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Doses to medical workers operating in a PET/CT department after the use of new dynamic techniques.

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Abstract: Since new radiopharmaceuticals are used like [18F]-fluoro-3'-deoxy-3'-L-fluorothymidine and 18F fluoromethylcholine, also new dynamic techniques of imaging are used, measurements concerning the doses to medical staff are needed. The aim of this study was to measure the effective whole body dose of the personnel and compare them with the oldest. Estimation of equivalent dose for all members of the staff was monitored with the use of TLDs badges and electronic dosimeters. The duration of the study was year 2011 (983 patients). Concerning the nurses, we measured 10% increase in the wholebody doses and that is due to the longer time they spent near the patient (dynamic protocol). For technologist we measure 15-21% increase for they come near the patient immediately after administration. We can observe that there is an increase of the doses for technologists and nurses the numbers are significantly lower than the recommended annual dose limit by Euratrom 97/43.

Introduction:
The PET/CT applications have been continuously increasing for diagnostic procedures. Although such an increase is a positive trend for the benefit of patients, the associated risk of radiation exposure of staff needs to be properly evaluated.

Positron Emission Tomography is considered to be one of the most relevant diagnostic imaging techniques having peculiar characteristic to provide both functional and morphological information for the patient. The most commonly used radiopharmaceutical is 18 F- Fluorodeoxyglucose (18F-FDG). [1]

Due to the high-energy tracers emitting 511 KeV and considering the risks associating to ionizing radiation that have been derived from the past, special attention is needed when dealing with radiation protection aspects in a PET/CT facility [2]. Medical workers are exposed to ionizing radiation during the procedure of PET/CT. Since new radiopharmaceuticals are used like [18F]-fluorothymidine (FLT) and 18F fluoromethylcholine (FCH) new techniques of imaging are used and new measurements concerning the doses to medical staff are needed [3]. Different activities of F-18 FDG, FLT and FCH are used in our center [4].

The aim of this study was to measure the effective whole body dose of the personnel and compare them with the oldest measurements, a comparison before and after the use of new dynamic techniques. Our department was the first PET/CT department operated in Greece in 2004, and the authors investigated and recorded the daily radiation exposure of the staff since the first day of operation. [1]

Material and Method:
The estimation of equivalent dose from external dosimetry for all seven (7) members of the staff (2 nurses, 2 medical physicists, 2 technologists, and 1 doctor) was monitored with the use of TLDs
(TLD-100, LiF:Mg,Ti) badges and electronic dosimeters worn at the upper pocket of their overall photo 1. The average workload of the department is 6-8 patients per day [5].

Photo 1: TLDs badges and electronic dosimeters.

During the time of the study 983 patients were examined. In our department 18F-FDG, 18F-FLT, 18F-FCH is available in multi dose vials. The vial arrives to the department in a 7 cm thick lead shielded container and it is placed in the hot lab. The lead container is brought in the lead hood, a tailor made hood with 20cm lead shield. With the use of a tong the vial is been placed in the dispenser (15cm of lead) [6].

The radiopharmaceuticals used for imaging were obtained with the use of shielded dispenser system which includes a mirror at the top in order for the multidose vial to be fully covered.

At all time, one nurse, one medical physicist, one technologist and one doctor are operating in the department. [7]

Nuclear Medicine procedures require patient interaction relating to patients preparation administration of radioactive and non-radioactive medication or parental route, explaining the procedure comforting and reassuring the patients. [3].

The typical 18F-FDG procedure for a patient that undergoes a whole body scan is the following:

Patient is injected with the radiopharmaceutical lying in a bed in the waiting area and he/she is asked to wait for 50 minutes. Before the beginning of the examination, the patient is asked to empty the bladder. The PET/CT examination last for about 35 minutes and then the patient, after changing, leaves the department. [8]

On the contrast, when 18F-FLT or 18F-FCH procedures are performed, the injection takes place inside the PET/CT room, were a dynamic examination is been performed. Specifically 3 min acquisition data are collected for 30 min and afterwards one bed of 12 min duration is held.

