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DOSIMETRIC STUDY OF PEDIATRIC PET/CT TESTS

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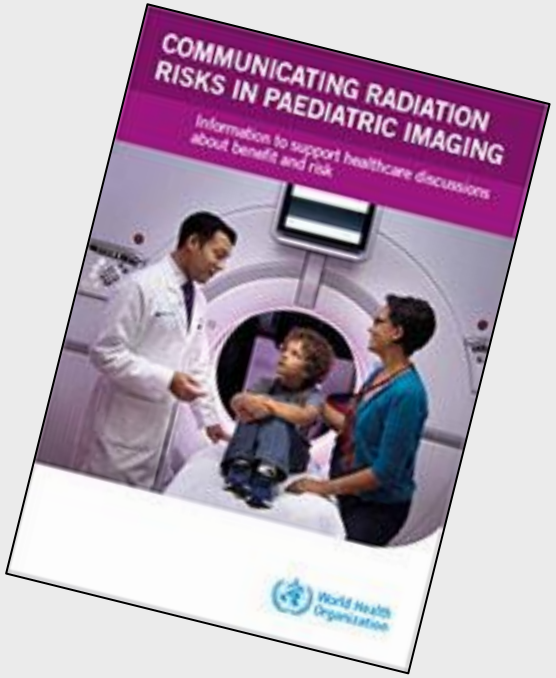
Introduction

- Since its introduction, **PET/CT** has gained increasing clinical acceptance as an important imaging diagnostic modality;

- The clinical applications of PET/CT have been expanding, mainly in oncologic diagnosis and management, but also for other clinical indications, leading to the increasing demand for PET/CT studies and more combined PET/CT scanners being installed in hospitals and clinics around the world.

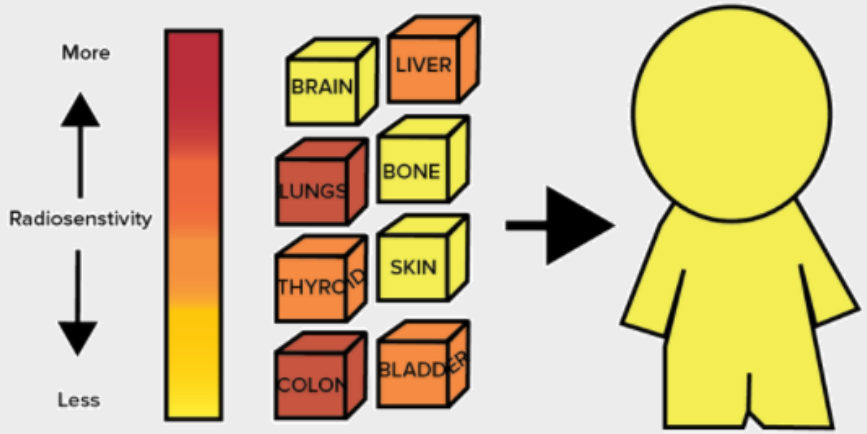
Introduction

- PET/CT examinations, especially those that include diagnostic CT, result in increased patient radiation exposure compared with a single CT or PET examinations.
  - Especially concerning for pediatric patients;
  - Children up to 10 years are two to three times more sensitive to radiation than adults and have many years of life remaining for the development of tumors.



Objective

- The aim of this study is evaluate and compare the absorbed and effective doses from PET/CT scan for patients of 2, 6 and 10 years using different phantoms.



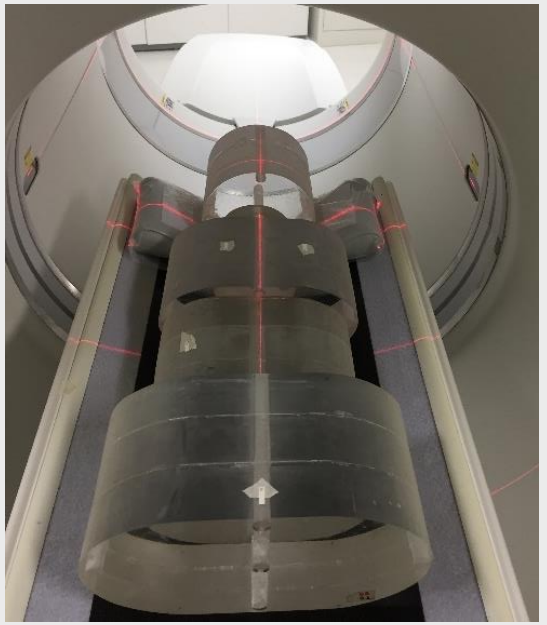
Materials and methods

- The experiments were carried out in the PET/CT of the CTMM-UFMG.
- This imaging center is equipped with a PET/CT Discovery 690 from GE.

