

Radiation dose to the nuclear medicine nurses

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ABSTRACT

Background: People who have been administrated radiopharmaceuticals could be a source of radiation to their relatives, medical nurses, and people who are in contact with them. The aim of this work was to estimate radiation dose received by nuclear medicine nurses.

Materials and Methods: In this study, the dose rates at various distances of 5 – 100 cm from 70 patients, who were administered diagnostic amounts of ²⁰¹Tl-Chloride and ^{99m}Tc-MIBI, were measured using an ionization chamber. For determination of external radiation dose to the nurses, three different time intervals were used for measurements.

Results: The maximum values of external dose rates of ²⁰¹Tl and ^{99m}Tc-MIBI were 11.2 μSv/h ±2.3 and 43.1 μSv/h ±11.9 respectively, at 5cm from the patients. Significant exposure from patients after injection of ^{99m}Tc-MIBI was limited to the day of administration. Departure dose rate of ²⁰¹Tl fell gradually; so, it became significant by 3 days after administration. Maximum and average absorbed dose of nuclear medicine staff from ²⁰¹Tl, was 4.6 and 2.7 μSv/h, and for ^{99m}Tc-MIBI was 18.1 and 9.8 μSv/h in each scan.

Conclusion: Significant exposure from the patients is limited to the few hours after administration, therefore patients should be recommended to urinate frequently before leaving the nuclear medicine department. *Iran. J. Radiat. Res., 2004; 2 (2): 59-62*

Keywords: External radiation, absorbed dose, radioactive patients.

INTRODUCTION

Patients who have received radiopharmaceuticals become a source of contamination and exposure for people, who come in contact with them, such as nuclear medicine technologists, nurses, visiting relatives (Shin-yin and Douglas 1992). Thallium Chloride and Technetium-Metoxo isobutyl isonitrit (MIBI) are the most frequently used radioisotopes in Iran, which have been produced in cyclotron department at Nuclear Research Center for Agriculture and

Medicine (NRCAM) (Haji Saeid and Afarideh 1995). Excretion rate, biokinetic models and dose rates per unit activity of this radiopharmaceuticals have been presented in ICRP 1991, but practical excretion and dose rate measurements have been considered only in few papers (Sattari 2001, Mountford 1991, Konishi 1994). The aim of this research has been to study the absorbed radiation dose to nuclear medicine nurses.

MATERIALS AND METHODS

In Rajai Heart Center (Tehran), 70 patients were selected for this study. These patients were divided into two groups: a) Patients who had received ²⁰¹Tl-chloride; b) Patients who had received ^{99m}Tc-MIBI. Table 1 gives data on the patients and their administrated activities. For all subjects, name, age, type of compound and

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Table 1. Administrated activity of each radionuclide to patients.

Radionuclide	Average age	Age range	Number of patients		Activity (MBq)
			Male	Female	
²⁰¹ Tl-chloride	51.8± 9.0	36-68	28	11	111
^{99m} Tc-MIBI	55.8±12.1	30-76	19	12	370

other relevant details were recorded. No diuretics and β - blocking agent were given to any patient during this study. Each administrated activity was measured using the radioisotope dose calibrator (Capintec-CRC-30 RC). For determination of external radiation dose, a small ionization chamber (Minera model SM2000x) was used. The chamber was calibrated by a standard source of ⁵⁷Co and ¹³⁷Cs in the Secondary Standard Dosimeter Laboratory (SSDL) department in NRCAM. Dose rate was measured at distances of 5, 10, 50 and 100cm from the left side of each patient's naval, while the patient was laid supine on a hospital bed. The measurements were done at 3 different time intervals: 30 minutes, 3 hours and 5 hours after injection. In order to measure the external dose rate as a function of time, the measurements were repeated 24 and 48 hours after injection.

For determination of external radiation to the nurses, the radiation dose in three different time intervals were measured, first at the time of injection, second half an hour later, during the first scan and third during the second scan. The period of the contact to the patient was measured practically. Maximum and average absorbed dose of nuclear medicine staff through and after a complete scan is shown in tables 2 and 3.