Regarding the responsibilities for each worker, Medical Physicist is handling the multidose vial and the dose segmentation. The nurses involved in this study are responsible for the dose administration. Also, nurses monitor the patient through the 50 minute uptake procedure after the injection in which time they provide assistant to the patient if needed. When the FLT or FCH procedure is performed the injection is done inside the PET/CT room. [9]

The technologist duties include escorting the patient in the examination room and positioning the patient in the examination table. In cases of FLT or FCH procedures were dynamic examination is been performed, the technologist interacts with higher amount of radioactivity, since they are near to the patient at the exact time of the injection and not after the 50 min uptake time like in FDG examinations [10]. The technologist is also responsible for helping the patient after the end of the examination.

Data were collected day-to-day concerning the interaction of the staff during PET/CT procedures. The technologists and nurses that are operating in our PET/CT facility have experience in Nuclear Medicine procedures for more than 15 years and are trained and experienced interacting with radiopharmaceuticals [11]. During the course of this study the actions of each staff member were observed and recorded. Medical Physicists were responsible for collecting the data concerning the time spent by the staff at less than 2 meters from the radioactive source or from the syringe containing
the radiopharmaceutical or from the injected patient, as well as patient data concerning the administered activity and the patient status [1].

**Results:**

We compared the first six months of 2011 a period in which no FLT or FCH procedures were performed, with the second semester in which 50 FLT and 26 FCH examinations were performed. The average of FDG patients was the same for every day, and all patients, FDG-FLT- FCH received 330-390 MBq dose each [4].

The time spent near open sources was 1-3 min for the nurses and 6-9 min for technologist depending on patient mobility and character. [12]

Dose values of the PET/CT staff were collected monthly with the use of TLDs dosimeters that are measured from the Greek Atomic Energy Commission and daily with the use of electronic dosimeters that were recorded by the radiation safety officer (Medical Physicists). [3]

The whole body dose for the first six months for the medical workers were the following:

Nurse #(#1) received 1,3 mSv as a whole body dose and Nurse #(#2) received 1,1 mSv respectively. In figure 1 we can see the monthly whole body dose for Nurse (1) and (2).

For Medical Physicist #(#1) the dose value was 1,9 mSv and for Medical Physicist #(#2) was 2,2 mSv respectively. Figure 2 saws the monthly dose distribution to medical physicist.

Lastly, Technologist #(#1) received 1,1 mSv as a whole body dose and Technologist #(#2) received 1,4 mSv respectively.

![Figure 1](image1.png)

![Figure 2](image2.png)

![Figure 3](image3.png)

![Figure 4](image4.png)
After the use of FLT and FCH at the second semester, the doses were:

- Nurse #1 received 1.6 mSv and Nurse #2 received 1.4 mSv.
- Medical Physicist #1 received 1.95 mSv and Medical Physicist #2 received 2.19 mSv.
- Technologist #1 received 1.6 mSv, Technologist #2 received 1.8 mSv.

In figures 4, 5, 6 we can see the monthly distribution after the use of FLT and FCH.

Regarding the whole body doses for medical physicist we can see that there were no changes and that is because they do not interact with patients undergoing FLT and FCH procedures. Concerning the nurses presenting the quantitative correlation we measured a 17-20% (per cent) increase in the whole body doses and that is due to the longer time they spent near the patient, since FLT and FCH examinations interact to the patient for longer time. For the technologist we measure a 15-21% (per cent) increase and that is because they come in touch with the patient, not after 50 min like in FDG procedures, but they are near to the patient at the time of the injection.

**Conclusions**

From our results we can observe that although there is an increase of the doses for technologists and nurses the numbers are significantly lower than the recommended annual dose limit by Euratom 97/43.

**References**


