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Short communications

Personal dosimetry in the PET Centre Prague

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Abstract

This work is focused on radiation protection in the PET Centre Prague. The personal year dose equivalents of physicians, technologists and lab-technologists in the period 1997–2000 are presented. Dose equivalents are listed for each group as collective, mean and maximum dose equivalents and number of people in the evaluated group. There is an increase in the dose equivalents in 1999 when the PET scanner was installed. Later on, when personnel was trained and better local shielding was used, the increase is not much higher even though the number of patients investigated per day doubled. The radiation field measurements showed that the radiation dose equivalent rate outside the controlled area is on the background level of about 0.17–0.18 μSv/hour.

Key words: dosimetry, PET

Introduction

The increased use of positron emission tomography brings also radiation protection discussions oriented on the protection of hospital staff. There are studies comparing the radiation load of the personnel resulting from conventional SPECT radiopharmaceuticals and ^{18}F-FDG [1, 2], and studies concerning the organisation of work and location and construction of the rooms in the departments of nuclear medicine [2–4].

In August 1999 the first PET centre in the Czech Republic was established in Na Homolce Hospital. Until then, the personnel used to work mostly with ^{99m}Tc-radiopharmaceuticals and one SPECT camera. Suddenly the positron emitters (^{18}F-FDG) with the 511 keV annihilation photons were present in the energy spectrum. Seen from the dosimetric point of view, there were questions about how this would affect the personnel dose equivalents, how fast the people would become accustomed to the work with new radiopharmaceuticals and if any changes in the daily routine would be needed in order to diminish the radiation burden. Therefore the personal dose equivalents have been watched carefully and the radiation field (i.e. the dose equivalent rate) at different places of the department has been measured.

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Material and methods

To obtain a realistic overview of the personal dose equivalents, the people at the department were sorted into 3 groups:

— the lab-technologists, who work partly in the radioimmunoanalytical laboratory and partly in the radiopharmaceutical laboratory, but only preparing the ^{99m}Tc radiopharmaceuticals (^{18}F-FDG is delivered from an other company);

— the PET Centre technologists, who fill the syringes with the ^{99m}Tc radiopharmaceuticals and also ^{18}F-FDG (5 GBq ^{18}F-FDG delivered twice a day), sometimes may administer them to the patients, assist the physician during the administration and take care of the patients, help them at the camera, etc.;

— the physicians, who administer the radiopharmaceuticals to the patients and stay in contact with the patients when necessary.

All listed personnel is equipped with a film dosimeter (worn on the left side of the chest) to estimate the whole body dose equivalent, and with a thermoluminescence dosimeter (placed on a ring on the finger) to get an estimate of the dose equivalent obtained by hands. The Czech Personal Dosimetry Service (CPDS) evaluates both dosimeters. The evaluation period is 1 month and CPDS provides also a yearly estimate of dose equivalent.

The radiation field has been measured to make sure that the radiation level is reasonably low, especially in those rooms or places where the personnel stays longer time. The measurement was done by use of general-purpose gamma and X-ray survey meter FH 40G (ESM Erlangen) with a sampling time of 5 minutes. Brick walls around and inside the controlled area are covered (each side) with 2.5 cm barite plaster, the walls around the room designed for housing the PET scanner are covered with 2 x 5 cm barite plaster. The reception desk is built from a 10-cm concrete core. Doors contain 2.5 mm lead plates. The windows between the controlling room and investigation rooms are made of 55-mm thick lead glass. During the work with radiopharmaceuticals the personnel uses different types of local shielding (for loading ^{18}F-FDG into syringes, syringe shielding or transportation shielding). Some parts of the shielding have been developed at the PET Centre Prague [5].

Results

The number of SPECT investigations per year is 1500–1700, there were 240 PET investigations in 1999 (September till December) and 1150 in 2000. SPECT investigations are done between 7.00 a.m. and 3.30 p.m. and PET investigations are carried out between 7.30 a.m. and 7.30 p.m. PET scans are performed on CTI/Siemens scanner ECAT EXACT, about 80% of them are oncological whole body scans with administered activity 525 MBq ^{18}F-FDG per 70 kg patient. Dose equivalents resulting from these investigations are shown in Table 1.

Table 1. Whole body dose equivalents of the personnel measured by film dosimeter on the left side of the chest and dose equivalents measured by thermoluminescence dosimeter on fingers

Physicians SPECT + PET (since 1999)	Whole body				Hands			
	1997	1998	1999	2000	1997	1998	1999	2000
Collective dose equivalent [mSv]	3.45	2.51	8.02	10.61	1.5	1	15.23	110.39
Maximum dose equivalent [mSv]	1.69	1.38	2.73	5.00	0.5	0.5	7.36	72.28
Mean dose equivalent [mSv]	1.15	1.26	2.43	3.03	0.50	0.50	4.62	31.54
Number of physicians	3	2	3.3	3.5	3	2	3.3	3.5
Technologists SPECT + PET (since 1999)	Whole body				Hands			
	1997	1998	1999	2000	1997	1998	1999	2000
Collective dose equivalent [mSv]	10.35	11.84	28.67	31.72			76.36	170.94
Maximum dose equivalent [mSv]	4.2	5.48	8.45	8.23			26.66	102.19
Mean dose equivalent [mSv]	2.59	3.64	7.17	5.77			19.09	31.08
Number of technologists	4	3.25	4	5.5			4	5.5
Technologists (radioimmunoanalytical lab. + ^{99m}Tc radiopharmaceuticals)	Whole body				Hands			
	1997	1998	1999	2000	1997	1998	1999	2000
Collective dose equivalent [mSv]	3.5	4.5	5.37	4.1	49.01	53.47	64.16	96.25
Maximum dose equivalent [mSv]	1.49	1.71	1.28	0.66	27.08	21.72	21.63	33.95
Mean dose equivalent [mSv]	1.17	1.50	1.49	1.03	16.34	17.82	17.82	24.06
Number of technologists	3	3	3.6	4	3	3	3.6	4

