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Lu-175 in PET Detectors –Impact on Medical Image and Legal Remediation Issues

Introduction: The most PET devices contain scintillation crystals based on lutetium - LSO or LYSO. Lutetium Lu-175 is incorporate with radioactive Lu-176 (abundance 2.6%; $T_{1/2}=(3.56\pm 0.07)\times 10^{10}$ years; β^- radiation ($E_{max}=596\text{keV}$), followed by three simultaneous γ -ray emissions (energies: 88, 202 and 307keV)). Taking into account long half-life, lutetium activity could be considered as constant - $52.61\pm 0.36\text{Bq/g}$.

Objective: The objective is to estimate the amount of radioactive lutetium in Siemens Biograph 40 64 PET-CT device, potential impact on the diagnostic information and to emphasize the importance of remediation, to protect environment.

Methods: Based on the dimensions of the crystal, mass number and the total number of crystals, it was estimated the share of isotope Lu-176 in the overall mass, and the associated radioactivity.

Results: According to the device technical specification, it was determined the detector size and calculated the mass of detector unit - 2,368g. Furthermore, there are 169 crystals per detector block and 144 detector blocks, which leads to the total detector mass - 57627g, from which the share of Lu-176 is 1150g. Hence, there is ring distributed radioactivity of about 60.5kBq.

Conclusion: Natural radioactivity of lutetium poses no problem in clinical PET imaging (excitation activities $\sim 100\text{MBq}$, energy threshold 350keV), but could have influence on the QC examinations with low activities, with Ge-68 point source (activity $\sim 5\text{kBq}$), and potentially at the end of dynamic studies using C-11 or O-15. After replacement of the detector block or termination of device exploitation, the proper disposal is mandatory.

Primary author: ARTIKO, Vera (Center for Nuclear Medicine, Clinical Center of Serbia)

Co-authors: Dr PETROVIĆ, Jelena (Center for Nuclear Medicine Clinical Center of Serbia); Dr ANTIĆ, Vojislav (Center for Nuclear Medicine Clinical Center of Serbia)

Presenter: ARTIKO, Vera (Center for Nuclear Medicine, Clinical Center of Serbia)

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