Radiation exposure levels in close proximity to therapeutic patients treated for thyroid carcinoma with high dose I-131

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ABSTRACT

High dose I-131 therapy is administered to thyroid cancer patients after thyroidectomy. In the treatment process when a radiopharmaceutical is administered to patients, they become a mobile source of radiation. After the treatment, contamination may arise from large amount of activity, which is excreted during the period of hospitalization. To reduce the rate of exposure it is essential to monitor workplace. This study determines the rate of radiation exposure in the room where the patient stays during the period of hospitalization as well as the adjacent rooms and surrounding areas.

INTRODUCTION

I-131, as sodium or potassium iodine, is supplied, either in liquid form or in a gelatin capsule. Iodine is extracted from the gut into the bloodstream and taken up by functioning thyroid tissue (including active metastasis). In malignant disease, where the patient has had a total or subtotal thyroidectomy prior to therapy, the uptake may be as low as 2% in residual thyroid tissue. The remainder is excreted primarily by the kidneys and consequently the patient should be encouraged to drink freely to minimize dose to kidneys, bladder and gonads (1). In most cases, 50-60% of the administered activity is excreted in the first 24 hours and around 85% over a stay of 4-5 days in hospital. This represents a significant potential for radioactive contamination. The next most significant pathway is saliva. This will manifest in contamination of eating and drinking utensils and pillow coverings (due to saliva excretion during sleep). Lesser pathway are sweat and faces. Therefore it is essential to monitor the workplace to reduce the rate of exposure. This study determines the rate of radiation exposure in the room where the patient stays during the period of hospitalization as well as the adjacent rooms and surrounding areas.

Radiation precautions were taken to minimize the spread of contamination from urine, saliva and perspiration to hospital personnel, patients and visitors. The patients used private sanitary facilities, have meal using disposable table service and stored their linen in an isolated box for monitoring by

trained radiation safety staff. External radiation exposure was minimized by adhering the therapy protocol suggested by SNMB (Society of Nuclear Medicine, Bangladesh)(2) and guidelines of BAERA (Bangladesh Atomic Energy Regulatory Authority) (3) that requires patients to stay in a private room until activity reduces to 1100MBq (~ 30mCi). Visitors and nursing staff could minimize exposure to radiation by reducing the time spent in close proximity of the patient and by increasing their distance from the patient.

METHOD AND MATERIALS

In this study, patients of DTC (Differentiate thyroid cancer) who received (30-250) mCi I-131 were observed for radiation exposure level. All these patients were given high dose of radioiodine 4-6 weeks after thyroid surgery. Among them, 17 patients were selected. Patients were admitted into single bed isolated cabins, used private sanitary facilities, had separate table/room service and their linen was stored in box for monitoring by trained radiation safety staff. A systematic survey of patients exposure rate was carried out over a period of 1 month using survey meter (Model Austral Rad Mini 8-in-1 #1091 Australia) in different places of clinic like toilet, corridor and close to wall of next room, patient's bed in the next room at distances of 1, 2 and 3 meter.

RESULTS

The exposure rate at the outer surface of door was different or fluctuated on the 1st day (Table -1).

