EFFECTIVE DOSES TO FAMILY MEMBERS OF PATIENTS TREATED WITH RADIOIODINE 131

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Abstract – Purpose: **The purpose of this study was to evaluate the effective dose to family members of thyroid cancer and hyperthyroid patients treated with radioiodine 131; also to compare the results with dose constraints proposed by International Commission of Radiological Protection (ICRP) and Basic Safety Standards (BSS) of the International Atomic Energy Agency (IAEA).**
Material and methods**: for estimation of effective doses at sixty family members of thirty thyroid cancer and thirty hyperthyroid patients treated with radioiodine 131, the thermoluminiscent dosimeters, Model TLD 100, were used. Thyroid cancer patients were hospitalized for three days, while hyperthyroid patients were treated on out-patient basis. The family members wore thermoluminiscent dosimeter in front of the torso for seven days.**
Results: **The radiation doses to family members of thyroid cancer patients were well below recommended dose constraint of 1 mSv. The mean value of effective dose was 0.21 mSv (min 0.02 - max 0.51 mSv). Effective doses, higher than 1 mSv, were detected at 11 family members of hyperthyroid patients.. The mean value of effective dose at family members of hyperthyroid patients was 0.87 mSv (min 0.12 - max 6.79)**
Conclusion: **After three days of hospitalization and detailed given oral and written instruction, thyroid carcinoma patients maintain not to exceed the proposed dose limits. Hyperthyroid patients present a greater radiation hazard than thyroid carcinoma patients. The estimated effective doses were higher than the effective doses at family members of thyroid carcinoma patients. These findings may be considered when establishing new national guidelines concerning radiation protection and release of patients after a treatment with radioiodine therapy.**

Keywords **– radioiodine 131, effective dose, TLD, relatives**

1. INTRODUCTION

Many types of cancer and some other non-malignant diseases can be treated with radiations emitted by radionuclides. The unsealed radionuclides, that are injected, ingested, or inhaled, and which move through the body, are radiopharmaceuticals. This can localize in body tissues until they decay or they can be eliminated through various pathways, such as sweat and saliva and excreted into urine and feces. The radionuclides used for radiopharmaceutical therapy are usually relatively short-lived beta emitters. Most of these radionuclides also emit photons, which usually contribute minimally to the treatment dose, but produce an undesirable radiation field emanating from the patient. The most frequently used radiopharmaceutical for treatment of thyroid diseases, such as Thyroid Cancer and Hyperthyroidism, is the radioactive iodine 131. It has very high success rate in treatment of patients with thyroid diseases and it has also proven to be safe and a relatively inexpensive treatment modality. The treatment renders the patient radioactive. The patients, treated with radioactive iodine 131 present a radiation hazard to other individuals such as hospital staff, the patient's family and members of the public with whom a treated patient may come in close contact. This situation can be overcomed by imposing restriction on the behavior of the patient, to minimize the dose to close relatives and other individuals. In 1991, the International Commission of Radiological Protection (ICRP) [1] has recommended a radiation constraint of 1 mSv/year to the general population.

According to Basic Safety Standards Directive [2], the dose limits to the general public are not valid for "exposure of individuals, who are knowingly and willingly helping, other than as part of their occupation, in the support and comfort of in-patient and our-patients undergoing medical diagnosis or treatment". Proposed dose constraint from the BSS is: 0.3 mSv per episode for public, 1 mSv for children, for the adults up to sixty years the dose constraint is 3 mSv and for adults more than 60 years old it is 15 mSv. The implementation of this guideline differs among various countries. In the Republic of Macedonia about 50 thyroid cancer patients are treated on in-patient basis and approximately the same number of hyperthyroid patients is treated ambulatory on out-patient basis. According to the local hospital rule and the old guidelines, the maximum given activity to hyperthyroid patients, treated on out-patients basis, is 1110 MBq. The new, not yet established guidelines, proposed to reduce the maximum given activity to hyperthyroid patients, treated on out-patient basis, from 1110 MBq to 555 MBq. This group of patients presents great radiation hazard to their family members. Upon discharge from hospital, the patients as well as their family members were given brief radiation safety instructions. The aim is to minimize the transfer of radioactive material to persons coming in close contact with the patient. There are several papers in the literature concerning the subject of doses received by family members of thyroid cancer and hyperthyroid patients [3-8]. Most of the published studies agree that doses to the family members are bellow the proposed dose constraint of 1 mSv. But there are also several papers [5, 9] that present cases where children or other persons have received higher radiation doses than proposed dose limit and usually it is case with hyperthyroid patients and their relatives. This study was undertaken to measure the effective doses to family members of patients treated with radioiodine 131 for thyroid diseases at our nuclear medicine centre.

