

METABOLIC RADIOTHERAPY PLANNING – DOES IT MATTER TO RADIOTHERAPY TECHNOLOGISTS (RTT) PROFESSIONAL EXPOSURE?

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Outline

- ❑ Motivation
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- ❑ PET/CT Simulation Procedures
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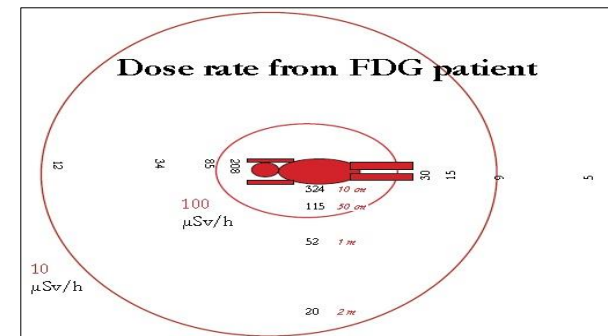
Motivation

Workflow and Radiation Safety Implications of ^{18}F -FDG-PET/CT Scans for Radiotherapy Planning

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➤ Radiation safety issues associated with PET/CT Simulations



Based on Benavir MM, Cronin BF, O'Doherty MJ Eur J Nucl Med. 2000;27:583-9

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Radiation safety issues with positron-emission/computed tomography simulation for stereotactic body radiation therapy

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PET/CT in Radiotherapy

- ❑ Staging disease and tumor volume for patient selection to treatment
- ❑ Defining biological target volumes (BTV)
- ❑ Evaluating tumor response following RT

PET/CT in Treatment Planning

- ❑ Revealing targets not detected by CT/MRI structural imaging
- ❑ Detecting additional regions outside the tumor volume defined by CT/MRI
- ❑ Revealing foci with increased biological activity within sub volumes of the tumor → dose painting

PET/CT in Treatment Planning



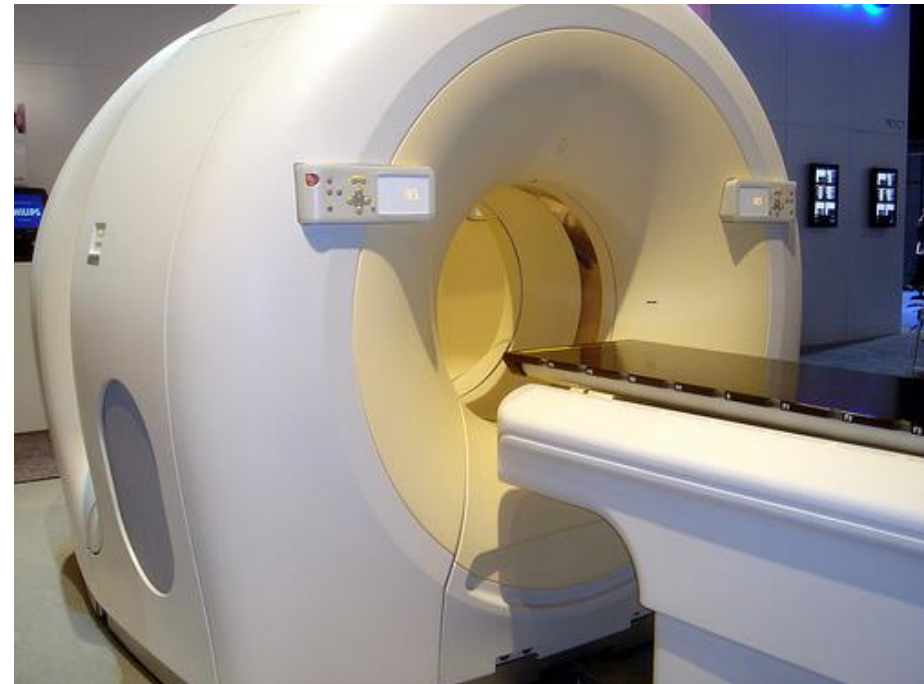
- Increasing the accuracy of target delineation including only metabolic active tissue

PET/CT Simulation Procedures

- ❑ PET/CT in Nuclear Medicine Unit
- ❑ 100 patients (since 2012)
- ❑ Setup and patient positioning done by RTTs
- ❑ Immobilization devices are site dependent (standard or customised)
- ❑ 10-15 min/patient positioning
- ❑ PET/CT planning after WB PET staging