Table -1: Survey Meter Count for CA-Thyroid Patient in µSv/h

A. Dose Recorded From Patients

No. of Patient	1st Day			2nd Day			3rd Day			4th Day			5th Day			
	1M	2M	3M	1M	2M	3M	1M	2M	3M	1M	2M	3M	1M	2M	3M	Activity
1	304	130	42	170	85	40	77	30	15	77	30	14	37.6	33.4	15	250mCi
2	265	111	95	76	29	13	7.7	2.7	2.1	2.6	1.0	0.8	2.03	1.04	.08	100mCi
3	170	107	55	50	29	20	6.8	5.7	1.6	3.1	1.3	0.7	3.0	2.7	2.1	150mCi
4	60	50	29	16	10	8	15	4.9	1.9	16	5.5	7.0	7.03	6	4.6	75mCi
5	142	91	63	33	10	8	20	8.2	5	9	7.2	6.9	5.1	4.6	4.4	150mCi
6	55	46	24	16	10	8	5.0	6.8	9.2	2.0	2.7	3.6	3.0	2.5	1	30 mCi
7	75	41	22	56	32	20.75	15.5	3.3	3.2	13.5	6.5	2.2	4.7	4	1.4	75 mCi
8	125	70	50	111	38	20.9	10.9	5.4	2.5	9	5.2	3.8	3.2	2.7.	2.1	100mCi
9	280	135	80	78.8	28	20	10.7	6.8	4.1	8.1	7.5	5.1	4.2	3.7	3.3	150 mCi
10	160	75	30	150	57	28	17	13	5.5	15	12	4.7	12.3	9.5	7.1	150mCi
11	485	305	75	385	110	67	52	22	15	44	18	11	33.6	16.2	11.3	250 mCi
12	156	92	41	95	22	11.2	12	4.3	3.5	10	3.2	2.1	11.3	9	7.6	75mCii
13	140	80	32	90	38	16	80	17	10	18	8	6	9.7	8.5	7.3	75mCi
14	190	65	27	88	32.11	16.98	50	20	10	18	9	6	9	8.06	6.8	100 *mCi*
15	120	60	28	35.7	15.23	13.4	30.0	10.0	9.00	20	10	9	4.5	4.35	3.7	75 mCi
16	200	150	83	55	35	19	30	16	10	10	6	4	2.9	2.4	2	100mCi
17	70	65	50	25	24	15	15	10	8	3	3	2	2.8	2.6	2.5	30 mCi

B. Dose Recorded From Toilet

No. of Patient	1st Day			2nd Day			3rd Day			4th Day			5th Day			
	1M	2M	3M	1M	2M	3M	1M	2M	3M	1M	2M	3M	1M	2M	3M	Activity
1	x	x	x	110	101	98	20.1	16.4	9.3	13.3	7.6	3.3	10.5	7.09	2	250mCi
2	x	x	x	44	38	19	10.4	4.3	3.7	1.3	1.2	1.1	2.5	3.5	1.6	100 mCi
3	x	x	x	22	17	13	16	13.1	10.2	9.4	7.5	3.2	5.4	4.4	1.8	150 mCi
4	x	x	x	6	4.9	-	5.5	4.2	-	5.3	4.5	-	2.6	1.8	-	75 mCi
5	x	x	x	25	16.7	13	11.5	7.3	5.1	6.2	4.1	2.6	3.8	3.4	2.3	150mCi
6	x	x	x	5.9	5.2	5	4.8	4.4	4	4	3.2	3	2	1	1	30 mCi
7	x	x	x	10.7	6.1	5.0	7.2	6.4	5.7	5.1	3.3	2.9	2.6	2.3	2.1	75 mCi
8	x	x	x	6.4	4.1	3.8	6.1	5.1	3.8	3.3	2.2	2	2.4	2.2	2.2	100 mCi
9	x	x	x	7.9	7.7	7.4	5.2	3.3	2.4	4.9	4.5	2.2	3	2.5	2.3	150mCi
10	x	x	x	13	11	-	12	6.1	-	10	5.5	-	4.8	4.2	-	150mCi
11	x	x	x	33	25	-	24	20	-	9	7	-	9.2	7.7	-	250mCi
12	x	x	x	11.6	8.8	7.3	7.4	5.3	4.2	4.1	3.3	2.1	5	4.2	3.3	75mCi
13	x	x	x	7.64	6.44	5.63	6.40	5.2	4.2	5.7	4.2	0.22	5.3	4.3	2.8	75 mCi
14	x	x	x	8.55	5.45	4.7	7	5	5	3.7	3	2.25	4.9	4.1	3.5	100 mCi
15	x	x	x	7.3	4.8	6.6	5.25	4.1	4.6	3	2	2	3.3	3	2.7	75mCi
16	x	x	x	7.9	5	4.25	5.5	3.2	3	4	3	2	3.4	3	2.9	100mCi
17	x	x	x	7.9	5	4.25	5.5	3.2	3	4	3	2	3.4	3	2.9	30mCi

