

# Unexpected dose to the daughter of a patient treated with iodine-131 for hyperthyroidism

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## Abstract

Patients treated with radioiodine for thyrotoxicosis and hyperthyroidism are a source of radiation exposure and represent a potential radiation hazard for the people in their environment. Doses to the relatives can be estimated from dose rates of the patient or measured with a proper dosimeter. Sensitive thermoluminescent dosimeters have been used to measure the doses absorbed by the family members of patients treated with iodine-131 (<sup>131</sup>I) for thyrotoxicosis. In the present case, a 12 year old daughter of a female patient, aged 41 years, treated with 592 MBq of <sup>131</sup>I, received a dose of 7.79 mSv during the first seven days. This value is well above the dose constraints proposed by the International Commission on Radiological Protection, i.e. 1 mSv for children and fetuses and 3 mSv for carers. Obviously, the patient and her daughter didn't follow the given restrictions. That was unexpected for a 12 year old child who didn't need special care and was able to understand and follow certain instructions. It is the opinion of the authors that if there are children in the family of a hyperthyroid patient treated with <sup>131</sup>I, they should stay in another house for at least a week. If this is impossible for social reasons, hospitalization of the patient should be considered, although treatment of thyrotoxicosis is held in an out-patient basis.

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## Introduction

The therapeutic use of unsealed radionuclides can result in the exposure of people in the environment of the patients and there is a need for guidance regarding the radiological protection of members of the public, relatives and caregivers from such exposures. Radiation doses to these people result mainly from external exposure although internal contamination via inhalation, direct contact with patient's fluids (sweat, urine or saliva) and general environmental pathways like the sewage system can not be excluded [1].

The International Commission on Radiological Protection proposed the concept of dose constraints as a process for optimization and has provided recommendations on the criteria for releasing of patients from the hospital after treatment with unsealed radionuclides [2]. The implementation of these guidelines differs among various countries [3, 4].

There is a significant number of papers in the literature covering the subject of doses received by family members of these patient-groups but almost all of them agree that, provided the recommendations are followed, doses to all patients are below the dose constraints i.e. 1 mSv for the public, children and fetuses and 3 mSv for the informed caregivers and adult relatives [5-8].

We present a case of a child living in the environment of a hyperthyroid patient treated with iodine-131 (<sup>131</sup>I) who received a high radiation dose.

## Case description

In the Medical Physics Department of Aristotle University of Thessaloniki a survey is being carried out in collaboration with the Nuclear Medicine Department of AHEPA University General Hospital, measuring the dose to the relatives of patients treated with <sup>131</sup>I. Treatment of benign thyroid disease with <sup>131</sup>I is performed in an outpatient's basis, so people in their environment are inevitably exposed to radiation.

Thermoluminescent dosimetry (TLD), using sensitive dosimeters (LiF: Mg, Cu, P) which have a minimum detectable dose of 1μSv, has been applied. The TLD were read with a Harshaw QS apparatus, model 3500. They were worn by the family member(s) who lived with the patient, thus measuring the real absorbed dose.

A female patient 41 years old was treated for hyperthyroidism with 592 MBq of <sup>131</sup>I. According to the department's protocol the patient was released two hours later. Detailed writ-

ten instructions, regarding her behaviour and contact with other people were given to her before leaving the hospital. The patient gave her informed consent for her daughter to participate in our survey and filled a questionnaire concerning the situation at home. At that time the dose rate at 1m was 38  $\mu\text{Sv/h}$ . After 96 h and 168 h the dose rate was 14.5  $\mu\text{Sv/h}$  and 7.2  $\mu\text{Sv/h}$  respectively. An exponential curve was fitted to the function of dose rate vs time ( $\text{DR}=38.532e^{-0.01t}$ ,  $r=0.998$ ).

The daughter of the patient was 12 years old, wore two hospital name bands containing two TLD dosimeters for a total of 7 days. The first wrist band was replaced on the day-4 and the dosimeters were read immediately. An exceptionally high mean dose value was recorded (5.57 mSv) and the patient was informed at once, to avoid further close contact with her daughter and take all other necessary precautions. In spite of our warnings dosimeters worn from 4-7 days also revealed a high dose of 2.22 mSv. Thus, the child had received a total dose of 7.79 mSv within the above period. According to the above DR calculated function, even if the child stayed continuously 1 meter from her mother during these 7 days she would have received only 3.06 mSv. Our actual measurements indicated that in spite of our recommendations, the child often stayed at a distance shorter than 1 meter from her mother.

## Discussion

Doses to the relatives of patients treated with  $^{131}\text{I}$  depend more on the behaviour of the patient and their relatives than on the residual activity. In fact, according to the preliminary results of our ongoing study, no relationship was shown between the dose rate from the patients and the doses actually absorbed by the relatives. If certain restrictions are followed, pre-set dose constraints can be met. On the other hand, if for social or economic reasons these restrictions cannot be met, the doses to the family members can reach impermissible levels.

In our case the dose received by the daughter of the patient (7.79 mSv) was far beyond the dose limit of 1mSv proposed by ICRP. Doses to the children have been also reported by other authors, though their results are not readily comparable to ours because TLD were worn for different time periods [7, 9]. High doses have been reported for younger children who need taking care of. At the age of 12, one would anticipate that the daughter of our patient would understand and obey certain rules. Detailed questions imposed to the mother after the measurements, revealed that for psychological reasons, the child during the day stayed close to her mother and often woke up at night to sleep in her mother's bed. Obviously none of our guidelines had been followed.

Another concern was the dose absorbed by the thyroid gland of the daughter after possible internal contamination with  $^{131}\text{I}$ . Although adults are fairly resistant to thyroid cancer induction, children show an excess absolute risk of  $1.6-2.3/10^4$  person-year Gy [10]. If the parent holds in her/his arms or even worse, kisses her/his child, then the child comes in contact with the patient's fluids and is possibly contaminated. It has been reported that 20 out of 31 relatives had detectable thyroid activity and the mean dose to the thyroid was 0.2 mSv [11]. Unfortunately, it wasn't possible to measure the child for thyroid activity, because the family left the city immediately after.

*In conclusion*, this case suggests that the decision to hospitalize or release as an outpatient a hyperthyroid patient who has been treated with  $^{131}\text{I}$ , should be determined on an individual basis. Release criteria should not be linked only to the residual activity in the patient but take into consideration specific parameters, like patient's contact with the other family members, space availability in the house, cost of hospitalization. If there are children in the family, it may be necessary to accommodate them in another house for at least a week.

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