The fundamental equality used in internal emitter absorbed dose (D) estimation is $D = S^*\hat{A}$. Here, D and $\hat{A}$ are vectors and S is a rectangular matrix. Generally D and $\hat{A}$ have components assigned to the various body organs. Voxel-based calculations are also possible if data are obtained in a 3-D format. The first step in making the estimate is to perform activity (A) measurements in each of the organs that can be visualized in the scanning and/or imaging process. Essentially 6 methods are available for this quantification ranging from inverse-square counting to quantitative SPECT (QSPECT) or PET. The most common technique is the geometric-mean method (GM) which requires that two images be acquired simultaneously on each side of the patient. Given a set of counts for each source organ over time $A(t)$, one must integrate numerically to find $\hat{A}$. It is standard procedure to represent data at times beyond the last imaging point as a physical decay using the half life of the radiolabel. We should note that some agents used for Targeted Radionuclide Therapy (TRT) may not give off photons so that a surrogate agent is used; e.g., 111-In-antibody in lieu of 90Y-antibody. Given the $\hat{A}$ vector, the estimator then may use S in two types of computations. A type I computation involves using the $S$ matrix obtained from a relevant humanoid phantom. In this case, all organ sizes are specified for a standard man, woman or child and the biological data ($\hat{A}$) from each animal or patient must be normalized accordingly. Type I calculations are used in regulatory applications and in comparing one agent with another scientifically. Type II computations are patient-specific in that $\hat{A}$ is unchanged, but S must be modified to represent the geometry of the individual. In TRT, Type II estimates are made with relatively small amounts of activity prior to the start of therapy. Generally, human S values are standard tabulations available in OLINDA and other software. If murine dose estimates are needed, however, some S values are available. The result of the matrix multiplication of $S$ and $\hat{A}$ is a set of doses for each of up to 30 or more target tissues. Because of external beam precedents, it is now becoming common to use both D and $D^2$ in the analysis of tumor regression and normal organ toxicity. In this analysis, one plots the clinical outcome, such as tumor size, vs. a quadratic polynomial in dose. One anticipates a sigmoidal response. Using such analyses, it is possible that TRT can evolve into a clinical strategy beyond its present limitation to B-cell lymphomas.

Learning Objectives:

1. Knowing methods to determine organ activity.
2. Realizing the errors in activity measurement.
3. Understanding the types of dose estimate (phantom vs patient).