**Sample Abstracts from IPET 2015**

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Example 1:

Optimization of Site Planning of PET Cyclotrons Using Monte

Carlo Simulations

M. Marengo, A. Infantino, G. Cicoria1, D. Mostacci

**Background:** The extraordinary growth of PET during the last 10 -15 years has determined the diffusion

of cyclotrons for production of PET radionuclides, with still increasing number of installations and new

models introduced into the market. The established documents giving guidance on proper site planning,

shielding and risk assessment typically refer to analytical methods for the calculation of both shielding

and materials activation, considering an approximate or idealized geometry set up. These valuable but

outdated approaches can be nowadays integrated or replaced by the use of Monte Carlo (MC) simulations.

Up-to-date MC codes have now accurate libraries for transport and interactions of neutrons and charged

particles at energies below 250 MeV, and recent computers allow the systematic use of simulations with

realistic geometries and high statistical accuracy in acceptable

computational time.

**Methodology:** In our work, the MC code FLUKA has been extensively used in order to model several

types of cyclotron for radionuclides production; a) the General Electric PET trace (16.5 MeV); b) the ACSI

TR19 (19 MeV); and c) the IBA Cyclone 70, including their targetry. Simulations allow for accurate

estimation of the source term, in particular the effective dose rate distribution during irradiation of each

specific type of target material, the effective number of neutrons produced per incident proton and

neutron spectral distribution; parameters that are fundamental in order to properly calculate shielding.

Moreover, simulations make it possible to assess specific components of the shielding (local shielding or

additional on-purpose barriers) and the transmission of dose in ducts, mazes and doors. The activation of

the structure of the cyclotron, of the ambient air, in particular for the production of 41Ar; of the structural

walls and of the underground soil and water can be prospectively studied.

**Results:** Validation of the dose distribution around the cyclotrons PET trace and TR19 has been made

comparing predictions from the simulations with experimental measurements of neutron environmental

dose equivalent with TLD, bubble detectors and rem-meter. The comparison sows an excellent

agreement, within the interval of statistical fluctuations and experimental uncertainties. The study of the

dose distribution around cyclotrons was fundamental in planning new installations, in particular as

regards to “bad geometry” items, like ducts and wall penetrations. The estimates of 41Ar in air were

validated against experimental sampling and analysis by high resolution gamma ray spectrometry. Target

activation studies for 18F, 89Zr and 99mTc gave results in agreement with experimental measurements

and theoretical yields.

**Conclusion:** MC simulations represent an up-to-date solution for relatively complex problems of

estimation of the source term, in particular in the case of accelerators, assessment of shielding and

conditions of “bad geometry”. Computational time is affordable, with modern workstation or clusters, giving scientists in the biomedical field a powerful tool for optimization of radiation protection.

Example 2:

Incremental Value of Routinely Including Brain as a Part of the

Whole Body 18F-FDG PET/CT and Use of Contrast for Staging

NSCLC - Its Efficacy and Comparison with MR Imaging of Brain

for Detection of Asymptomatic Brain Metastases

S. Ray, J. Das, A. Chandra, R. Shrimali, S. Chatterjee

Tata Medical Center

**Background:** Brain MRI is the accepted standard to detect asymptomatic brain metastases (ABM)

although some centres propose the use of contrast enhanced brain CT in staging non-small cell lung

cancers (NSCLC). In most centres, staging with fluorodeoxyglucose (FDG) PET-CT protocol for NSCLC

does not include the brain. We investigated the benefit of routinely including brain CT with contrast as a

part of the PET-CT staging protocol in NSCLC and compared their asymptomatic brain metastases

detection rates to MRI.

**Methodology:** Data from the first 100 consecutive patients was retrospectively analysed. TNM staging

information was tabulated. Comparison of brain image of the whole body PET-CT, non-contrast plain CT

and contrast enhanced CT (CECT) images of the brain not fused with PET and dedicated brain PET

images was performed in correlation with brain MRI.

**Results:** T3/T4 primary was found in 52% patients with 89.2% having N2/N3 nodal disease on PET-CT

scan. 18% had ABM on MRI, 61.1% of whom had adenocarcinoma. Amongst adenocarcinoma, 72.2%

and 88.9% had T3, T4 lesions or N2, N3 disease respectively in the ABM group, compared to 45.1% and

64.6% in those without ABM. Similarly, in squamous cell carcinoma 100% versus 32.3% had either

T3/T4 and/or N2/N3 disease respectively in the ABM versus non-ABM groups. Table 1 shows the

differential detection of brain metastases using the various techniques: 4 of the 14 brain metastases

detected in PET-CT had FDG avidity and in other 10 cases it was photopenic. MRI brain detected

metastases in 4 extra cases (size range 4-8mm) compared to CECT.