Materials and methods

- To evaluate the Absorbed Doses (D_T) from the CT scan and calculate the amount of Activity (A) of radiopharmaceutical to be injected, volumetric phantoms built with PMMA were used, with dimensions similar to children at ages 2, 6 and 10 years.

2Y



6Y

10Y

Materials and methods

- The activity of ^{18}F-FDG to be injected may vary according to the patient mass and the detector sensitivity. The model proposed by ICRP 106 were used to calculate the amount of absorbed dose in the organs from the radioactivity injected, and thus determine the Effective Dose (E) to the patient.

- The protocol used to calculate the amount of Activity to be injected was 3.33 MBq.kg-1 (0.09 mCi.kg-1), this amount is commonly used in the service were the study was done, multiplied by the mass of each phantom, being:
  - 12.2 kg for 2Y
  - 24 kg for 6Y
  - 31 kg for 10Y

Materials and methods

- To measure the doses from CT scan, radiochromic film strips were used, placed inside the phantoms at points corresponding to the desired organs. Punctual absorbed dose values were obtained subtracting the BG recorded dose of the absorbed doses in the organs from CT scan.

(a) Non-irradiated film

(b) Irradiated film

Materials and methods

- The CT protocol analyzed were the commonly used in the service where the study was done, with diagnostic quality.

Parameters used in CT scanner	
Reconstruction	3.75 mm
Pitch	0.984
Rotation tube time	0.7 s
kV	120
mA	Automatic
mA range	50-400
Noise index	16.05