The Table shows by category (physician, technologist, lab-technologist) the collective dose equivalent, the number of persons who share the dose equivalent and the maximum dose equivalent in the category. Maximum dose equivalent allowed by Czech regulations is 500 mSv on hands per year, 50 mSv on whole body per year and 100 mSv during the following 5 years together

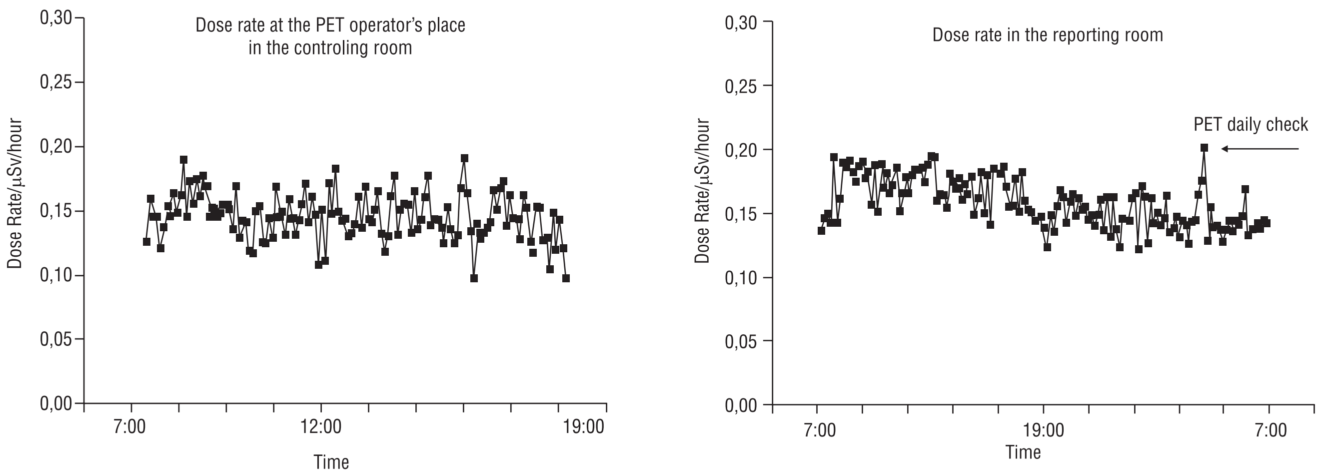

Figure 1. The dose equivalent rate in the controlling room at the PET operator's console and in the reporting room (measured during 24 hours). It can be seen that the background in the reporting room is slightly higher during the PET investigations and there is a peak in dose rate during the night when the daily blank scan is acquired.

The dose equivalent rate background in the building is about 0.17 μSv/hour. This rate is measured in the physicians' offices, daily room for technologists, reception desk and in the controlling room at the operators' consoles (during working hours). In the reporting room (adjacent to the PET scanner room) the measured dose equivalent rate is 0.18 μSv/hour, which is still the background level. The rate in the controlling and reporting rooms can be seen in Figure 1.

Discussion

It can be clearly seen that PET investigations caused a dramatic increase in both whole body dose equivalents and hand dose equivalents for all categories of personnel. The increase between 1999 and 2000 is not as high as one would expect due to the number of patients because the personnel were trained and local shielding protecting hands was installed [5]. Also all personnel minimised the stay in the controlled area (and possible contact with the radioactivity) and shared the work with ^{18}F-FDG. The preliminary results for 2001, when 1800 PET investigations (50% more than in 2000) are planned, show that the dose equivalents will be similar to 2000.

Conclusions

The start of PET investigations meant an increase of personal dose equivalents at the department, however no radiation limits given by Czech regulations have been exceeded. It is reasonable that technologists and physicians handling patients rotate at the department between PET and SPECT, which helps to split the total dose equivalent among more people. The maximum dose equivalents in Table 1 show that there is still some reserve in work sharing because the aim is to bring the maximal dose down as close as possible to the average dose.

The radiation field at the department is not homogeneous, but outside the controlled area only background is measured (0.17 μSv/hour), respectively 0.18 μSv/hour in the room for reporting. Therefore we can conclude that the shielding on the "macroscopic scale" is so far good.

Work with positron emitters requires careful preparation and planning of the department concept. After PET facility installation, continuous monitoring of workers and radiation field at the department is necessary and can lead to further improvement of local shielding.

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