Brain metastasis MRI PET-CT CECT PLAIN CT DEDICATED BRAIN

PET

Present 18 14 14 9 15

Absent 82 86 86 91 81

Total 100 100 100 100 96

SENSITIVITY 77.8% 77.8% 50% 83%

**Conclusion:** Routine inclusion of brain CECT as part of FDG PET-CT protocol could detect

asymptomatic brain metastases in 77.8% cases therefore negating the requirement of an additional brain staging MRI in NSCLC. This could enable resource optimised use of MRI staging in more advanced T/N

stages. There is no significant difference in sensitivity between CECT brain and fused PET-CT image of

the brain. Non-contrast plain CT has very poor sensitivity (only 50%) for detection of brain metastasis.

Addition of dedicated brain PET to CECT enhances the sensitivity for identification of brain metastasis to

83%. We recommend routine inclusion of brain in the whole-body protocol for staging with PET-CT in

NSCLC along with use of iodinated contrast and preferably an additional dedicated brain PET

acquisition.

Example 3:

Preparation and Preliminary Biological Evaluation of Lu-177

Labelled Somatostatin Analogue DOTA-Pasireotide

for Tumour Imaging

F. Liu1, H. Zhu1, C. Xiong , C. Li, Z. Yang

Peking University Cancer Hospital

The University of Texas MD Anderson Cancer Center

**Background:** The purpose of this work was to develop a new somatostatin analogue for tumour peptide

receptor radionuclide therapy (PRRNT). Octreotide and its derivatives have been widely used for

somatostatin receptor positive tumours therapy; however, they only have high affinity for SSTR 2 among

the five somatostatin receptors. Recently, Pasireotide was reported to have a better binding affinity for

SSTR 1, 3, 5 and similar affinity for SSTR 2 compared with Octreotide. As the contemporary β- and γ-

emission of 177Lu makes it a suitable radionuclide both for therapeutic and diagnostic purposes, herein

we report the new somatostatin analogue Pasireotide labeled by 177Lu to present a preliminary evaluation

of its behaviour in vivo and to explore the possibility of its usage as a diagnostic and therapeutic

radiopharmaceutical for neuroendocrine tumours and PRRNT.

**Methodology:** Cyclic peptide amide DOTA-Pasireotide was synthesized and radiolabeled with 177Lu to

yield 177Lu-DOTA-Pasireotide (Figure 1). The precursor DOTA-Pasireotide was labeled with 177Lu in

sodium acetate buffer (pH 4.0) by heating at 100 °C for 15 min and the products were determined by

radio-instant thin-layer chromatography (TLC) and radio-HPLC. In vitro stability experiment was

undertaken in 5% human serum albumin, NaAc (pH 5.5) and PBS (pH 7.4) at room temperature (25 °C)

for about 120 hours of incubation. After purification by Sep-pak C18 column, 12.95 MBq of 177Lu-

DOTA-Pasireotide was injected intravenously to BALB/c nude mice bearing human HT29 colon tumours

via tail vein. The SPECT/CT images were taken 2 h, 4 h, 8 h after radiotracer injection.



**Results:** DOTA-Pasireotide was radiolabeled with 177Lu in 98% radiochemical yield as determined by

radio-TLC and radio-HPLC. In vitro stability experiments showed that after 120 hours 177Lu-DOTAPasireotide

was stable in 5% human serum albumin, NaAc (pH 5.5) and PBS (pH 7.4). In vivo, the HT29

cell xenograft tumours uptake of 177Lu-DOTA-Pasireotide increased with time, and was clearly

visualized at 8 h postinjection. Biodistribution studies in KM mice demonstrated that 177Lu-DOTAPasireotide

was mainly excreted by kidneys.

**Conclusion:** In this study, we describe the radio-synthesis and characterization of 177Lu labeled cyclic

peptide 177Lu-DOTA-Pasireotide. We found that 177Lu-DOTA-Pasireotide could be taken up by HT29

cell exonograft tumours. It is found to have high labeling efficiencies, short labeling time and high tumour

cell uptake. In brief, the 177Lu labeled somatostatin analogue 177Lu-DOTA-Pasireotide may be useful

both for cancer diagnostic and therapeutic applications.

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