RESULTS AND DISCUSSION

The dose rates were measured during three days after the injection. The dose rates variations in different distances from the patients versus time is shown in figures 1 and 2. Three hours after *administration* of ²⁰¹Tl, the average dose rates at the distances of 10, 50 and 100 cm from

Table 2. Average and maximum absorbed effective dose of staff in a ²⁰¹Tl Scan from patients at different distances.

Distance	10 cm		50 cm		100 cm	
Average contact time (min)	13		18		10	
	Mean	Max	Mean	Max	Mean	Max
Effective Dose (μ Sv)	1.8 ± 0.4	3.2	0.7 ± 0.2	1.1	0.2 ± 0.04	0.3

Table 3. Average and maximum absorbed effective dose of staff in a ^{99m}Tc-MIBI Scan from patients at different distances.

Distance	10 cm		50 cm		100 cm	
Average contact time (min)	13		18		10	
	Mean	Max	Mean	Max	Mean	Max
Effective Dose (μ Sv)	6.0 ± 1.3	11.0	3.1± 0.8	5.7	0.7 ± 0.15	1.4

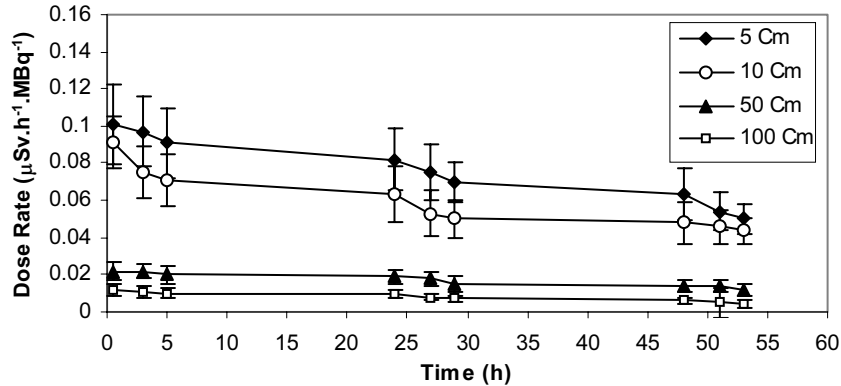


Figure 1. Mean external dose rate per unit activity of ²⁰¹Tl as a function of time.

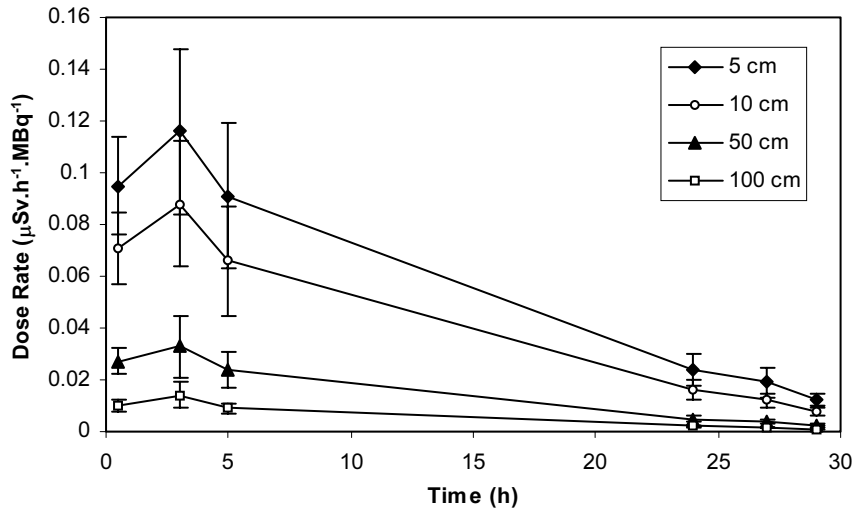


Figure 2. Mean external dose rate per unit activity of ^{99m}Tc-MIBI as a function of time.

