

IMPACT OF THE MONTE CARLO CODE GATE FOR TARGETED RADIONUCLIDE THERAPY (TRT): IMAGING AND DOSIMETRIC CALCULATIONS

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Targeted Radionuclide Therapy (TRT) combines the specificity of a biological vector with the action of short-range radiations. Assessing the absorbed dose delivered to tumours and healthy tissues participates to the evaluation and optimisation of the therapy. It implies combining quantitative imaging and absorbed dose calculations. Monte Carlo modelling can be involved in both steps, first as a process control aid for the improvement of image quantification, and secondly for the personalization of absorbed dose calculations by taking into account organ shape and density.

The Monte Carlo code GATE¹ has been widely used for scintigraphic image modelling, both for preclinical and clinical PET/SPECT studies, and is available for absorbed dose calculations in Nuclear Medicine since its version 6.0. Therefore the possibility to use the same code to model both aspects of radiopharmaceutical dosimetry was considered as an asset.

This work investigates the input of GATE as a toolkit for applications in internal dosimetry in a context of improvement of dosimetric methods.

A wide heterogeneity is observed in dosimetric approaches and no standardized dosimetric protocol has been proposed to date. The DosiTest project (www.dositest.com) aims at evaluating the impact of the various steps contributing to the realization of a dosimetric study, by means of a virtual multi-centric inter-comparison based on Monte-Carlo modelling, and eventually propose a reference methodology.

To this end, pharmacokinetics of two radiopharmaceuticals (OctreoscanTM and ¹⁷⁷Luoctreotate) was created following a compartmental modelling. Two virtual patients were defined from these radiopharmaceuticals and from two anthropomorphic models (XCAT², ICRP 110³ reference computational model) split in functional compartments. Scintigraphic images were generated with GATE from these virtual patients following imaging protocols dedicated to each radiopharmaceutical, with a successful outcome in one of the cases. Reference dosimetric calculations were performed with GATE in both situations for a further comparison with results obtained by centres participating to the virtual clinical trial.

Key words: Targeted radionuclide therapy – Clinical dosimetry – Monte Carlo modelling – GATE – XCAT model – ICRP110 models

1 Jan (2011), Phys Med Biol, 56(4), 881- 901

2 Segars (2010), Med Phys, 37(9), 4902- 15

3 ICRP (2009), Ann. ICRP, 39, 1- 166