C. Dose Recorded At Corridor from Door (door must be closed)

No. of Patient	1st Day			2nd Day			3rd Day			4th Day			5th Day			
	1M	2M	3M	1M	2M	3M	1M	2M	3M	1M	2M	3M	1M	2M	3M	Activity
1	9.88	7	5	7.8	5.4	3.4	2.4	1.7	1.4	2.4	1.7	1.3	1.8	1.6	1.0	250mCi
2	9.8	8	7.9	2.44	1.9	1.39	0.84	0.7	0.17	0.17	0.16	0.15	0.15	0.14	0.13	100mCi
3	11	10	16	9	6.0	12	8	5	9.7	5	3	7	3	3	3	150mCi
4	7	6	9	6	5	8	3	4	6	2.1	2.7	5	1.1	1.01	2	75 mCi
5	11	14	9	9.4	4.3	2.4	3.2	3.8	1.5	3.0	3.8	1.3	0.9	0.6	0.22	150mCi
6	3.4	2.9	2.4	2.9	2.4	2.4	2	2.2	1.9	1.8	1.5	1.6	1	1	0.09	30 mCi
7	6.6	4.4	3	8.3	10.04	6.6	3.2	6.6	1.5	0.03	0.03	0.01	1.75	11.75	2.0	75 mCi
8	18	8	6	7.6	3.1	1.3	1.5	0.20	0.15	0.22	0.20	0.22	0.53	0.63	0.25	100 mCi
9	12	9	8	3.9	4	3.1	1.0	0.6	0.2	1.29	1.6	0.53	0.9	0.8	0.72	150 mCi
10	7	6	4	7	5.8	4.8	4.6	4.4	4.3	1.1	0.34	0.17	2.3	1.9	1.6	150 mCi
11	15	12	16	11	11	8.8	7.7	4.1	3.3	2.5	2.2	1.7	7.4	6.7	5.3	250 mCi
12	12	7	5	3.2	2.7	2.1	2.1	2.1	1.9	1.2	0.35	0.22	1.25	1	0.9	75mCi
13	13	6	4	4.5	1.9	0.44	4	0.92	0.30	1.5	1.3	0.75	3.8	2.3	2.2	75mCi
14	7	5	4	3.30	2.53	1.96	2.10	2.00	1.17	1	1	1	1.2	1.1	0.63	100 mCi
15	7	6	5	3.3	2.54	1.96	2.10	1.92	1	2	1.1	1	1.2	1.1	0.63	75mCi
16	12	7	5	7	5	3	5	4	2	4	3	2	0.8	0.8	0.3	100mCi
17	10	7	6	7	5	3	6	4	2	5	3	2	0.8	0.8	0.3	30mCi

