BONE-SCANNING AGENTS: DISTRIBUTION AND SCANNING TIME

There has appeared a series of articles comparing various ^{99m}Tc bone-imaging compounds. These have included distribution data in animals and man as well as bone scans and comments on the scanning time and quality. A phrase has appeared in one of these articles (*1*) to the effect that the scans performed after injection of ^{99m}Tc-pyrophosphate are accomplished considerably faster than with ^{99m}Tc-polyphosphate. The localization data (Fig. 7, *1*) do not bear out this idea because both of these compounds are estimated to be present in the bone in equal amounts at the time of scanning. We should be interested in clarification of this dilemma.

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THE AUTHORS' REPLY

We appreciate the interest shown by Drs. Howard and Teates in our work. The amount taken up by the bone and other tissues was identical for both ^{99m}Tc-polyphosphate and ^{99m}Tc-pyrophosphate (58.5% and 58.8%, respectively), but the time taken to accumulate an equal number of counts from the same region of the body was less with ^{99m}Tc-pyrophosphate. We do not have any tissue distribution levels in these patients and, therefore, can only speculate as to the reasons for this time difference. It should be noted that the blood background radioactivity was less with ^{99m}Tc-pyrophosphate (*1*). The decreased time taken with ^{99m}Tc-pyrophosphate may suggest, therefore, relatively increased bone uptake of pyrophosphate.

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EXPRESSION OF TISSUE ISOTOPE DISTRIBUTION

We have read with interest and approval the letters from Oldendorf (*1*) and Blau (*2*) proposing improvement in the methods of expressing tissue isotope distribution and should like to extend the discussion of the subject.

Both Oldendorf and Blau point out that if radionuclide retentions are expressed as percent of administered dose per gram of tissue it is impossible to make meaningful comparisons of the metabolic patterns in different species or even between individuals of the same species but of different sizes. A manifestly absurd example would be to postulate that the same dose of a radioactive particulate that is trapped quantitatively in the liver is administered to a mouse with a 1.7-gm liver and a man with a 1,700-gm liver. The uptake, expressed as percent of dose per gram, would be 59% for the mouse and 0.059% for the man. These results would differ by three orders of magnitude although the metabolic pattern is the same in the two species by definition. Less obvious is the fact that there can be a twofold difference between results in a 50-kg woman and a 100-kg man or a built-in source of error of 25% in results in a group of rats with the rather small weight range of 175–225 gm. Results expressed as percent of administered dose per gram are not valid for comparison of metabolic patterns between individuals of different sizes. One wonders how many of the apparent age-related metabolic differences that have been reported are due to this artefact. This difficulty was recognized as long ago as 1941 by G. Failla (*3*). It was at his suggestion that Kenney, Marinelli, and Woodward (*4*) used the term "differential absorption ratio". This was defined as:

$$\frac{\mu\text{Ci found per kg tissue}}{\mu\text{Ci administered per kg body weight}}$$

A similar term, but one based on retained dose rather than on administered dose, was used by Woodard and Kenney (*5*). One of us (HQW) has continued to use this or the similar term "differential retention" whenever appropriate. The term "percent mean body

concentration" suggested by Oldendorf is identical to the term "differential absorption ratio" except that it is expressed in percent.

We propose the following terms for expressing radionuclide concentrations in tissues: (A) relative concentration (RC):

$$\frac{\mu\text{Ci found per gm specimen}}{\mu\text{Ci administered per gm body weight}}$$

This term should be used when the whole-body burden at the time the specimen was obtained is unknown) and (B) relative retention (RR):

$$\frac{\mu\text{Ci found per gm specimen}}{\mu\text{Ci retained per gm body weight}}$$

This last term should be used whenever the whole-body burden is known at the time the specimen is obtained either by direct measurement or because excretion has been measured or is known to be negligible. The term RR has the advantage that a value of unity is physiologically meaningful, i.e., it corresponds to no preferential uptake or elimination of radionuclide from the specimen under examination. Some users may prefer, as Oldendorf does, to multiply the ratios by 100 so that results may be expressed as percentages. If this is done, the abbreviations would be % RC or % RR. Obviously all activities must be corrected to some common time.

We would like to present these suggestions in the interest of making the results of determinations of radionuclides in tissue more meaningful and of broader application.

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RADIOACTIVE TRACER STUDIES OF THE HEART AND CIRCULATION

Radioactive tracers, which were among the earliest noninvasive tools for obtaining quantitative physiologic information about the cardiovascular system, are of growing importance in the field of diagnostic cardiology. Currently they provide diagnostic data unavailable by other means, such as measurements of regional blood flow, as well as supplementary information of importance in hemodynamic and angiographic examinations involving cardiac catheterization. Procedures for estimating the size and location of acute myocardial infarcts, delineation of regional ischemia during exercise, and evaluation of regional and total right and left ventricular function are rapidly being developed. Special-purpose instrumentation specifically designed for patients with cardiovascular disorders will soon be available, including (A) lightweight portable imaging instruments capable of use at the bedside, in the operating room, and in intensive care and coronary care units; (B) emission and transmission tomographic systems capable of producing transverse sections of the heart to help locate regions of infarction or dyskinesis; and (C) single-purpose hard-wired systems for use in the cardiac clinic, such as a device for radiocardiography capable of computing cardiac output and ejection fractions. In addition, efficient computer codes are being developed that, in conjunction with radionuclide angiocardiography, provide a wide range of indices of ventricular function, including cardiac output, pulmonary vascular volume, stroke volume, ejection fraction, and shunt flow measurements. These modalities are the subject of a newly issued report by the Inter-Society Commission for Heart Disease Resources (ICHD) published in the current issue of *Circulation* (*1*) which is in effect an overview of the status of cardiovascular radionuclide diagnostic studies as well as a guideline to the hospital resources, both physical and human, that are required for an exemplary nuclear medicine service dealing with this area of study.

In a previous report (*2*), the ICHD outlined resource specifications for regional pulmonary perfusion and blood pool imaging and anticipated the development of regional myocardial perfusion and regional pulmonary ventilation. In the current guideline, published 4 years later, 11 categories of nuclear cardiovascular examinations are described: radiocardiography, radionuclide angiocardiography, ventricular wall motion and performance, evaluation of myocardial perfusion, acute myocardial infarct visualization, radionuclide arteriography and venography, regional pulmonary perfusion and ventilation,