13c

New dosimetric methods

S.E. Strand (Lund)

Nuclear medicine dosimetry is still a controversy because of its still faint correlation with biological effects. This has been mostly emphasized in radionuclide therapy where several efforts have been done to find this correlation with limited success.

All nuclear medicine procedures are based on physiological processes where the administered radiopharmaceutical is distributed in the tissues governed by its chemical properties. Most radiopharmaceuticals are taken up or accumulated in certain cells in the tissues which in fact are the basis for functional imaging.

Considering that most radiopharmaceuticals inherent due to its behavior will distribute heterogeneous in most organs and tissues, internal dosimetry must address this fact, in order to obtain the realistic activity and absorbed dose distribution.

Although the geometry for radiation emission in the tissue must rely on realistic distributions also the activity must be quantified in vivo with high precision and the pharmacokinetics followed in sufficient time.

With different imaging techniques different levels of resolution determine how accurate absorbed dose distributions can be elucidated. For example with in vivo imaging with scintillation camera, SPECT or PET the resolution is very low in that only mean absorbed dose calculations can be obtained. Although a heterogeneous activity distribution mostly is present it will not be reveled with such imaging. Complementary imaging techniques are needed based on tissue sampling as biopsies in patients or experimental animal data. Then more real activity distributions can be obtained.

The present lecture will address the issues of activity quantification and pharmacokinetic modeling to obtain the cumulated activity. The dosimetry will be discussed from the microscopic level over small scale dosimetry to macro dosimetry [1].

The quantification method mostly used is the conjugate view method. The accuracy of that method will be discussed aiming at accuracy needed in the co registration of transmission images for attenuation corrections. Also the problem with overlapping organs will be addressed. More accurate activity estimations can be obtained with SPECT and PET however mostly not used routinely in the clinic because of long imaging times needed to be repeated during several days. For PET Also the availability of more long lived positron emitting radionuclides will hamper that technique [2].

Different models for more realistic organ dosimetry will be discussed and example as a new model for the crypt cells in the intestine will illustrate the strive for more realistic geometries for organs and tissues [3]. One factor in radionuclide therapy that can affect the mean absorbed dose to a tumor is its shrinkage during therapy. That effect will be addresses.

On the tissue level the heterogeneous distribution of radioactivity will in most cases result in great deviation of the tissue dose distribution from the mean absorbed dose. Examples will be given from tumors evaluated with digital autoradiography. Similar results will be illustrated from the liver and the kidneys.

The cellular distribution of radioactivity is of great importance especially when dealing with short ranged particles. Also the heterogeneity of i.e. antibody distribution in tumor cells will be illustrated. This effect will have great impact for alpha emitters and Auger emitters.

In summary for an accurate dosimetry estimate and to get closer to the goal of having a dosimetry that can predict the biological effect, a combination of macro-small scale-micro dosimetry needs to be explored and further developed.

References

1. Adelstein SJ, DeLuca P, Feinendegen LE, Green L, Howell RW, Humm JL, Leichner PK, O'Donoghue JA, Strand S-E, Wessels BW (2002) ICRU report nr 67 – Dose Specifications in Nuclear Medicine. ICRU,
2. Flux G, Bardies M, Monsieurs M, Savolainen S, Strand S-E, Lassmann M (2006) The Impact of PET and SPECT on Dosimetry for Targeted Radionuclide Therapy. Z Med Phys 16:47-59
3. Jonsson L, Liu X, Jonsson BA, Ljungberg M, Strand SE (2002) A Dosimetry Model for the Small Intestine Incorporating Intestinal Wall Activity and Cross-Doses. The Journal of Nuclear Medicine 43:1657-1664