2. PURPOSE

The main purpose of this study was to estimate the radiation exposure to family members of patients treated with radioiodine 131 either for thyroid carcinoma or hyperthyroidism. The other purpose was to use the results to identify necessary restrictions to ensure recommended dose constraint proposed by ICRP and BSS from the IAEA.

3. MATERIALS AND METHODS

The study population comprised thirty family members of the same number of thyroid cancer patients and thirty family members of thirty hyperthyroid patients. The total number of people included in the study was hundred and twenty. The administered dose for treatment of Thyroid cancer patients ranged from 3700 MBq to 5550 MBq of ^{131}I. Mean administered dose was 3539 MBq. Twenty six patients received 3700 MBq, two patients received 4440 MBq and two patients received 5550 MBq radioiodine 131. They were hospitalized three days after administration and the dose rate was measured every day at distance of 0.25 m, 0.5 m, 1.0 m and 2.0 m by medical physicist. The dose rate measurements were performed with calibrated survey meter "mini-rad" series 1000, Morgan. When the level of 8 μSv/h at 2m was reached the patients were released from hospital. Upon discharge, the patients were given radiation safety instructions for their further behavior, in order to minimize the transfer of radiation to persons coming in close contact with them, especially children and pregnant women. Their relatives wore the TLD for one week and they were informed not to stay very close to the patient; and if so, to reduce the time of staying. It was suggested to maintain the distance between them and patient more than 2.0 m and to reduce time of staying less than 10 minutes up to one hour. Hyperthyroid patients were treated with 185 MBq to 1295 MBq of radioiodine 131. Mean administered dose activity was 683 MBq. Ten patients were diagnosed with *Autonomous adenoma*, eight with *hyperthyroidism*, six with *Struma Diffuse Toxic*, two with *Struma Nodular Toxic* and one patient was follow up with *Ca. papillarae* as well as one patient with *Morbus Basedow syndrome*. External dose rate measurements were performed at the same distance as Thyroid cancer patients fifteen minute after administration of therapy. After that they were released from hospital. The patients were interviewed and informed on the research aims by medical physicist and physician. They signed an agreement for receiving a therapy and all patients and their relatives feel positive about participating in the study. Family members groups were consisted of 12 female and 18 male person in the hyperthyroid group and 24 male and 6 female in the thyroid cancer group. Their age varied from 15 up to 80 years. The effective dose measurements were done with thermoluminiscent dosimeters, model TLD 100, which contains hot pressed chips from lithium fluoride (LiF:Mg,Ti) with 3 mm^2 square, encapsulated between two sheets of Teflon 10 mg/cm^2 thick and mounted on an aluminium substrate with-bar code and within shielded filter holders (type 8814 Harshaw). A detection threshold of a dosimetry system is 0.0054 mSv. TLD's were most appropriate to estimate radiation because the amount of ionizing radiation is directly proportional to the effective dose [10]. Actually it was estimated Hp (10). These types of dosimeters have photon energy response for gamma rays that ranges from (15 keV- 3MeV) (IEC 1066). The TLD Reader and Cards are calibrating on regular basis. The combined standard uncertainty of a dosimetry system is less than 15%. The control TLD was kept separately to measure the background. The background readings were subtracted from the readings of estimated effective doses to relatives TLD's.

