

AbstractID: 2319 Title: Radionuclide Dosimetry I: Introduction to Radionuclide Dosimetry, and Measurement of Radioactivity by Planar Imaging

Patient absorbed dose (D) estimation in the case of internal emitters requires the calculation of two parameters. Given the traditional formula $D = S \cdot \tilde{A}$, the analyst must determine both S and \tilde{A} prior to doing this matrix multiplication. While at least some S matrices are available from prior Monte Carlo calculations on phantoms, determination of \tilde{A} must be done on site with patient imaging and other sample data. Since \tilde{A} is the vector of time-activity integrals, the analyst must initially obtain activity curves $[A(t)]$ in the various source organs. In two-dimensional analyses, there are three techniques that may be applied to activity quantitation. The best known of these is the geometric mean (GM) of two planar organ images obtained from opposing sides of the patient. Generally these are gamma camera images, but ion chambers or other detectors may suffice for assay of whole body activity. It may be that tissue attenuation makes detection of the organ possible only from one particular projection (eg the spleen from the posterior side). For such situations, that single projection (SP) must be used and, as in the GM method, corrected for camera efficiency and patient attenuation. Finally, it may occur that the source organs are superimposed in any projection so that neither the GM nor the SP is possible. In that case, the CT assisted matrix inversion method (CAMI) has been invented to permit most probable linear activity densities in all tissues. In this algorithm, a fusion of a coronal CT (or MRI) projection with the planar nuclear image is required. As a result, one can define the type and length of activity-bearing tissues along a given ray perpendicular to the camera face. Fusion of anatomy and physiology is also important so that the analyst does not confuse a normal tissue with a cancer site in the nuclear image. Errors in these various methods of estimating activity may be considerable as seen in phantom studies. Typically the GM and SP lead to variations on the order of +/- 30% from true values while CAMI has uncertainties of approximately half that amount. Requisite image fusion has been a limitation on the widespread utilization of the CAMI technique, however. Image archiving and workstation technology may alleviate this difficulty sufficiently to make the CAMI method, or a strategy like it, a more popular activity quantitation technique in the future.

Educational Objectives:

1. Understand the matrix formula for internal emitter doses: $D = S \cdot \tilde{A}$.
2. Realize that source organ activity $A(t)$ must be estimated from patient data.
3. Know that there are at least three planar methods to determine $A(t)$.
4. Understand the importance of fusion of anatomic and physiologic images.