a gamma of 39.5 keV. However, as with ^{125}I, this gamma is greatly overshadowed by daughter xenon x-rays of about 7% higher energy than ^{125}I-Te x-rays. It is actually these x-rays for the most part that are counted in a sodium iodide crystal detector. If the 39.5-keV gammas of ^{129}I were its dominant output, it would be a poor substitute for ^{125}I.

Although ^{125}I emission characteristics are available (*1*), no similar characterization of ^{129}I was found.

To document these spectral characteristics, photon emissions of ^{125}I and ^{129}I sources were kindly examined by Michael E. Phelps of the Edward Mallinckrodt Institute of Radiology, Washington University School of Medicine, St. Louis, Mo., using a sodium iodide (thallium-activated) crystal detector and a 5-mm thick cooled germanium high-resolution solid state detector. The detector outputs were subjected to pulse-height analysis and are shown in Fig. 1. The characteristic x-rays of each daughter nuclide are shown both at high resolution and as lumped together by the sodium iodide detector. The relatively small numbers of gammas relative to x-rays are quite evident for both nuclides. The gamma rays of ^{129}I constitute only about 12% of its total photon output.

This report is intended to point out that these two spectral peaks of ^{125}I and its common long-lived phantom, ^{129}I, are not at the gamma energies of 35 and 39.5 keV, respectively, but at a considerably lower energy. This could achieve some practical significance if ^{125}I windows were optimized by dial number. Ideally, one would optimize ^{125}I window settings by obtaining a maximum count by adjusting an approximately 25–38-keV window using a ^{125}I uncalibrated source. The count obtained from a calibrated ^{129}I source with this same window setting would be the reference count for subsequent ^{125}I samples.

WILLIAM H. OLDENDORF
Veterans Administration
Wadsworth Hospital Center
Los Angeles, California

REFERENCE

1. 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, 25, 1969

RADIATION DOSIMETRY OF ^{131}I-19-IODOCHOLESTEROL: THE PITFALLS OF USING TISSUE CONCENTRATION DATA

As part of a program of evaluating ^{131}I-19-iodocholesterol for adrenal scanning, we have been collecting biologic distribution data for radiation dose calculations. The paper by Kirschner, Ice, and Beierwaltes (*1*) presents preliminary distribution data and dose calculations for this compound. By and large, our results correlate reasonably well with theirs. We have discovered a major error, however, in their method of dose calculation that results in an overestimation of the dose to liver and gonads by an order of magnitude.

The MIRD equation used for their calculation is:

$$D = \frac{\tilde{A}_s}{m_t} \Delta\phi$$

which says that the radiation dose to a target organ, t, from a source organ, s, is the product of the amount of radioactivity in the source and the length of time it stays there, $\tilde{A}_s$ (μCi-hr); the rate at which the nuclide puts out energy, Δ; and the fraction of the energy deposited in the target, ϕ. Since the dose, D (rads), is the amount of energy deposited per gram of target, the weight of the target organ, m_t, must be included. In calculating the radiation dose to an organ from the radioactivity localized in that organ (the "self-dose"), the first term of the equation, $\tilde{A}/m$, takes on the appearance of a concentration term (μCi/gm or % dose/gm) times the exposure time in hours. Since it is concentration that is most often measured in radiopharmaceutical distribution studies, there is a natural temptation to use concentration data directly in dose calculations. This is very dangerous. It can be done only under special circumstances.

The difficulty in the calculations in the paper by Kirschner, et al arises when tissue distribution data from dogs are used to calculate the dose to human organs. The authors have carried out the calculations using concentration data (% dose/gm) measured in dogs. In effect, by using the wrong m_t, they have calculated the dose to the human liver, testes, and ovary as if all of the energy were deposited in dog-sized organs. This overestimates the radiation dose to these organs by roughly the ratio of the body weights of the dogs used and "standard man." They have not normalized for the difference in organ weights. It is fortunate that rats or mice were not used for the distribution studies; the calculated radiation dose would have frightened us all away from this useful scanning agent.

In the last paragraph of their paper, the authors report that the initial results from human distribution studies indicate that the gonadal concentration is indeed a factor of 10 lower than in dogs. This is the

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.

MONTE BLAU
Roswell Park Memorial Institute
Buffalo, New York

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