the day at different times can be done readily. We do not agree that the coincidence counting method will cure all of the problems of thyroid uptake measurements.

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Re: Attenuation Compensation in Single-Photon Emission Tomography: A Comparative Evaluation

I wish to offer two criticisms of the recent article by Lewis et al. (*1*) in which the following methods of attenuation compensation were compared: (a) filtered back-projection; (b) exponential ray-sum combining method; (c) geometric-mean corrector; and (d) iterative least-squares steepest-descent method. The authors concluded that "the additional expense of the iterative method is not justified under the conditions of this study." I suggest that this conclusion was reached primarily because their choice of an iterative procedure was inadequate.

First, the χ^2 function minimized by their iterative method did not contain any weighting factor for the random error of each projection-ray measurement. This might well explain the worse sum-of-squares error (SSE) that resulted from their iterative reconstructions of the low-count simulated data presented in Table 1. It may also affect the accuracy of lesion size determinations.

Second, χ^2 minimization using the steepest-descent method is significantly slower than the method of conjugate gradients, which converges in about ten iterations (*2*). Another iterative technique (*3*), based on the method of Chang (*4*), has been shown to be capable of providing absolute activity measurements in only three iterations by repeatedly applying a first-order correction during the analytic reconstruction of each iteration's error projections. If an array processor were available, the reconstruction time for this type of iterative procedure could be comparable to that of the noniterative reconstruction methods.

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Re: Attenuation Compensation in Single-Photon Emission Tomography: A Comparative Evaluation

There exists a tendency among nuclear medicine users of digital image processing to do lengthy computer work without paying due attention to the theory behind the image processing.

The paper referred to (*1*) is a typical example in which the authors confuse two very different problems in this field: image enhancement and restoration, and image analysis. Filtering in the reconstruction of images (paragraph B in the paper) belong to the first type of problem. Establishing relationships between an image and a template ("reference image") is a problem in image analysis to obtain a description of its properties. When the description refers to specific parts (regions or objects) in the picture, the technical literature speaks of "segmentation operations" (thresholding, edge detection, matching, and tracking). When these properties do not depend on the number of counts at each pixel but only on the relative positions of the points, we are talking of "geometrical operations," and when we are involved with properties of parts of the image and its relationships, "description operations" are required.

By calculating the SSE index for different images (obtained by the authors using different activity ratios and restoration methods), we are measuring a specific picture characteristic (perhaps texture). When using the Lesion Size index we are measuring a different property and, a priori, there should be no correlation between them.

Finally, the specialized literature (*2,3*) provides specific techniques to optimize restoration algorithms based on a-priori knowledge of the degradation function, the noise, constraints on the solution of the restoration algorithms (least-squares Winer filtering, residual statistical or average properties, etc.), or particular combinations (as in proposals A, B, C and D of this paper), in which a priori knowledge of the attenuation coefficient is considered. In this kind of discussion (Ref. 4 is a good example) phantom images are used for performance tests of the mathematical solution, but they are not used to extract information from the reconstructed image.

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Reply

The purpose of our work was highly focused in its scope, namely, to investigate a specific property of some selected reconstruction methods for single-photon tomography. We were interested in whether and how these methods affected the ability to quantify the size of myocardial infarction in patients from Tc-99m PPi uptake. We suggested caution in extrapolating our results beyond the scope of the study (see the last paragraph of the paper), and we would like to emphasize that point again.

Dr. Moore's observations about the iterative least-squares method are correct. At the time when we performed our study we limited ourselves to a single iterative method and two commonly used one-step correction techniques. Newer iterative attenuation-correction methods may prove superior to those used in our study; thus, additional comparisons are suggested, and we have proposed this to Dr. Moore in personal correspondence.

As Dr. Vergara pointed out, the methods of image enhancement and restoration are quite different from those of image analysis. To address the basic problem of image restoration we used conventional techniques to reconstruct the radionuclide activity distribution and compensate for attenuation loss. The SSE criterion, while widely used as a 'goodness of reconstruction' measure, does not reflect image geometry. Since our goal was to assess the impact of the reconstruction methods on lesion sizing, we considered the simple geometric area measure to be more appropriate than SSE for this study.

We would welcome further comments on these points.

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The Uncertain Specific Gamma-Ray Constant for Tl-201

A recent review of the information supplied by manufacturers in radiopharmaceutical package inserts revealed that the value listed as the specific gamma-ray constant for Tl-201 had been changed by an order of magnitude in just a few years. A November, 1977, package insert gave a value of 0.47 R cm^2/mCi-hr, whereas that in January, 1982, was given as 4.7 R cm^2/mCi-hr. It was discovered that the *External Radiation* data in the package insert is specified by the FDA, which recently (1980) changed the constant to the latter value. This new value includes contributions from the 10-keV L-shell x rays (*1*), whereas the original value did not. Because of the abundance (46%) of these photons and the high absorption coefficient at this energy, the inclusion of these photons has a disproportionate effect on the value for this constant. Both values had been provided to the FDA by the Radiopharmaceutical Dose Information Center at Oak Ridge.

The specific gamma-ray constant Γ_δ—better called the exposure rate constant (*2*) or, still better, the air kerma rate constant (*3*)—is defined for photons greater than some specified energy δ. The value chosen for δ depends on the application. This constant is commonly used for health-physics calculations such as in the calibration of ionization chambers or estimation of exposure rate from a radioactive patient. As almost all of the 10-keV x rays will be absorbed locally in the vial or patient, there seems to be no justification for including these photons as external radiation. It has been suggested that for health-physics application a choice of 20-keV for δ, the cutoff energy, would be more appropriate (*4*). Furthermore, the resultant first half-value layer calculated when using the 10-keV x rays is 0.006 mm Pb, which does not give a true indication of the shielding required—although it must be admitted that other attenuation values are given in the insert.

For calculations of internal dosimetry, low-energy photons are classified as penetrating or nonpenetrating, depending on the energy of the radiation and the dimensions of the volume (*5*). Except for very small volumes, the MIRD convention is to classify photons of less than 11.3 keV as nonpenetrating, since over 95% of the energy is absorbed within 1 cm of the source in soft tissue (*6*). It would be more appropriate to choose a δ of 11.3 keV for this application.

In view of the present lack of standardization, however, it would be helpful if the information contained in the package insert clearly explained the assumptions used.

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