RADIATION EXPOSURE AROUND PATIENTS AFTER ADMINISTRATION OF Tc-99m-DPD OR Tl-201-CHLORIDE

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INTRODUCTION

In connection with the diagnostic use of radiopharmaceuticals in nuclear medicine it often is asked if the radiation exposure by patients after administration of the radioactive substances might endanger their sorroundings and to what extent countermeasures are necessary for protection (e.g. establishment of special waiting rooms, hospitalization of the patients in special bedrooms as it is normal in nuclear medicine therapy). We examined quantitatively the radiation exposure caused by two of the most frequent nuclear medicine investigations: bone scintigraphy with Tc-99m-Dicarboxypropan-Diphosphonat (-DPD) and cardiac studies with Tl-201-chloride, respectively.

MATERIAL AND METHODS

Dose rate measurements were performed in 0.5m, 1m and 2 m distance from the surface of the bodies of two groups of patients, within the first 4 h after they had received 600±30 MBq of Tc-99m-DPD or 100±10 MBq Tl-201-chloride, in time periods of 30 minutes. In the case of Tl-201-chloride the measurements were repeated 24 hours (in some cases in addition up to 370 hours) after administration. Both groups consisted of 16 patients.

We used three calibrated dose rate detectors of the same type (Berthold LB 133®) in a stationary geometry. The patients were sitting on an chair, and the sensitive counting volumes of the detectors were positioned in about the height of the sternum (ventral).

RESULTS

In Table 1 the initial values of the dose rates are listed. Figure 1 shows the time course of the measured dose rates. Monoexponential functions were fitted. In the

Table1. Initial values of the dose rates in μGy/h (mean ± SD; n=16)

Distance	Tc-99m-DPD	Tl-201-chloride
0.5 m	19,7 ± 3,9	3,82 ± 1,04
1 m	5,66 ± 0,75	1,18 ± 0,29
2 m	1,85 ± 0,13	0,30 ± 0,08

case of Tc-99m-DPD the dose rates decreased with an effective half-life of 2.3 hours; in the case of Tl-201-chloride the effective half-life was estimated to be 60 hours. The corresponding biological half-lives thus were 3.7 hours and 330 hours, respectively. The total error in all cases was about 10%.

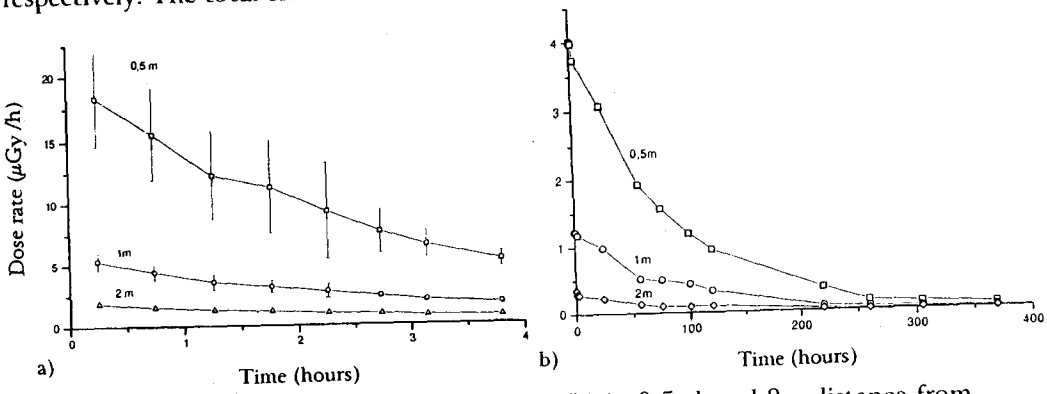

Figure1. Time courses of the dose rate (in μGy/h) in 0.5, 1 and 2m distance from patients after administration of 600 MBq Tc-99m-DPD (Figure 1a) and 100 MBq Tl-201-chloride (Figure 1b), (mean ± SD; n=16).

