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Investigation of the level of safety for out-patients treated with high dose of ^{131}I in Sudan

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HIGHLIGHTS

- We model one hospital which cover about 90% of ablative radioiodine therapy.
- We study the effective doses for family members of ^{131}I outpatients.
- We report the highest values of contaminated surfaces in bedrooms and bathrooms.
- We report the necessity to formulate new instructions for hyperthyroid out-patients.

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ABSTRACT

The aim of this study was to describe and analyze the patterns of radiation exposure of contacts of Sudanese patients treated with radioactive ^{131}I on an out-patient basis and post discharge after high dose ^{131}I therapy, and also to compare the family members' results with dose constraints proposed by the European Commission (EC). Thermoluminiscent dosimeters (Model TLD-100 H) were used to estimate the effective doses for 40 family members of fifteen patients treated with ^{131}I. The family members wore a TLD in front of the chest for 10 days. The effective dose ranged from 0.23 to 6.74 mSv (mean 1.75 mSv). These findings may be considered when establishing new national guidelines concerning radiation protection and release of patients after a treatment with radioiodine therapy.

1. Introduction

Radioactive iodine (^{131}I) is a widely utilized therapy for patients with thyroid disorders through doses commonly ranged from 100 to 7400 MBq (2.7–200 mCi), whereas larger activities are used to ablate thyroid remnants or to treat metastatic diseases in patients with thyroid cancer. These larger activities increase the direct exposure hazard to other individuals; furthermore the patients become a source of contamination because of ^{131}I secreting in body fluids such as sweat and saliva and excreted into urine and feces. From the economic point of view, the cost of admission and hospitalization for those patients treated with ^{131}I is high, and is increasing with more improvement in medical services. Accordingly, many practitioners accept the use of a high dose of ^{131}I on an outpatient basis with proper instructions to the patient as well as to his family members, and this was endorsed by relevant professional societies in the United States and international commissions. This is an alternative strategy helping to reduce the cost of hospitalization, which is estimated at 450 US dollars per day in Sudan. The United State Nuclear Regulatory Commission (NRC) recommendation (USNRC, 1997) allows the release of patients immediately after ^{131}I therapy if the total effective dose equivalent from the patient to an individual does not exceed 5 mSv (0.5 rem) in any 1 year, while the dose limits according to the European Commission (EC) (European Commission, 1998) for relatives willingly helping the patient should not exceed 1 mSv for children, 3 mSv for adults up to 60 years of age, and 15 mSv for adults more than 60 years of age.

The aim of this study was to describe and analyze the pattern of radiation exposure of the contacts of Sudanese patients treated with radioactive ^{131}I on an out-patient basis after high dose ^{131}I therapy and also whether the exposure levels are in the accepted international limits or whether there are some contacts who are over-exposed to radiation.

Caldwell and Ehrlich (1999) stated that outpatient therapies with relatively high doses of ^{131}I can be performed safely.

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They advised that care should be taken to ensure that the patient's home environment is suitable and that the patient can understand and comply with the precautions.

Pace-Asciak et al. (2007) stated that high dose ^{131}I therapy can be given safely on an outpatient basis provided that patients can comply with precautions, understand the risks involved and have a suitable home environment. Moreover there are several papers in the literature concerning the use of high dose ^{131}I on outpatients with proper instructions to the patient and his family members (AlMaskery and Bererhi, 2009; Barrington and et al., 1999; Mathieu et al., 1997; Monsieurs and et al., 1998**?**). Most of the published studies present that some doses to the family members are below the proposed dose constraint, while some cases present family members having received higher radiation doses than the proposed dose limit.

2. Materials and methods

This study was carried out at the Radiation and Isotopes Center Khartoum (RICK) in Sudan. Since 1999, the RICK has been the main radiation facility in all parts of Sudan, for the treatment of about 90% of ablative radioiodine therapy. Since 2009, a new nuclear medicine center at Shendi University has been established to cover about 10% of ablative radioiodine therapy, but it was not involved in this study.

The administration of all activities was undertaken at the Nuclear Medicine Department overseen by a physician and a radiation-safety officer (RSO). Before administration, patients were asked if they would be interested in participating in this study and whether they were willing to comply with medical and radiation-safety guidelines. The radiation-safety precautions included the consideration of acceptable living conditions, the distance from the patient's residence to the hospital ($<$ 100 km) and the sewage system in the area of patient's housing. Whereas the sewage system in Sudan is primitive and the network of this system is limited in the scope of the capital, Khartoum only, most areas outside Khartoum used wells as a substitute system for sanitation which does not guarantee sewer overflow and protection from radioactive contamination. Furthermore, the RSO insured that patient does not live with a pregnant woman, has a private toilet, has a private room, has a private transportation option, and lives with children under the age of 12 who are able to stay away from the home for up to the first 5 days following the administration of the ^{131}I therapy. In addition the RSO made sure that patient would be able to sleep alone in a private room for up to 14 days and understood the potential radiation risks to others.