PET/CT Specifications

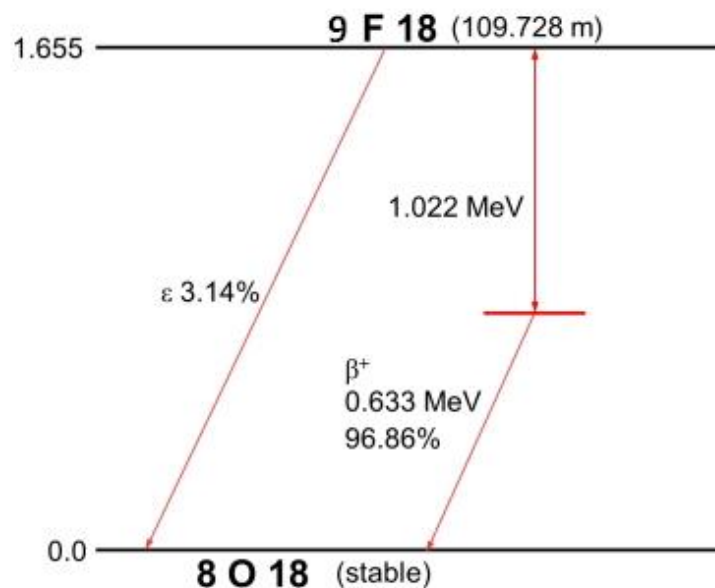
- ❑ Philips GEMINI
- ❑ ToF technology
- ❑ PET platform : Astonish TF
- ❑ CT platform : Brilliance
- ❑ Patient port : 70cm (PET and CT)
- ❑ Timing resolution : 495 ps
- ❑ Flat table top
- ❑ External laser system



PET RADIOPHARMACEUTICALS

- ^{18}F - FDG
- ^{18}F - Colina

- ^{18}F Physical half-life = 109.8 minutes



Material and Methods

- ❑ 14 patients / several pathologies
- ❑ Dosimeters:
 - ❑ TLD whole body dosimeter
 - ❑ Extremities (right and left ring fingers)
 - ❑ Eye (glabella)
 - ❑ Thyroid (skin over the thyroid region)
 - ❑ Electronical

EXPERIMENTAL DATA

Patient n.º	Weight (Kg)	Height (m)	Local	Activ._0 (MBq)	Wait time (min)	Activ._1 (MBq)	Activ._1 -15% (MBq)	H ₀ (µSv)	H ₀ -36% (µSv)
1	82	1,72	Pelvis	320,00	85	187,12	159,05	4,17	2,67
2	72	1,65	Pelvis	278,00	90	157,51	133,88	3,72	2,38
3	82	1,72	H&N	320,00	192	95,23	80,94	4,79	3,07
4	85	1,73	Pelvis	296,00	126	133,61	113,57	4,41	2,83
5	83	1,64	Pelvis	288,60	111	143,21	121,73	4,17	2,67
6	51	1,6	Thorax	207,57	160	75,60	64,26	3,17	2,03
7	73	1,69	Abdomen	270,10	153	102,82	87,39	4,12	2,64
8	66	1,68	Thorax	270,60	168	93,70	79,64	4,13	2,64
9	63	1,7	H&N	236,80	203	65,74	55,88	3,50	2,24
10	68	1,76	Pelvis	262,70	271	47,48	40,36	3,37	2,16
11	63	1,75	Abdomen	240,87	94	133,07	113,11	3,28	2,10
12	103	1,8	Pelvis	270,40	197	77,97	66,27	4,03	2,58
13	101	1,87	Thorax	400,30	239	88,54	75,26	5,55	3,55
14	61	1,68	Pelvis	235,70	131	103,09	87,62	3,54	2,27

Note: H₀ @ 1m and considering the patient as a “point source” (>2h after F-18 administration).

EXPERIMENTAL DATA

Accumulated dose <> 14 patients

TLD Dosimeter	Hp10 (mSv)	Hp0.07 (mSv)
Right ring finger	0,00	0,00
Left ring finger	0,00	0,00
Crystalline	0,00	0,00
Whole body	0,11	0,11
Thyroid	0,09	0,09
Electronic (EPD Mk2)	N.º of patients	Accum. Dose (μ Sv)
Abdomen	2	21
H&N	2	12
Pelvis	7	74
Thorax	3	10
Total (μ Sv):		117

DATA ANALYSIS

- ❑ Summed values of the H_0 column is the total accumulated theoretical dose.
- ❑ The total accumulated theoretical dose is 0,0358 mSv at 1 m.
- ❑ This value considers an average attenuation of 36% in the patient (AAPM TG108).
- ❑ From the Inverse Square Law, the dose at staff level (≈ 55 cm) is \approx **0,119 mSv**.
- ❑ The total accumulated dose in the electronic dosimeter is **0,117 mSv \pm 20%**.
- ❑ And the total accumulated dose in the TLD (whole body) is **0,110 mSv \pm 3,5%**.
- ❑ The dose/PET simulation is \approx **8,2 μ Sv**.
- ❑ Anually: $20 \text{ mSv/year} \div 8,2 \text{ μ Sv/simulation} \approx 2400 \text{ PET simulation/year}$.
- ❑ Maximum value of ≈ 10 PET simulation/day.

CONCLUSIONS

- Extremities doses → inconclusives
- Whole body dose → <<<< Annual dose limit
 $20000 \mu\text{Sv} / 8,2 \mu\text{Sv} = 2439 \text{ simulations/year}$

10 PET simulations/day

- Further investigation → high sensitivity dosimeter for dose extremities measurements

Acknowledgments

- Laboratório dosimetria Individual Medical Consult
- Interphysix - Equipamentos Técnicos, Unipessoal Lda

THANK YOU FOR YOUR ATTENTION

A large, modern, curved building with a light-colored facade and numerous rectangular windows. The building is situated on a grassy area with several young trees in the foreground. A large, white, 3D sign in the foreground reads "Champalimaud Centre for the Unknown". The sky is clear and blue.

Champalimaud Centre for the Unknown