Dose and Optimisation Approaches for Nuclear Medicine Hybrid Systems

Stelios Christofides, PhD, Partner 13 coordinator

Funded by the European Commission under the specific programme (Euratom) for research and training in the nuclear energy field (2002-2006) as part of the 6th Framework Programme

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Delft – The Netherlands
18th – 20th April 2007

Nuclear Medicine Hybrid Systems

- SPECT with Attenuation Correction (AC)
- SPECT-CT (AC and or Image Fusion)
- GCPET with AC
- PET with AC
- PET-CT (AC and or Image Fusion)

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Dose and Optimisation Approaches

- Modalities (Hardware Combinations)
- Radiopharmaceuticals
- Patients

We need to Optimise the Procedure Pathway

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The above three main factors give a choice of combinations for a particular diagnostic procedure. Each combination has its advantages and disadvantages.

The optimum combination is the one that will give the images with the best diagnostic value at the lowest possible dose to the patient.

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This can best be illustrated by using an example:

Let consider the Myocardial Perfusion Study that can be performed by two categories of Modalities in combination with a number of radiopharmaceuticals as follows:

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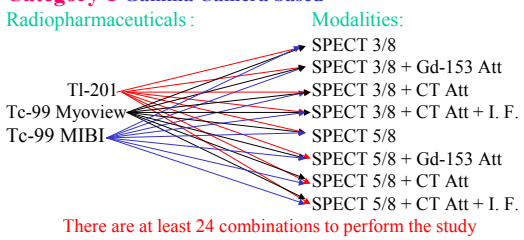
Category 1 Gamma Camera based



There are at least 24 combinations to perform the study

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Category 2 Positron Emission Tomography based

Radiopharmaceuticals:

- ^{13}N-NH_3
- ^{82}Rb
- $H_2{}^{15}O$

Modalities:

- SPECT 5/8
- SPECT 5/8 + Gd-153 Att
- SPECT 5/8 + CT Att
- SPECT 5/8 + CT Att + I. F.
- PET
- PET + Gd-153 Att
- PET + CT Att
- PET + CT Att + I. F.

There are at least 24 combinations to perform the study

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The Dose Effective Index (I_{DE})

The optimum is often defined such that one obtains an image quality that is sufficient for the intended purpose, with the lowest possible dose to the patient. Defining the actual operating point would require a detailed comparison of costs, health detriments from the patient's radiation dose and expected health benefit from the examination.

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Therefore there is a need to evaluate the clinical utility of each modality for a specific examination procedure.

Each characteristic parameter (i.e. Spatial Resolution, linearity, low and high contrast resolution) needs to be considered in relation to its importance for a particular procedure. Similarly the specificity and sensitivity of the different radiopharmaceuticals needs to be considered.

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For this purpose it is proposed to have Performance Factors (P_F) with corresponding Functional Scores (F_S).

Each F_S for each P_F will need to be multiplied by a weighting factor (W_F) depending on the importance of that particular imaging parameter.

The summation of the weighted F_S's will give the total weighted score (T_W) for each modality component of the hybrid system.

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The T_W's of each modality will need to be multiplied by a weighting factor for each modality (W_M) depending on the importance of that particular modality.

The summation of the weighted T_W's of each modality component of the hybrid system will give the total score of the hybrid system (T_H) for a particular examination procedure.

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Consequently it is possible to define a Dose Effective Index (I_{DE}) for the comparison of different modalities for a particular examination procedure that can be used to indicate the modality with the best diagnostic value of its final images.

This total score T_H, can be defined as the Dose/Effective Index that is given in mathematical form by:

$$I_{DE} = T_H = \sum_{j=1}^{j} Tw_j \cdot Wm_j$$

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Where Wm_j is the weighting factor of the modality component or special feature j of the hybrid system and Tw_j is given by:

$$Tw_j = \sum_{n=1}^{n} Wf_n FS_n$$

Where Wf_n is the weighting factor of each parameter **n** of each modality component or special feature **j** of the hybrid system and FS_n is functional score for each parameter **n** of each modality component or special feature **j** of the hybrid system.

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It would be necessary to define the P_F's, F_S's, W_F's for each parameter of each modality component or special feature as well as the W_M's for each modality component or special feature.

Similarly the above evaluation can be used for the radiopharmaceuticals available for each examination procedure.

Should I dare to say also for the experience of the Physician???

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This will be the object of the follow up project.

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