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New isotopes for medical applications

Ulli Köster[1]

[1]*INSTITUT LAUE-LANGEVIN, 6 RUE JULES HOROWITZ, 38042 GRENOBLE CEDEX 9, FRANCE*

Contact email: *Ulli.Koster@cern.ch*

Radioisotopes play an important role for diagnostics and therapy in nuclear medicine.
The leading isotopes for SPECT (^{99m}Tc) and PET (^{18}F) are characterized by nuclear properties (half-life, energy and branching ratio of gamma rays or positrons respectively) that are very well matched to many diagnostic applications.

On the other hand, for therapy the traditional isotopes are not necessarily optimized for all applications. ^{131}I is perfect for treating thyroid cancer and some other thyroid dysfunctions, but its high energy gamma rays cause a considerable dose to adjacent persons and require a prolonged isolation of the patient. Therefore, applications that do not make use of the chemical properties of iodine but that are using antibodies, peptides or other targeted bioconjugates for receptor targeted radionuclide therapy should be better combined with other therapeutic radionuclides.

Some of these “new” isotopes are not yet available commercially and require unconventional production methods. A recent example is the production of a quadruplet of four different terbium isotopes produced by thermal neutron capture in the high flux reactor of Institut Laue Langevin (^{161}Tb) and by GeV proton induced spallation of tantalum targets and on-line mass separation at ISOLDE-CERN (^{149}Tb, ^{152}Tb, ^{155}Tb) respectively. These four isotopes cover all nuclear medicine modalities (low energy gamma ray emission for SPECT, positron emission for PET as well as beta-minus, alpha and Auger electron emission respectively for therapy), but have identical (bio-)chemical behavior. That makes them particularly interesting for “Theranostics” where the administrated activity of the therapeutic isotope is individually optimized based on the measured patient-specific uptake of the corresponding diagnostic isotope.

While present RIB facilities play an important role in facilitating preclinical research towards new promising applications in nuclear medicine, future RIB facilities could even provide certain isotopes with unique properties in sufficient quantities for clinical applications.