dose rads/mCi of ^{198}Au injected		
Tissue	Normal liver	Early-to-intermediate diffuse parenchymal liver disease	Intermediate-to-advanced diffuse parenchymal liver disease
Liver	39	24	19
Ovaries	0.14	0.27	0.47
Red marrow	2.7	4.5	8.9
Spleen	12	38	56
Testes	0.035	0.11	0.19
Total body*	1.4	1.4	1.4

* Includes dose from source organs plus dose from ^{198}Au assumed to be distributed uniformly in the total body.

RADIOPHARMACEUTICAL

This dose estimate report is applicable to ^{198}Au-colloidal gold prepared commercially for routine clinical studies. For purposes of these dose calculations the radiochemical purity of the pharmaceutical was assumed to be 100% and the radionuclidic purity 100%.

NUCLEAR DATA

Nuclear data for ^{198}Au are given in Table 1.

TABLE 1. NUCLEAR DATA*

Radionuclide	^{198}Au (I)	
Physical half-life	2.69 days	
Decay constant	0.2576 days^{-1}	
Mode of decay	Beta minus	
Equilibrium dose constant for nonpenetrating radiation (g-rad/μCi-h)	0.6987	
	E_i (MeV)	n_i
Principal photons:	0.0725‡	0.0276
E_i, energy	0.4117	0.956
n_i, mean number/dis†	0.6758	0.011

* For complete compilation of nuclear data, reader is referred to Ref. 1. Values computed by L. T. Dillman using method described in Ref. 1.

† Photons whose mean number per disintegration is 0.01 or greater.

‡ Weighted mean energy of K x-rays.

BIOLOGIC DATA

No retention, excretion, or tissue data from humans were available to the Committee for this radiopharmaceutical. For this reason, estimates were solicited for the percentage localization of ^{198}Au after a single intravenous injection of ^{198}Au-colloidal gold to normal patients and to those with either early-to-intermediate or intermediate-to-advanced diffuse parenchymal liver disease. Responses were received from 8 of the 14 nuclear medicine laboratories contacted. The sites of ^{198}Au localization were assumed to be liver, spleen, red marrow, and the rest of body (Table 2). It was also assumed that no ^{198}Au was excreted from the body. These laboratories also provided estimates for the mass of the liver, spleen, and red marrow for the two abnormal liver conditions given in Table 3, as classified by J. G. McAfee from data in Refs. *2-5*.

Early-to-intermediate diffuse parenchymal liver disease includes patients who may or may not be symptomatic but who usually have hepatomegaly and frequently splenomegaly. The biochemical tests may either be normal or show an increase in serum globulins, serum transaminase, impaired BSP excretion, and increased urobilinogen in the urine.

Intermediate-to-advanced diffuse parenchymal liver disease refers to jaundiced patients who may have ascites associated with generalized symptoms of weakness, emaciation, and frequently fever. The bio-

TABLE 2. TISSUE DISTRIBUTION FOR ^{198}Au FROM COLLOIDAL GOLD

	Percent of injected ^{198}Au per organ			
Liver condition*	Liver	Spleen	Red marrow	Other†
Normal	90	3	7	0
Early-to-intermediate diffuse parenchymal liver disease	70	13	12	5
Intermediate-to-advanced diffuse parenchymal liver disease	35	30	25	10

* Classification developed by J. G. McAfee from data in Refs. *2-5*.

† Gold-198 is assumed to be taken up by macrophages in the lung and elsewhere. For dose calculations, this activity is assumed to be uniformly distributed in the mass of the total body less the mass of the liver, spleen, and red marrow, and has an effective half-life equal to the physical half-life of ^{198}Au.

TABLE 3. LIVER, SPLEEN, AND RED MARROW MASS FOR VARIOUS LIVER CONDITIONS

Liver condition	Organ weight (grams)		
	Liver	Spleen	Red marrow
Normal*	1,809	174	1,500
Early-to-intermediate diffuse parenchymal liver disease	2,400	250	1,500
Intermediate-to-advanced diffuse parenchymal liver disease	1,400	400	1,500

* Organ weights for the anthropomorphic model used to estimate the dose for the normal liver condition (7).

chemical tests would indicate elevated serum globulins, urinary urobilinogen, serum alkaline phosphatase and transaminase, impaired BSP excretion, and elevated serum bilirubin.

ABSORBED-DOSE ESTIMATES

The cumulated activity in the four source regions for the three liver conditions was computed assuming instantaneous uptake and uniform distribution of the activity in the source regions. The effective half-life is assumed to be equal to the physical half-life of ^{198}Au. The distribution data are given in Table 2.

The absorbed fractions used for the dose estimate calculations in this report were obtained from special Monte Carlo computer calculations using the complete energy spectrum of penetrating and nonpenetrating radiations emitted by ^{198}Au instead of from the interpolated values of absorbed fractions published in MIRD Pamphlet No. 5 (6). The heterogeneous phantom (7) used for these calculations is a modification of that described in MIRD Pamphlet No. 5 and more nearly simulates man. The red marrow is considered as a separate source organ in the modified phantom.

Calculation of the radiation dose for the two pathologic conditions required modification of the phantom model to account for the changes in mass of the liver and spleen. The liver is defined by a right elliptical cylinder cut by a plane that corresponds approximately to the visceral surface of the liver (6). For the pathologic liver conditions, the increase in the liver mass is obtained by moving the plane that cuts the cylinder toward the spleen, and the decrease in the liver mass is obtained by moving the plane away from the spleen. The spleen is defined by an ellipsoid (6). For the pathologic liver conditions, the increase in splenic mass is obtained by increasing the dimensions of the axes of the ellipsoid by a constant factor.

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