C. In the next Room

No. of Patient	1st Day			2nd Day			3rd Day			4th Day			5th Day			
	Close to Wall	At Pt. Bed	Middle of Room	Close to Wall	At Patient Bed	Middle of Room	Close to Wall	At Pt Bed	Middle of Room	Close to Wall	At Pt. Bed	Middle of Room	Close to Wall	At Pt Bed	Middle of Room	Activity
1	2	1.6	1	0.345	0.299	0.189	0.25	0.16	0.17	0.25	0.3	0.22	0.34	0.02	0.22	250 mCi
2	8.1	8	7.9	3.59	1.67	0.175	1.5	1.1	0.5	1.8	0.7	0.3	1.1	0.6	0.03	100 mCi
3	3	2	2	1	0.34	0.7	6.0	4.1	2.9	0.44	0.34	0.22	0.34	0.25	0.01	150 mCi
4	2	1.9	1.8	1.7	1.6	1.4	1	1	1	0.86	0.65	0.54	0.22	0.22	0.25	75 mCi
5	3.5	2	2.5	3	1.8	2	2	1	1.3	1.4	1	1	0.86	0.24	0.55	150mCi
6	3	2.2	2.5	2	1.5	1.8	2	1.1	1.5	1.1	1	1	0.77	0.36	0.68	30mCi
7	2.5	1.9	1.5	0.72	0.63	0.7	1.0	1.1	1.2	0.25	0.25	0.3	1.25	0.22	0.2	75 mCi
8	2.5	1.9	1.5	1.8	1.6	1.3	1.3	1.1	1.1	1.1	1.0	0.17	0.22	0.2	0.175	100mCi
9	16	7	5	4.7	3.9	3.2	3.7	2.9	2.4	0.17	0.25	0.17	1.3	1	0.9	150mCi
10	2	16	1	2.5	2.3	1.9	1.4	1.3	2.0	1.7	0.25	0.17	0.5	0.34	0.22	150 mCi
11	5	4	4	6.7	5.4	4.4	3.9	2.3	1.8	1.5	0.02	0.2	1.4	13	1.3	250 mCi
12	2.2	1	0.5	5.1	3.6	2.7	5.5	3.2	2.1	0.8	0.6	0.45	0.53	0.44	0.34	75 mCi
13	2	1	0.9	6.4	2.7	1.58	0.40	1.60	1.30	0.3	0.2	0.2	1.7	1.58	1.20	75mCi
14	3.5	2.6	1.7	3.11	2.15	1.58	2.10	1.80	1.00	1	1	0.7	0.72	0.53	0.44	100mCi
15	0.3	0.29	0.29	0.44	0.29	0.53	0.20	0.17	0.11	0.20	0.20	0.20	0.22	0.22	0.20	75 mCi
16	2	1	1	0.75	0.22	0.22	0.15	0.10	0.10	0.17	0.12	0.12	1.5	1.2	1.1	100mCi
17	1	1	1	0.75	0.5	0.1	0.5	0.3	0.1	0.17	0.12	0.12	1.5	1.2	1.1	30mCi

Dose rate varied between (18 - 3.4) µSv/h. The dose rate in the toilet varied between (13-5.9) µSv/h. Among them, few patients dose rate in the toilet was found high (110-22) µSv/h. Dose rate varied between (16-0.3) µSv/h in next room walls, close to the patient's room.

DISCUSSION

The exposure rate at the outer surface of door was different or fluctuated on the 1st day (Table -1). Dose rate varied between (18- 3.4 µSv/h) due to difference in patients' activities, position of rooms, and position of patients' bed. Dose rate was high when a patient's bed was near the door and when the patient was sitting in the veranda the dose rate was low. Besides, when two patients stayed in opposite rooms with common corridor, the corridor reading was high and fluctuated. Therefore, changing the room arrangement can minimize radiation level in corridors. The dose rate in the toilet varied between (13-5.9 µSv/h), when the patient took sufficient fluid like water, soft drinks, soup etc. and proper flush of the toilet. Dose rate in the toilet was found high (110-22 µSv/h) due to intake insufficient fluid like water, soft drinks, soup etc. In some toilets, there were not enough space to measure exposure rate at 3m distances. In the next room walls, close to the patient's room, dose rate varied between 0.3 µSv/h 16 µSv/h . Dose rate of wall close to patient's bed was high for one patient due to the patients bed in one room is placed against the same wall as a bed in an adjacent room. It is to be ensured that the patient's bed in one room is not placed against the same wall as a bed in an adjacent room. Otherwise, the distance between the beds will also be very small and the walls do not provide effective protection against this type of radiation (4). When a cabin is reserved for a patient's admission it should be noted that no child patient or pregnant women

is admitted into the next room as these groups of patients' embryos, fetuses and children are at greatest risk from external radiation exposure (5,6). After 5 days of hospitalization, the radiation level did not exceed maximum permissible limit (7), in fact it was significantly below the permissible limit

CONCLUSION

Radiation is an essential part of daily life. Not only radiation is an essential part of human life, it can also be used to improve human life. It is the role of health care providers to use ionization radiation in medicine efficiently to maximize benefit and minimize risk. Survey of the radiation exposure is required limit unnecessary radiation exposure.

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