4. RESULTS AND DISCUSSION

4.1. Thyroid cancer patients

Table 1 presents the effective dose to relatives of the thyroid cancer patients treated with radioiodine 131, measured by TLD dosimeters. They have worn the TLD for one week. The sum of the effective dose varied from 0.02 mSv to 0.51 mSv. At three family members the TLD showed value 0 mSv and the explanation was that patients continue to be isolated from others after they had left the hospital for one week period of time.

Table 1. Effective doses to family members of Thyroid cancer patients

No.	mSv	Sex	Age (y)
1	0.05	m	28
2	0.00	m	35
3	0.00	m	26
4	0.27	f	38
5	0.00	m	46
6	0.16	m	35
7	0.02	f	50
8	0.43	m	35
9	0.32	f	33
10	0.23	f	73
11	0.31	m	32
12	0.25	m	70
13	0.17	f	60
14	0.20	m	44
15	0.15	m	40
16	0.40	m	40
17	0.51	m	70
18	0.08	m	40
19	0.43	m	40
20	0.06	m	41
21	0.33	f	60
22	0.02	m	41
23	0.15	m	61
24	0.20	m	65
25	0.41	m	40
26	0.17	m	38
27	0.23	m	56
28	0.37	m	60
29	0.02	m	58
30	0.35	m	48
Mean	**0.21**		

The mean value of the effective dose to spouses of thyroid cancer patients is 0.21 mSv.

The figure 1 presents the effective doses to relatives of thyroid cancer patients versus proposed dose constraint for adults of 3 mSv and 15 mSv for older than 60 years according BSS. The family members' age varied from 28 years up to 73 years. The results were very impressive. All family members were well below the recommended dose constraints even below 1 mSv (recommended dose for children by BSS). The gained results agreed with the previously published paper by Buchan et al. and prove that the protocol used in performing radioiodine therapy for thyroid cancer patient is done on safety way. Three days of hospitalization and dose rate measurements should be continued. It is recommended to install an additional seven days of sleeping separately and avoiding close contact to other people, children and pregnant women [11]. Giving written instructions on the further behavior of the patients at home will improve a process of optimization in radiation protection to family members, public and environment. Mathieu et al. reported the dose to family members and children of thyroid cancer patients, and in all cases the measured doses were lower than 0.5 mSv [6].

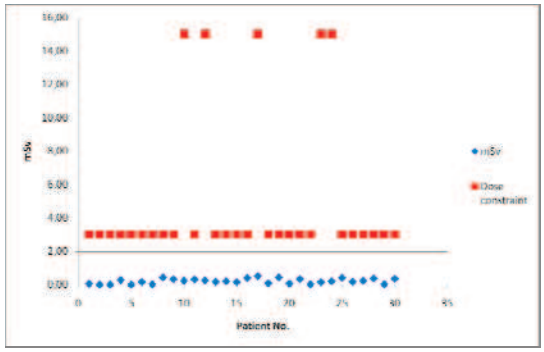

Figure 1. Effective dose to relatives of Thyroid cancer patients vs. Dose Constraint of 15 mSv and 3 mSv

4.2. Hyperthyroid patients

Table 2 presents the effective doses to relatives of the hyperthyroid patients treated with radioiodine 131 as measured by TLD dosimeter. They have worn the TLD for one week period.

There were 12 female and 18 male relatives. The mean value of the effective dose for the relatives of the hyperthyroid patients was 0.87 mSv. The range of the effective dose varied from 0.12 mSv to 6.79 mSv. At three patients spouses were measured value 0 mSv, and the explanation was that the patients stayed in different room and most of the time were away from home. Only the spouse of patient number 18 received the highest remarkable dose with value 6.79 mSv. The explanation was that the woman did not follow the given recommendation. She stayed very close to her husband all the time after he received the therapy. With further analysis, we found that it was woman aged 69 and according to BSS for the adults aged more than 60 years the allowed dose constraint is 15 mSv. Eleven family members received effective doses higher than 1mSv but less than 3 mSv.

