Volume 13, No 1 | International Journal of Radiation Research, January 2015

Radiation doses from ^{131}I treated hyperthyroidism patients versus life style: - a survey

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► ***Original article***

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Revised: April 2014
Accepted: May 2014

Int. J. Radiat. Res., January 2015; 13(1): 67-72

DOI: 10.7508/ijrr.2015.01.009

ABSTRACT

Background: Radioactive iodine is widely used for the treatment of various thyroid disorders. Safety issues are often a source of worry and anxiety for the patients, their families and comforters. The patients are advised to restrict their social and work related activities. The work presented in this study describes the results of a structured survey conducted on patients visiting our hospital. ***Materials and Methods:*** The total number of patients inducted was 419. The patients were asked about their housing conditions, family set up, number of children, travelling modes and travelling time back to home. The hospital leaving exposure rates from the patients were measured and radiation doses to others were estimated. ***Results:*** Patients residing in joint family system were 93%. The measured dose rate at one meter were 5.7, 11.0, 15.7, 18.7, 23.0 and 28.0 μSvh^{-1} for the administered ^{131}I activity of 185, 370, 555, 740, 925 and 1100 MBq respectively. The corresponding radiation doses to others from the patient were estimated as 0.76, 1.53, 2.29, 3.06, 3.82 and 4.58 mSv. The patients using public transport were 78.04% whereas 21.96% used private transport. There were 11.93% of the patients with no children and 88.07% of the patients had children residing with them. It was observed that 1.67% of the patients had no toilets at home and 98.33% had multiple toilets available. ***Conclusion:*** The radiation protection advice and regulatory requirements need to be formulated keeping in view the individual patient life styles and other living conditions.

Keywords: *Radioactive iodine, hyperthyroidism, protection advice, radiation doses, life styles.*

INTRODUCTION

The radioactive iodine (RAI) is widely used for the treatment of various thyroid disorders since long. In most of the countries the differentiated thyroid cancer (DTC) is treated by admitting the patients in hospital whereas hyperthyroidism patients are treated on outpatient basis [1-7]. The safety issues for the patients, their families, comforters, hospital staff and the general public arise with either treatment approach. The radiation hazards are more in treating cases of hyperthyroidism as compared to DTC due to shorter effective half life of ^{131}I in the later application. Therefore at the time of release of the patient from medical confinement, the retained radioactivity in DTC patients is much lower thus causing low risk of radiation exposure to other people. In case of hyperthyroidism treatment the administered radioactivity is much lower as compared to DTC treatment but radiation doses to others are more due to high uptake of RAI by these patients [8-11]. The patients undergoing such treatments are advised to restrict their social and work related activities in order to reduce radiation exposure to others, when they return to their families in community [12-15]. This

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[DOI: 10.7508/ijrr.2015.01.009]

radiation protection advice is usually based on residual activity or radiation exposure level and is not specific to an individual patient circumstances or socioeconomic conditions. These advices are generally formulated by the developed countries and are adopted as such in most of the developing countries. In actual practice the compliance to the protection advice depends on life styles and living conditions of the patients. Therefore keeping in view this aspect of RAI treatment, an interview based structured survey was conducted on patients visiting nuclear medicine department of the Institute of Radiotherapy and Nuclear Medicine (IRNUM) Peshawar, Pakistan for the treatment of hyperthyroidism. The aims of this study were to: survey the life styles, living conditions, compliance to safety instructions and to estimate radiation doses to family members, care givers and fellow travelers from the patients undergoing RAI treatment for hyperthyroidism.

MATERIALS AND METHODS

The patients were asked about their living conditions, family set up, number of children, mode of travelling and travelling time back to home from the hospital. The total number of patients inducted in the present survey was 419. The data collected was tabulated and reviewed for completeness. A calibrated dose of ^{131}I (185-1100 MBq) was administered to the patients. The exposure rate from the patient was measured at a distance of one meter from standing position with a hand-held pressurized battery operated β γ survey meter, Victoreen Model 450P, calibrated from secondary standard dosemetry laboratory, Islamabad. The dose rate was recorded in units of μSvh^{-1}. The patients were instructed to sleep alone, drink fluids liberally and avoid prolonged close personal contact with others for the first 2 days. The patients and family members were told that they could resume normal activities thereafter [12-14]. The estimated radiation doses to the maximally exposed person were calculated using equation 2 given in United States Nuclear Regulatory Guide 8.39 [16].

RESULTS

Three hundred and eighty five patients (93%) resided in joint and 29 (07%) in separate family system as shown in table 1. It was observed that 15.27 % of the patients were males and 84.73% were females with age wise distribution shown in table 2.

The measured hospital leaving dose rates at one meter from the patients were 5.7, 11.0, 15.7, 18.7, 23.0 and 28.0 μSvh^{-1} for an administered RAI activity of 185, 370, 555, 740, 925 and 1100 MBq respectively. The corresponding radiation doses to others from the patient at one meter using occupancy factor of 0.25 were calculated as 0.76, 1.53, 2.29, 3.06, 3.82 and 4.58 mSv as shown in table 3.