Fifteen patients, 10 women and five men out of 66, were enrolled for ablative radioiodine therapy at the Nuclear Medicine Department in the RICK. All patients had previously undergone a total thyroidectomy for papillary or mixed papillary-follicular thyroid cancer. The mean administered dose for the treatment of thyroid cancer patients was 3996 MBq of ^{131}I. Table 1 shows the distribution of patients according to the administered dose of ^{131}I. The patients' average age was 42 years, ranging from 23 to 61 years.

The outpatients were released after signing a formal consent as stated in the US Code of Federal Regulations (USNRC, 1997). Upon discharge, the patients and relatives were given additional radiation safety instructions in order to minimize the transfer of radiation to others, especially children and pregnant women. Subsequently, the patients were released to return home by taxi or a private vehicle. The relatives at home were informed not to stay very close to the patient, and if so, to maintain a distance between them and the patient of more than 2 m and to reduce time of staying to less than 10 min up to 1 h. In addition, patients were informed to not share any eating tools with family members and to use a separate toilet with emphasis on flushing and cleaning the toilet after each use.

The physician and radiation-safety officer conducted home visits three times. The purpose of the first visit, prior to treatment, was to assess the housing and socioeconomic factors which were not assessable in the hospital. The second visit was to distribute the thermoluminescence dosimeters (TLDs) to the family members the day before ^{131}I adminstration and to provide the patient and family with written instructions of ^{131}I therapy. Depending on ^{131}I activity an appointment was arranged for the third visit to collect the TLDs, to measure household radiation contamination and to interview the patients and family members about following instructions.

The contamination monitor model como 170 was used in this study to measure the surface contamination in a patient's home and the Geiger-M ü ller Model 190 detector (Victoreen Co., Austria) with a β–γ probe was used to measure exposure rates. Four TLDs were distributed in different living areas of each patient's home and 40 family members of the patients were supplied with a chest TLD, model TLD-100 H (GR200A), which contained 4.5 mm chips of lithium fluoride (LiF:Mg,Cu,P) to measure the whole-body radiation dose when accompanying the patient after radioiodine administration. The TLD Reader PCL3 (Fimel, Vélizy, France) was calibrating on a regular basis. The combined standard uncertainty of a dosimetry system is less than 10%. Control TLDs were kept separately to measure the background. The background readings were subtracted from the dose readings of the relatives.

Table 1
Distribution of female and male patients according to the administered dose of ^{131}I.

Sex	3700 MBq	4440 MBq	5550 MBq
Male	4	0	1
Female	8	1	1

3. Results and discussion

Administered activities and exposure rates in the patients measured precisely at the time of radioiodine administration are shown in Fig 1. Table 2 presents the effective dose to family members of the thyroid cancer patients treated with ^{131}I and measured with TLD dosimeters. The ages of the family members range from 18 to 53 years and the TLDs were worn by them for 10 days. All children in each family stayed away from the home for up to the first 5 days from ^{131}I adminstration. The range of the effective dose varied from 0.23 mSv to 6.74 mSv (mean 1.75 mSv). The TLD showed a low effective dose indicating that the relatives

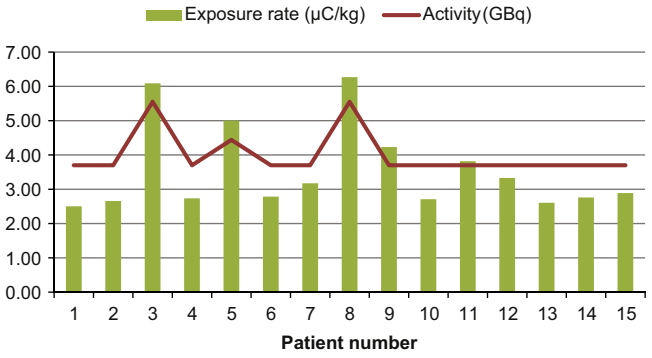

Fig. 1. Patients' administered activity and exposure rates measured in the first day of ^{131}I therapy.