expected result if the compound distribution is the same in both species. The important point we wish to make here is that when animal data are used for human dose calculations, it is the percent dose per total organ that should be used, *not the concentration* (% dose/gm). If the concentrations are used, then the data must be normalized by multiplying by the ratio of the organ weights or the whole-body weights.

The total-body and adrenal doses given in the paper by Kirschner, et al are based on human distribution studies and are essentially correct.

The question of normalizing data from distribution studies where different species are used is the subject of a letter by Oldendorf (*2*). The term he proposes, percent mean body concentration, is useful and easily conceptualized but rather cumbersome for radiation dose calculations.

It should be pointed out that even when human data are used for MIRD dose calculations, the value of m_t must be taken from the "standard man" table. Tissue samples from patients must be normalized to the standard 70-kg phantom. With tissue samples from a 35-kg patient, the concentration values (% dose/gm or μCi/gm) must be divided by 2 in calculating $\tilde{A}$. This procedure has obvious limitations in tissues from cachectic or obese patients but it is probably better than using the raw concentration data. Total organ uptake measurements (% dose/total organ or μCi/total organ) should not be normalized.

It must be kept firmly in mind that in order to use the ϕ tables in the MIRD pamphlets, there is only one possible choice of m_t—the weight of the organ in the "standard man" phantom used for calculating the tables.

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REFERENCES

1. KIRSCHNER AS, ICE RD, BEIERWALTES WH: Radiation dosimetry of ^{131}I-19-iodocholesterol. *J Nucl Med* 14: 713–717, 1973

2. OLDENDORF WH: Expression of tissue isotope distribution. *J Nucl Med* 15, 725–726, 1974

THE AUTHORS' REPLY

Dr. Blau is correct in reporting that the liver and gonadal dose of ^{131}I-19-iodocholesterol is a factor of 10 less than what we calculated 2 years ago. This possibility was mentioned in the discussion section of the article. Because human liver and gonadal data were not available at the time of publication, we were constrained to report the most conservative dose estimate. Note our comment on p. 715 where we indicate the animal data was used as a first-order approximation of human data. Similarly, we used an assumption of gonads centrally located in a 70-kg ellipse thus giving maximum radiation absorbed dose rather than average dose.

We especially appreciate Dr. Blau's comments on units and dose calculations. The detailing of dosimetry estimates is important in assessing underlying methods and assumptions of calculations. Too often in radiopharmaceutical dosimetry only the results are indicated and thus calculation parameters, such as those pointed out by Dr. Blau, would not be evident.

We presently describe tissue distribution studies of radiopharmaceuticals in percent kilogram dose per gram (% kg dose/gm) and propose this unit to others to assist in the extrapolation of animal to human data.

$$\%\ \text{kg dose/gm} = \left(\frac{\mu\text{Ci in organ/gm}}{\mu\text{Ci (dose)/kg body wt}}\right) 100 \qquad (1)$$

This unit (% kg dose/gm) provides an adequate means of extrapolating tissue distribution data between species (Table 1). Note how species mass variation is normalized using this unit although there are changes in total dose (as usually employed with radiopharmaceuticals) or when the dose is administered in proportion to body weight (as used in pharmacology). Thus, one can (A) easily extrapo-

TABLE 1. EXAMPLES OF RADIOPHARMACEUTICAL LOCALIZATION DATA IN SPECIES OF DIFFERENT MASSES ASSUMING HOMOGENEOUS DISTRIBUTION

	70 kg	1 kg	200 gm	20 gm
Assuming constant total dose				
Total dose (μCi)	20	20	20	20
Concentration (μCi/gm)	0.00029	0.02	0.1	1.0
Percent dose/gm	0.00143	0.1	0.5	5.0
Percent kg dose/gm	0.1	0.1	0.1	0.1
Assuming constant μCi/kg dose				
Total dose (μCi)	4,200	60	12	1.2
Dose (μCi/kg)	60	60	60	60
Concentration (μCi/gm)	0.06	0.06	0.06	0.06
Percent dose/gm	0.00143	0.1	0.5	5.0
Percent kg dose/gm	0.1	0.1	0.1	0.1