DISCUSSION

Integrating the dose rate functions the dose around the patients can be calculated for any time period after the administration of the radiopharmaceuticals (Figure 2). Thus the possible radiation exposure of other patients, attendents, and nurses in the surrounding of the "radiating" patients were estimated. Let us discuss five cases of possible exposure to other persons.

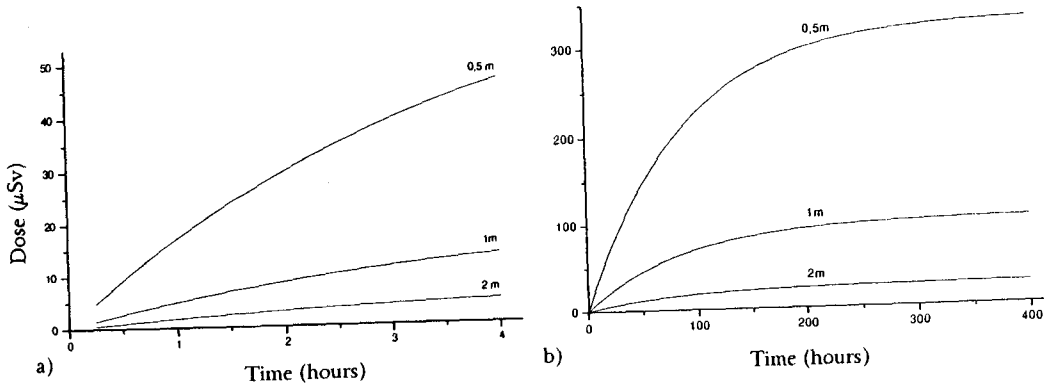

Figure 2. Courses of the radiation doses (in μSv) in 0.5, 1 and 2m distance from patients after administration of Tc-99m-DPD (Fig.2a) and Tl-201-chloride (Fig.2b), calculated from the mean values of the dose rates.

Tc-99m-DPD

The maximum dose around a patient after application of 600 MBq Tc-99m-DPD was calculated to be 67 μGy in 0.5m (19 μGy in 1m, 6.7 μGy in 2m) distance (1).

Case A: After application the "radiating" patient is sitting for 4 hours in a distance of 0.5m beside another patient. This is the longest time period a patient has to wait for bone scintigraphy. The exposure of the neighbour patient then may amount to 46 μSv, corresponding to 3% of the maximum permissible additional annual exposure to non-radiation workers.

Case B: After bone scintingraphy a patient is realeased from the hospital or is situated as in-patient in a ward. During a permanent stay in a mean distance of 1m an accompanying person or a nurse may be exposed by a dose of 7 μSv, corresponding to <0.5% of the permissible annual dose.

Tl-201-chloride

In the case of Tl-201-chloride the maximum doses in 0.5m, 1m and 2m distance from the patient are 330 μSv, 102 μSv and 26 μSv, respectively.

Case C: Due to a cardiac investigation a patient is sitting permanently from ½ to 4 hours after administration of Tl-201-chloride in a distance of 0.5m beside another patient. Then the exposure to this patient is 13 μSv, corresponding to <0.9% of the permissible annual dose.

Case D: After a cardiac investigation a patient is released from the hospital or is situated in a ward. During a permanent stay in a mean distance of 1m during the whole following day the exposure to a relative or to a nurse is <26 μSv, corresponding to <1.8% of the maximum permissible annual dose.

Case E: The patient (Case D) is hospitalized for two weeks or longer in the same sick-room. In this case from a permanent stay in 1m distance a nurse may receive a dose of 105 μSv. Considering a working time of 40 hours per week, this maximum dose ist reduced to 25 μSv, corresponding to <1,7% of the permissible annual dose.

As a result even under very restrictive assumptions the doses to the environment caused by "radiating" patients are far below the limits set by radiation protection regulations. There is no necessity to separate patients from other patients in a special waiting area after administration of the radioactive agents. This result is confirmed by studies of other researching groups (2), (3).

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