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First clinical SPECT imaging and characterisation of 155Tb from CERN-ISOLDE: towards a theranostic isotope quartet

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Introduction

Interest in the element terbium (Tb) for medical application has grown recently [1]. Four Tb isotopes have been identified with the potential to provide unique theranostic treatment strategies which combine cancer therapy with diagnostic imaging. The isotopes ^{155}Tb and ^{152}Tb can provide SPECT and PET imaging respectively [2], whilst ^{161}Tb can be used for beta– therapy and auger electron therapy [3] and ^{149}Tb for alpha therapy [4][5]. Using a combination of these isotopes as labels for radio-pharmaceuticals can provide both pre-therapy diagnostic imaging and post-therapy dosimetry and treatment optimisation using the same delivery vector. In order to validate the use of these isotopes for patient treatments extensive pre-clinical studies [1] are required to provide the foundation for future clinical trails.

Accurate determination of administered activity, traceable to a primary standard of radioactivity is essential for all radio-pharmaceuticals. Molecular radiotherapy (MRT) is a cancer therapy technique in which radioactive pharmaceuticals are administered to deliver a lethal radiation dose to malignant cells whilst sparing surrounding healthy tissue. Calculations of absorbed dose for MRT require the determination of the specific distribution of radioisotopes within the body - primarily from SPECT imaging. Clinical SPECT camera systems are typically optimised for imaging with 99mTc (Eγ = 140 keV), in contrast the decay of ^{155}Tb produces gamma rays of 87 keV, 105 keV, 180 keV and 262 keV. Establishing optimised SPECT imaging protocols for ^{155}Tb with a clinical camera system is a crucial first step in demonstrating the efficacy of ^{155}Tb for clinical applications.

Methods

Samples of ^{155}Tb were collected at the ISOLDE GLM beamline. The samples were imaged using a GE Discovery 670 SPECT/CT camera at The Christie NHS Foundation Trust (Manchester, UK). Data was acquired in 'list-mode' enabling retrospective projected SPECT images to be produced from scan data after the initial samples had decayed. Experimental SPECT/CT data was combined with a Monte Carlo simulation of the Discovery 670 SPECT camera [6] to optimise the energy windows and collimators used to acquire ^{155}Tb SPECT images. An additional sample of ^{155}Tb has been characterised for purity and activity using high precision gamma-ray spectroscopy at the UK National Physical Laboratory.

Results

Preliminary results will be presented on the characterisation of ^{155}Tb samples produced at CERN-ISOLDE. These results will be discussed in the context of providing a primary standard of activity for this isotope.

The first isotope-specific photopeak and scatter imaging energy windows for ^{155}Tb will be presented. The effect of applying these energy windows, calculated using a minimization method applied to data from a full MC simulated SPECT acquisition, to clinical SPECT/CT imaging will be discussed.

References

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