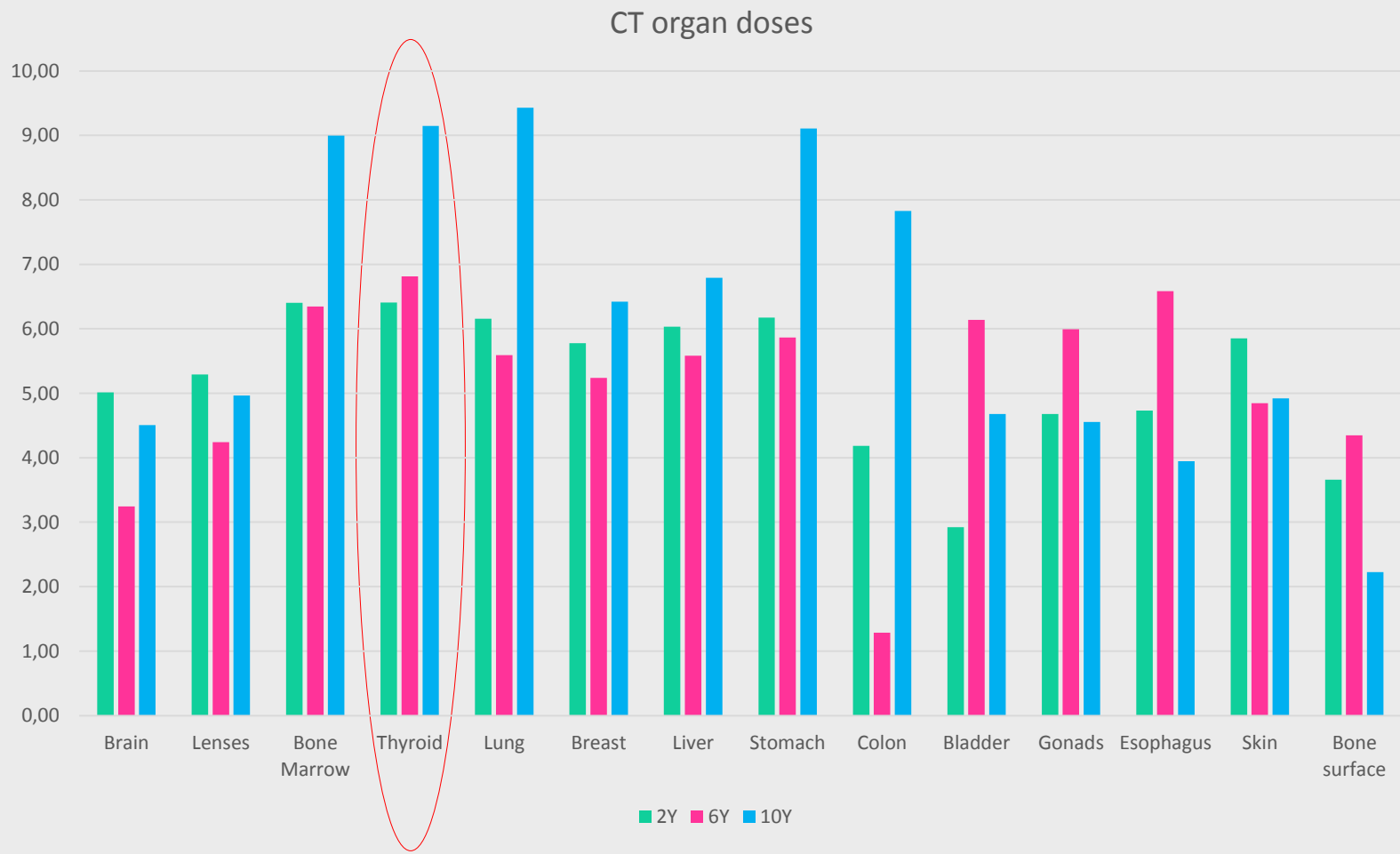
Results

Effective doses from ^{18}F-FDG PET

Phantom version	Effective Dose (mSv)
2 years	2.77 ± 0.15
6 years	3.90 ± 0.27
10 years	3.38 ± 0.25

Results

Doses from CT scan



Results

- The average of the absorbed doses from CT were similar for the 2 and 6 years old and were approximately 21% higher in the 10-year phantom.

- The differences found between the phantoms are explained by the distance scanned in each of them, being 50.35 cm for the 2 years-phantom, of 62.1 cm for the one of 6 years and of 73.9 cm for the one of 10 years.

- In addition, the CT has a dose modulating tool, i.e., the intensity of the X-ray beam varies according to the thickness of the patient.

Results

Effective Doses from CT Scan

Phantom version	Effective Dose (mSv)
2 years	9.77 ± 0.15
6 years	5.03 ± 0.16
10 years	5.69 ± 0.16

- When the effective dose is analyzed the ratio of increased radiosensitivity to lower ages is evidenced.
- The 2-year phantom had the highest effective dose when compared to other phantoms.

Results

Final Effective Dose

Phantom version	Effective Dose (mSv)
2Y	12.54 ± 0.15
6Y	8.94 ± 0.16
10Y	9.07 ± 0.16

- The **highest** effective dose value was found for the **2Y phantom**. Considering tissue radiosensitivity and also the fact of have more years of life for the development of radio-induced tumors, the concern for **optimization should be higher in this age group**. For the phantoms **6Y and 10Y the effective dose values are very close**.

Conclusions

- The final effective dose in patients submitted to PET/CT scan is higher than the other image modalities.
- It is important to emphasize that is necessary a careful evaluation in the choice to be performed with high image quality and consequently a higher dose for all patients, and not only in cases in which this protocol is essential.
- The use of appropriate image acquisition techniques and promoting the application of the principle of optimization and justification of practice are the basis of this study.

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Conclusions

- The importance of the optimization of the tomographic protocols is emphasized since diagnostic CT scan is responsible for higher contribution for the effective dose in the patient.

- The use of the individualized calculation proportional to body mass of radiopharmaceutical activity is also a primary factor in reducing the effective dose, avoiding unnecessary exposure.

- Knowledge of PET/CT equipment resources and how manage them is very important for the good use of this diagnose technology. So, professional training in radiological protection of patients can directly interfere in the choice of protocol and thus the dose to which these patients will be submitted.

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Thank you!

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