TABLE 2. ^{131}I IN HUMAN GONADAL TISSUE OF SINGLE I.V. ADMINISTRATION AFTER ^{131}I-19-IODOCHOLESTEROL

	(% kg dose/gm)			
Time	Testes	Ovaries	Pt	Diagnosis
8 days	0.024	—	GH	Prostatic carcinoma
16 hr	0.14	—	CB	Prostatic carcinoma
24 hr	0.11	—	JR	Prostatic carcinoma
2 days	—	0.006	PD	Cervical carcinoma
2 days	—	0.230	MN	Cervical carcinoma
21 days	—	0.007	MM	Leiomyoma uteri
20 hr	—	0.210	VS	Nabothian cysts

TABLE 3. SUMMARY OF ESTIMATED ABSORBED DOSE (RADS/mCi) OF ^{131}I FROM SINGLE INTRAVENOUS ADMINISTRATION OF ^{131}I-19-IODOCHOLESTEROL

Tissue*	Absorbed dose† (rads/mCi)
Total body	0.94
Adrenals	30.0‡
Testes	2.01
Ovaries	2.88
Liver	1.38

* All tissue data from humans except liver which has been extrapolated to man as described.
† Assumes instantaneous uptake of maximum concentration observed.
‡ Assumes 0.4% of administered activity in adult adrenals.

late percent kilogram dose per gram to other species, (B) calculate absorbed radiation doses with this unit without additional regard for species, and (C) any value greater than 0.1% kg dose/gm reflects tissue concentration of a drug greater than that evident by general distribution.

To calculate the absorbed radiation dose from the units described above according to the MIRD scheme (Eq. 2)

$$\bar{D} = \tilde{C} \sum_i \Delta_i \phi_i \qquad (2)$$

the percent kilogram dose per gram must be divided by 70 kg to give percent dose per gram. This, in effect, is identical to normalizing the data as described by Dr. Blau. Therefore,

$$C(t) = \frac{\%\ \text{kg dose/gm}}{(70\ \text{kg})\,(100\%)} \qquad (3)$$

And the cumulative concentration is

$$\tilde{C} = (\mu\text{Ci dose}) \int_0^\infty C(t)\,dt \qquad (4)$$

Thus, as indicated, appropriate tissue concentration data can be used to calculate absorbed radiation doses.

We agree with Dr. Blau that it is the total accumulated radioactivity in an organ that is needed for complete radiation absorbed dose estimated. The concentration unit should only be used when the target and source organ are the same. The total cumulative radioactivity in a human organ can be determined from percent kilogram dose per gram units by

$$\tilde{A}_o = \mu\text{Ci dose} \int_0^\infty \frac{\%\ \text{kg dose/gm}}{(70\ \text{kg})\,(100\%)} [\text{organ wt in gm}]\,dt \qquad (5)$$

where organ weight is representative of standard man. Thus, absorbed radiation dose estimates can be ascertained using total activity or concentration providing the right units are used with an understanding of their limitations.

Using the parameters from our original preliminary communication and human gonadal tissue concentrations (Table 2) we wish to report our current dose estimate for ^{131}I-19-iodocholesterol (Table 3).

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RETENTION OF ^{99m}Tc-SULFUR COLLOID IN THE LUNGS

We read with interest the letter of Per Brunn (*1*) and the reply by Klingensmith (*2*). It was shown by Turner, et al (*3*) and others (*4–6*) that lung uptake of ^{99m}Tc-sulfur colloid during liver-spleen scanning is not due to flocculation either before or after injection.

The theory of Klingensmith (*2*) that the amount of lung uptake of ^{99m}Tc-sulfur colloid may be an index of the number of circulating macrophages as long as blood clearance is in the normal range looks attractive. This hypothesis was negated by the autopsy findings on a patient with lymphosarcoma and hepatic cirrhosis who showed lung uptake of ^{99m}Tc-sulfur colloid when a liver-spleen scan was done 1 month prior to his death (*3*). After a thorough discussion, it was postulated that in certain patients,