AbstractID: 11974 Title: Determination of Dose to Individual Patients in Radionuclide Imaging Procedures Including Planar, SPECT, and PET

Individual patient absorbed dose estimates are a relatively novel feature in nuclear medicine physics. Historically, almost all estimates were made using phantoms having predetermined geometries and organ sizes. Yet none of their various geometries may be suitable for a given person and other methods are being implemented to allow patient-specific dose computations. For either phantom or patient-based estimates, target organ dose is given by the matrix product: D (target organ) = **S** * Ã (source organs). In the equality, the rectangular matrix **S** depends upon the energies of emission, their probabilities and the geometry of either the phantom or patient. Ã is a vector containing elements which are the total decays from each source organ. Total decay means essentially an integral over the activity A(MBq) in that source over the time interval $0 \leq t \leq \infty$. For an individual, **S** can sometimes be determined using manipulations of a phantom value for a given radionuclide. In a pure beta or alpha emitter, **S** becomes diagonal and its elements are proportional to the inverse of the organ mass. This situation is common in targeted radionuclide therapy (TRT) and is the most important application of patient-specific dose. If the radionuclide emits significant photon radiation, a Monte Carlo approach is probably required to estimate individual organ doses. If one does not correct for target mass, errors in **S** can approach factors of two to three. This becomes particularly important in some clinical conditions such as lymphoma where the splenic mass may become very large. Determination of Ã is based on measuring activity (A) at-depth in the patient. At least six techniques are in the literature for activity quantitation. The simplest is single probe counting with corrections for distance such as using inverse-square law for surface structures. This method, however, cannot be used at-depth in the patient. Geometric-mean gamma camera imaging is the most common method of activity quantitation, but suffers from overlapping source organs. Its accuracy is on the order of +/- 30% in phantom and animal studies. The most advanced camera technique is quantitative SPECT imaging. This measurement (QSPECT) is ideally done with hybrid SPECT/CT scanners. Corrections are made for attenuation, scatter, collimator geometry and partial volume effects. Absolute activity accuracy approaches +/- 5% in QSPECT. PET imaging can be competitive with this result if a positron emitter of sufficient half life and emission probability is available for labeling. The ultimate dose uncertainty for a given patient is a quadratic combination of errors due to **S** and Ã.

Educational Objectives:

1. Understand use of D = **S***Ã for internal emitters.
2. Realize that patient-specific doses are obtainable.
3. Know the sizes of uncertainty in activity and **S** measurements.
4. Discover the use of QSPECT and quantitative PET.