The survey showed that 4.77, 17.66, 22.91, 24.10, 12.66 and 17.90% patients had accommodation consisting of one, two, three, four, five and more than five rooms respectively as shown in table 4.

It was observed that 78.04% patients used public and 21.96% used private transport for travelling back to home following RAI administration. The radiation doses to others during travelling were calculated at 0.1m and 1m

Table 1. Family status (N=419).

Status	No of patients (%)
Joint Family	390 (93)
Separate Family	29 (07)

Table 2. Age and sex distribution of patients*, **.

Age (Years)	No. of Patients (%)
<16	3 (0.7)
17 to 28	36 (8.59)
29 to 40	161 (38.42)
41 to 50	119 (28.4)
51 to 60	67 (15.9)
>60	33 (7.8)

*15.27 % of patients are males
** 84.73 % of patients are females

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Table 3. ^{131}I administered vs average radiation doses.

S. No.	^{131}I activity (MBq)	No. of patients (%)	Average leaving dose rate at 1 meter (μSv/h)	Average Dose* to others at 1 meter (mSv)
1	185	12 (2.88)	5.7	0.76
2	370	18 (4.3)	11	1.53
3	555	99 (23.62)	15.7	2.29
4	740	233 (55.6)	18.7	3.06
5	925	47 (11.21)	23	3.82
6	1100	10 (2.3)	28	4.58

* Average doses to total decay (t=∞) to other individual exposed to the patient at one meter using occupancy factor of 0.25.

Table 4. Status of Patients in relation to No. of rooms in joint / separate system.

No. of rooms in home	No. of Patients (%)	Patients living in Joint Family System	Patients living in Separately
1	20 (4.77)	18	2
2	74 (17.66)	69	7
3	96 (22.91)	90	7
4	101 (24.10)	96	4
5	53 (12.66)	46	4
More than 5	75 (17.90)	71	5

distance and plotted against travelling time as shown in figures 1 and 2 respectively. It was observed that radiation doses to others at 1m and 0.1m with administered ^{131}I radioactivity of 185, 555 and 1100 MBq increased linearly with the travelling time.

It was also observed that 1.67% of the patients had no sanitary arrangements at home and they used open space in the fields as toilet. The patients residing in localities where there are comparatively better sanitation arrangements had one (31.74%), two (36.04%), three (17.42%) and more than three (13.13%) toilets available as shown in table 5.

The survey showed that 88.07% of the patients had children and out of these 82.33% lived in joint family system whereas 5.73% lived separately. The number of children and the family status showed that 17.18%, 31.50% and 33.65% patients had 1-3, 4-6 and more than 6 children respectively lived in joint family system while 2.86%, 1.91% and 0.95% patients had 1-3, 4-6 and more than 6 children respectively and they lived in separate family system as shown in table 6.

DISCUSSION

This study was carried out in an effort to emphasize the formulation of radiation protection guidelines for the patients undergoing RAI treatment for thyrotoxicosis, in accordance with their life style and living conditions.

The patients treated for hyperthyroidism

Table 5. Sanitary status of patients.

No. of Toilets in home of Patients	No. of Patients (%)
Open without flush	07 (1.67)
With one flush	133 (31.74)
With two flush	151 (36.04)
With three flush	73 (17.42)
More than three flush	55 (13.13)

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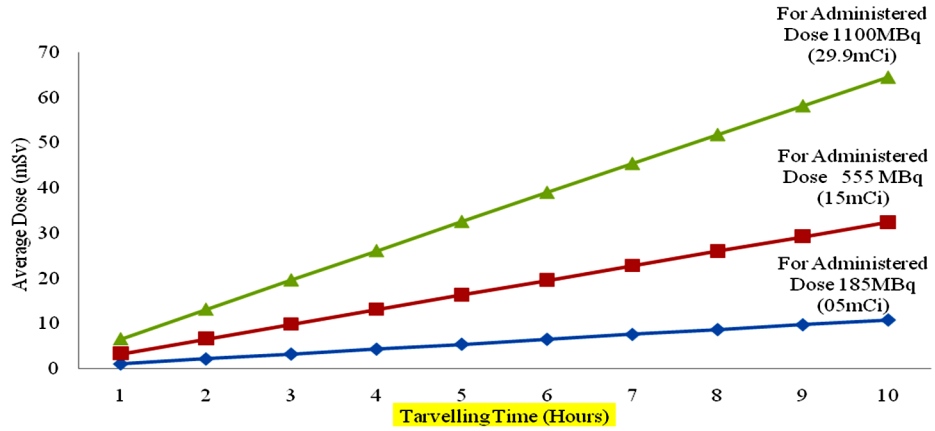

Figure 1. Radiation Doses (mSv) at 0.1m Vs Travelling Time (Hours).