On the figure 2 are presented the values gained from all hyperthyroid patients vs. Dose Constraint from the BSS. All values, except one, are below 3 mSv. The results presented in this study confirm the results of the other studies by Culver et al., stating that the doses for relatives of hyperthyroid patients are higher than the doses for relatives of thyroid cancer patients. This observation is due to the lower retention and the faster wash – out of the iodine 131 activity from the body of the thyroid carcinoma patients, in spite of the

higher administered activity. The hyperthyroid patients were treated on out-patient basis. The thyroid cancer patients after received activity were hospitalized for three days in an isolation room. That is one of the explanations for the higher doses to family members of hyperthyroid patients. The other reason for the differences of the effective doses to family members is that thyroid cancer patients retain less iodine as a result of the minimal thyroid tissue left after surgery. The given oral and written instructions were same, either for hyperthyroid or thyroid cancer patients. The restriction time is different (seven days for thyroid cancer patients and three days for hyperthyroid patients) and this information is usually given orally by the physicians. Even the radiation doses to hyperthyroid family members are within recommended limit; the values are higher in comparison with the doses of family members from thyroid cancer patients. Although the recommended dose limits are generally well met among the family members of thyroid cancer patients as well as hyperthyroid patients, the higher doses of the last one are related to higher ^{131}I retention by the gland and justify more extended and stringent restriction periods [6].

Table 2. Effective doses to family members of Hyperthyroid patients

No.	mSv	Sex	Age (y)
1	1.25	m	63
2	0.00	m	40
3	0.00	m	29
4	0.78	f	44
5	0.23	m	45
6	0.52	m	41
7	0.23	m	52
8	0.12	m	39
9	1.02	f	44
10	1.14	m	58
11	0.52	m	80
12	0.54	m	40
13	0.17	m	32
14	0.16	m	56
15	0.48	m	70
16	1.90	m	55
17	0.33	f	52
18	6.79	f	69
19	0.21	m	56
20	1.23	m	66
21	0.38	f	33
22	0.40	f	44
23	0.21	m	57
24	0.00	m	40
25	0.51	f	43
26	1.25	f	57
27	1.48	f	50
28	1.32	f	42
29	1.70	f	47
30	1.17	f	60
Mean	**0.87**		

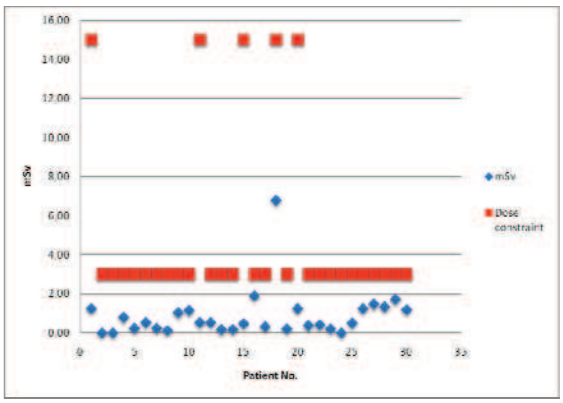

Figure 2. Effective doses to relatives of Thyroid cancer patients vs. Dose Constraint of 15mSv and 3 mSv

5. CONCLUSION

The radiation doses to family members of patients treated with radioiodine 131for Thyroid cancer were found to be well below proposed dose limit of 1 mSv. Thyroid cancer patients should continue to be treated as in – patient to be sure that after three days of hospitalization they do not present radiation hazard to their family members.

The effective doses at eleven family members of the hyperthyroid patients were higher than 1 mSv. One person received 6.79 mSv.

It is necessary to formulate new guidelines on the instructions of out-patients after treatment with radioiodine 131to comply with requirements based on the revised ICRP limits.

This study has provided useful information on radiation protection and exposure to family members of patients with Thyroid carcinoma and hyperthyroid patients treated with radioiodine 131.

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