patients, were 8.3, 2.4 and 1.2 $\mu\text{Sv/h}$ respectively. These values are in close agreement to the mean corresponding values of 9.2, 2.5, and 0.9 $\mu\text{Sv.h}^{-1}$ obtained by Mountford *et al.* (1989). The maximum departure dose rates at these distances were 0.14, 0.04 and 0.02 $\mu\text{Sv h}^{-1} \text{MBq}^{-1}$ respectively. The external radiation dose rate from ²⁰¹Tl fell gradually, so that by 48 hours after the administration it was about half of the obtained value immediately after administration. After injection of ^{99m}Tc-MIBI, a rising of the external dose within 1-3 hours (due to deposition of the activity in the heart) was observed. The maximum departure rate per unit activity at the distances of 5, 10, 50

and 100 cm was 0.12 $\mu\text{Sv}^{-1}.\text{MBq}^{-1}$, 0.09 $\mu\text{Sv}^{-1}.\text{MBq}^{-1}$, 0.03 $\mu\text{Sv}^{-1}.\text{MBq}^{-1}$ and 0.01 $\mu\text{Sv}^{-1}.\text{MBq}^{-1}$ respectively. The departure dose rates from the patients' administrated ^{99m}Tc-MIBI were significant from point of view of the radiation protection only during the first few hours. This observation has a good agreement with result reported by Konishi in 1994.

According to ICRP, the maximum exposure for nuclear medicine staff is 55 μSv per day.

It should be considered that the absorbed effective dose to the staff is not only taking place through exposure from the patient, but other sources such as syringe, radiopharmaceuticals,

which come as increment, are effectible. Therefore the absorbed dose from these sources should be added to the patient dose. These points are also needed to be studied thoroughly.

In conclusion for ^{99m}Tc -MIBI cardiac studies, significant exposure from the patients are limited to the few hours after administration. In case of ^{201}Tl administration the dose rates from the patients continues to decrease until three days after the injection. The patients should be recommended to urinate frequently and to urinate before leaving the nuclear medicine department. These data could be considered as a base for calculating exposure dose in close contact during working hours of nuclear medicine staff (Harding *et al.* 1990).

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REFERENCES

- Haji Saeid S. and Afarideh H. (1995). Cyclotron and their applications. The NRCAM cyclotron facilities. Proceeding of the 14th international conference, Cape Town, South Africa. p.128.
- Harding L.K., Harding N.J., Warren H., Mills A., Thomson W.H. (1990). The radiation dose to accompanying nurses, relatives and other patients in nuclear medicine department waiting room. *Nucl. Med. Commun.*, **11**: 17-22.
- Harding L.K., Mustafa A.B., Roden L., Williams N. (1985). Dose rates from patients having nuclear medicine investigation. *Nucl. Med. Commun.*, **6**: 191-194.
- ICRP (1987). Radiation dose to patients from radiopharmaceuticals, publication 53. Annals of the ICRP, 18, Nos 1-4, Pergamon Press, Oxford.
- ICRP (1991). Addendum to Publication 53. Radiation dose to patients from radiopharmaceuticals. Publication 62. Annals of the ICRP, Vol.22, No. 3, Pergamon Press, Oxford.
- Konishi E. and Kusama T. (1994). Urinary excretion and external radiation dose from patients administrated with radiopharmaceuticals. *Radiat. Proect. Dosim.*, **54**: 61-64.
- Mountford P.J., O'Doherty M.J., Froge N.I., Jefferies A., Coakley A.J. (1991). Radiation dose rates from adult patients undergoing nuclear medicine investigation. *Nucl. Med. Commun.*, **12**: 767-777.
- Mountford P.J. and Coakley A.J. (1989). Radioactive patients. *Br. Med. J.*, **298**: 1538-9.
- Sattari A. (2001). External radiation and urinary excretion from the patient administrated thallium-201 and technetium-99m - metaisobutylisonitryl. *Radiat. Protect. Dosim.*, **95**: 59-61.
- Shin-Yin H. and Douglas R.S. (1992). Radioactive contamination in hospitals from nuclear medicine patients. *Health Phys.*, **62**: 462-466.