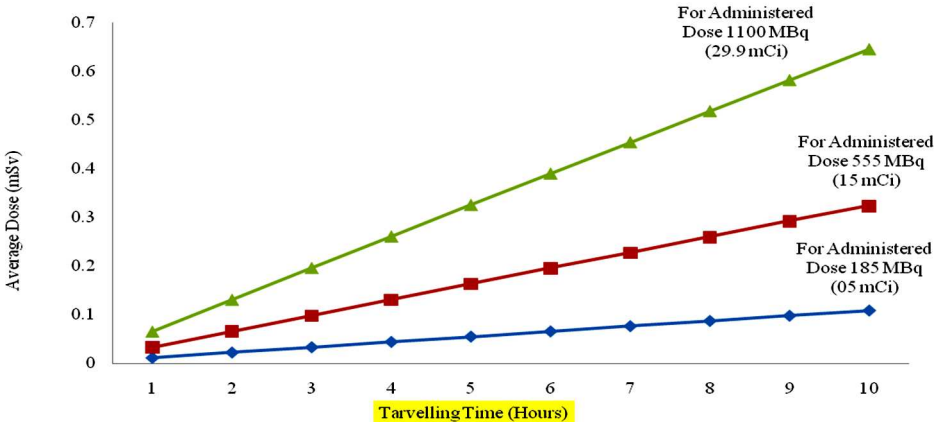

Figure 2. Radiation Doses (mSv) at 1m Vs Travelling Time (Hours).

Table 6. Children status vs family system.

Children Status	Joint Families (%)	Separate Families (%)
Without Children 50 (11.93)	45 (10.74)	05 (1.19)
With Children 369 (88.07)	345 (82.33)	24 (5.73)
Up to 3 Children 4 to 6 Children 7 and above	72 (17.18) 132 (31.50) 141 (33.65)	12 (2.86) 08 (1.91) 04 (0.95)

with RAI (^{131}I) are advised certain restrictions on behavior in order to ensure the radiation safety of all other individuals with whom they may come into contact. Generally it is assumed that the patients are unlikely to create a hazard to other persons. A dose limit of 5 mSv and 1 mSv had been recommended for caregivers and others depending upon the nature and type of their interaction with the patient [17]. The compliance to the safety instructions depends upon patient's literacy level in general and patient living conditions and life styles in particular [18,20].

The overall literacy level of the survey region is 37.26 % [21] which reflects patients low decision making capacity, health education, grasping and understanding the course of RAI treatment. It was observed that most of the patients were not aware of the radioactive nature of their treatment and were unable to comprehend that they would emit radiations which would be harmful for other people. The low literacy level affects the capacity of the patients to comply with the safety instructions like avoiding prolong contacts and sleeping alone for initial few days.

The life style of the patient undergoing RAI treatment plays a vital role in compliance with safety instructions. In view of socioeconomic and

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cultural reasons 93% of the patients inducted in the survey lived in joint family system. This aspect coupled with the low literacy level requires the patients receiving RAI treatments to comply with the instructions strictly.

The restriction on mode of travelling back to home is an important factor in RAI treatment especially when 78.96% of the patients used public transport for travelling back to home from the hospital. In low and middle income countries (LMIC) like Pakistan, the tertiary care hospitals with RAI treatment facility are usually situated in big cities with large patients catchment areas. The patients need longer travelling time back to home following RAI treatment. These patients pose more hazards if they travel in public transport system. Therefore patients needing longer travelling time should use private transport for journey back to home from the hospital. The regulatory authorities need to reassess the situation with respect to private or public mode of travelling for the patients while recommending patient release guidance levels for RAI treatment. In Pakistan the regulatory authority recommends radioactivity based guidance level of 1100 MBq for ^{131}I [22], whereas United Kingdom department of health and social security, prior to change in approach to that based on 5 mSv or 1mSv, recommended 1100 MBq limit for the patient using private transport and 555 MBq for those using public transport following RAI treatment [23].

Another factor that needs to be evaluated is the home environment in a socioeconomic sense such as family system, presence of children, available number of rooms, type and quality of sanitary installation in the house which should be such as to allow the patient and his family to comply with the safety instructions received from the hospital. The radiation doses from the patient to others, for total decay ($t=\infty$) at one meter using occupancy factor of 0.25 for RAI administered were well within recommended dose limit of 5 mSv for adult care givers. However for patients residing in single room accommodation along with children in a joint family system, the dose limit of 1 mSv is unlikely to be adhered to. This aspect becomes more important where a very large percentage of the patients (82.33%) having children live in joint family system as was observed in the present survey. Similarly the sanitary conditions of the patient at home are important to protect the family members from radioactive contamination and associated external radiation exposure.

In conclusion the results of the survey indicate that radiation protection advice and other requirements need to be formulated keeping in view patients socioeconomic status, life style and living conditions as these factors directly affect their capacity, ability and understanding the course of treatment.

Conflict of interest: *Declared none*

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