trol including radiochemical and radionuclide purity, quantitative assay, distribution in animals, and sterility and pyrogen testing.

c. Biochemistry and physiology of radiopharmaceuticals including mechanism of localization and metabolism.

d. Calculation of the radiation dose from internally administered radionuclides to both patients and laboratory personnel.

e. All aspects of radiation safety including shielding, monitoring, disposal procedures, and knowledge of related state and Federal regulations.

IV. In Vivo Studies:
He should be familiar with:

a. Imaging of brain, CSF, thyroid, parathyroid, salivary glands, lung, heart and vessels, liver, spleen, pancreas, kidney, placenta, soft tissue tumors, bladder, bones, joints, and bone marrow.

b. Stationary and moving detector devices.

c. The use of single and multiple external detectors for time-dependent studies such as cerebral blood flow, thyroid uptake, cardiac output, and differential renal function.

d. Total-body counting and total-body scanning.

V. In Vitro Studies:
He should be familiar with:

a. Binding capacity studies such as iron and thyroxine; relative binding coefficients such as "T_3 uptakes", and quantifying assays of substances present in body fluids —the displacement assays, such as are used for thyroxine, growth hormone, and insulin.

b. Body composition tests such as blood volume, exchangeable sodium, and total-body water.

c. Erythrokinetics and absorption-loss studies such as vitamin B_{12} absorption, and fecal protein and red cell loss.

d. Principles of activation analysis and autoradiography.

VI. Therapeutic Uses of Radionuclides:
He should be familiar with:

a. The investigative procedures necessary to establish the need for such therapy.

b. Indications and contraindications for the use of radionuclides, including their value in relation to other therapeutic approaches.

c. Proper techniques of administration.

d. Potential early and late adverse reactions.

e. Special problems of patient care.

f. Dosimetry to the area of primary interest, to the surrounding areas, other special tissues *or* organs, and the total-body exposure.

He should also understand:

a. The more common therapeutic applications of radionuclides.

b. The range of doses in each specific application.

c. The timing of anticipated clinical response.

d. The followup care and evaluation which are needed.

In addition he should be familiar with the following:

a. Therapeutic uses of radioiodine in hyperthyroidism, thyroid carcinoma, and conditions benefited by suppression of thyroid function in euthyroid cases.

b. Radiophosphorus as the soluble sodium phosphate in treatment of polycythemia rubra vera and metastatic bone diseases.

c. Colloidal preparations of radiophosphorus or radiogold in intracavitary instillation for management of malignant effusions.

ABSORBED-DOSE CALCULATIONS

The correspondence regarding Hine and Johnston's incompletely annotated collection of literature values for the absorbed dose from internally administered radionuclides (*J Nucl Med* 11: 468, 1970) emphasizes that the accuracy of dosimetry calculations is often misconceived. The excellent MIRD publications provide convenient tabulations, which unfortunately enable dose calculations to be readily performed without due regard to their relevance in any particular clinical situation.

Hidalgo (*J Nucl Med* 11: 768, 1971) has taken exception to some dosimetry calculations (J. M. Henk et al, *Brit J Radiol* 40, 327, 1967) which were intended to draw attention to the appreciable

radiation doses given to the thyroid following renography, in which Hippuran preparations contaminated by free iodide were used. Hippuran supplied commercially at this time is not likely to be contaminated to the same degree. The methods of calculation used by Henk et al, together with their assumptions, were described in some detail.

Hidalgo has performed calculations of the mean dose to the bladder together with its content, whereas Henk et al considered the dose to the bladder wall to be of greater relevance. Hidalgo assumes that the activity is retained for 30 min and is uniformly distributed in a mass of 509 gm, whereas Henk et al clearly stated their assumption that the bladder content had a mean mass of 82 gm and contained all the activity for a period of 3 hr before total voiding. The dose at the bladder wall was taken to be one half that at the center. It is therefore not surprising that the value obtained for the dose to the bladder wall was some 18 times that calculated by Hidalgo for the bladder content.

In the work cited, the thyroid dose was calculated using the stated assumption that the effective half-life for clearance of iodide from the thyroid was 7.6 days. For a measured mean uptake of 25% the dose to a 20-gm thyroid was calcuated by ICRP methods (see Vennart J, Minski M: *Brit J Radiol* 35, 372, 1962) as 1,610 mrad/μCi iodide administered. Using the MIRD method we now calculate the corresponding dose to the thyroid as 1,450 mrad/μCi. The difference lies in the effective energy absorbed in the thyroid which was taken to be 0.23 MeV for the ICRP calculation and proves to be 0.21 MeV for the MIRD calculation. In presenting a value of 1,000 mrad/μCi Hidalgo, unfortunately, does not cite the biological half-life on which his calculation was based. Further, in the work by Henk et al, the dose to the thyroid from the administration of Hippuran was indeed calculated on the basis of a measured value for the mean free iodide content of 8% in the particular Hippuran samples used.

We would endorse most strongly the exhortation to use literature values for the radiation dose delivered only as a guide. The calculated values are not unnaturally closely related to the assumptions made, and it is really a matter for those concerned with clinical investigations to consider the validity of these assumptions in the light of the best available data relevant to the particular problem, or indeed, the particular patient.

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THE REPLY

I am indebted to Messrs. Cottrall, Taylor and Unnikrishnan for continuing discussion of the Letter to the Editor by Hine and Johnston concerning tabulated absorbed dose values.

I appreciate the affirmation of the only real point intended by my letter, that is, the table as published must be regarded "only as a guide". This point is well-amplified by the differences noted in Cottrall's letter. For example, many laboratories perform the renogram with the patient "hydrated". Under these conditions it would be difficult to assume a mean mass of 82 gm for bladder content or a delay time of 3 hr before voiding.

I must agree that dose computations should be based on clinical relevance and the same constraints apply to all dose computation methods. I do not see the penalizing or "unfortunate" aspects of the MIRD method.

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