

## Exposure rate measurements and radiation control in post therapy with I<sup>131</sup>

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**ABSTRACT:** During hyperthyroidism treatment, I<sup>131</sup> activities from 111 MBq up to 296 MBq are used. In the aim to determine if the I<sup>131</sup> uptake by the patient is a radiological risk to family members and public around the patient exposure rate measurements were carried out, using a limit 1.8 mR/h. Measurements were carried out in the Nuclear Medicine department of Almenara hospital in Lima, Peru. The exposure rate was measured to 0.3, 0.6, and 1.0 m from the patient from 0 to 11 days after post-administrated dose (PDA). In this study measurements were carried out in 21 hyperthyroid patients. Measurements to 1 meter, along 2-4(16/16), 5-7(15/15), and 8-11(14/14) days after PDA, indicate the dose rate around 100% of patients is  $\leq 1.8$  mR/h. Measurements to 0.6 meters along 2-4(16/16), 5-7(15/15), and 8-11(14/14) days after PDA, indicate that the dose rate around 44%(7/16), 93% (14/15), and 100%(14/14) of patients is  $\leq 1.8$  mR/h. On the other hand, dose rate measurements to 0.3 meters, along 2-4 (16/16), 5-7 (15/15), and 8-11 (14/14) days after PDA, indicate that the dose rate is 13% (2/16), 6% (1/15), and 43% (6/14) of patients is  $\leq 1.8$  mR/h. Measured exposure rates are alike to values reported in the literature, and were used to define radiation control recommendations.

**Keywords:** External dosimetry, Hyperthyroidism, I<sup>131</sup>, Radiation control.

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### I. INTRODUCCIÓN

The I<sup>131</sup> therapy is the treatment of choice for most adult patients with hyperthyroidism pathology [1].

Administered dose treatment with I<sup>131</sup> for 3 to 8 mCi (111 MBq-296 MBq) patients continue with their daily routine, ie free circulation.

The therapeutic dose administered to the patient, this becomes a source of external radiation to their families and others who have close contact. Precautions should be taken, as well as special instructions to avoid exposure to radiation.

Exposure to external radiation can be minimized by reducing the length of time used in proximity to people who maintains contact and by increasing distance between them.

“Studies suggest that the external exposures often exceed the internal thyroid dose equivalent in family members of therapy patients” [2,3].

A number of recommendations were issued to minimize these external exposures. NCRP Report No. 37 in 1970 [4], recommends that measures the rate of exposure lower than 1.8 mR / hr at 1 meter, patients should be released from hospital care without restrictions. Indicates "1.8 mR / hr is the rate of initial exposure, which is composed of a total exposure of 0.5 R to 1.0 meter over the full decay of I-131". (The maximum allowable equivalent dose for individuals not occupationally exposed is 500 mrem / year).

In the Journal Nuclear Medicine, 1991, Cheryl M. Culver and Howard J. Dworkin published a guide for external exposures of hyperthyroidism in patients receiving doses up to 30 mCi (1110 MBq). In his studies considered restrictive limit rates dose not exceeding 2.0 mR / h for the patient to return to take personal contact to distances of 1.0m; 0.6m; and 0.3m. and time intervals 2-4; 5-7 and 8-11 days [5]

Considering the levels of radiation exposure less than 1.8 mR / hr as a criterion for patients treated with I<sup>131</sup> to resume contact, the study consists of obtaining guides in patients receiving doses ranging from 3mCi to 8 mCi, and can resume with close personal contact with their children, spouses and co-workers after therapy.

### II. MATERIAL AND METHODS

In Nuclear Medicine department of "Almenara" hospital in Lima, Peru, twenty (21) patients are treated for hyperthyroidism with I<sup>131</sup> were initial volunteers to participate in this study. The age range of patients is 32 to 73 years, with average of 48.2 years; of which 12 patients were female and 09 male sex.

Upright patients are monitored their rate of exposure from the waist to the neck. We recorded the maximum rate exposure.

A distance of 1.0 m, initial exposure rates within 20 min post dose administered therapy (PDA) are recorded

All patients are cited return three times after receiving therapeutic doses. Were recommended to return if possible on the third, seventh and tenth day PDA, and agreeing, at intervals of 2-4 days, 5- 7 days and 8-11 days PDA.

During his return to testing, the exposure rate of the patients was measured and recorded at a distance of 1.0 m, 0.6 m and 0.3 m.

The exposure rate is measured with an ionization chamber Victoreen Model 470. The camera was calibrated to start the study of 03 points on the scale to use in X10 and X3 ranges. The dosimetry was performed in the Calibration Laboratory of IPEN [6].

A reference source of Cs<sup>137</sup> (accuracy of ± 3%) marks CEA, France Model -CS 104 was used

The energy response of the camera is 0.97 to I<sup>131</sup>, and 0.97 for Cs<sup>137</sup> source. Similarly, quality control testing of nuclear instrumentation used were made.

### III. RESULTS

The administered dose of I<sup>131</sup> in the range of 3mCi - 8 mCi (111 MBq-296 MBq), the results show:

- The initial exposure rate recorded in 20 of 21 patients (20/21) measured at 1 meter in 20 minutes PDA, registered values 1.8 mR / h.
- The exposure rate in patients measures to 1 meter for 2-4 days (16/16), 5-7 (15/15) and 8-11 (14/14) PDA suggest that 100% of them rates registered 1.8 mR / h.
- The exposure rate in patients measures 0.6 meters during days 2-4 (16/16), 5-7 (15/15) and 8-11 (14/14) PDA , suggest that 44% (7/16) 93% (14/15) and 100% (14/14) of patients registered dose rates 1.8 mR / h.
- The exposure rate in patients measures 0.3 meters in 2-4 days (16/16), 5-7 (15/15) and 8-11 (14,14) PDA suggest that 13% (2/16), 6% (1/15) and 43% (6/14) of patients registered dose rates 1.8 mR / h.

The guidelines prepared are based on the dose administered and according to existing health standards.

For measurements of exposure rates, the corresponding range (mR / h) are given by:

Distance: 1.0 meters:

2-4 days (range 0.0-1.0); 5-7 days (range 0.0 -0.6); 8-11 days (range from 0.0 to 0.4).

Distance 0.6 meters:

2-4 days (range 0.1 - 3.2); 5-7 days (range 0.0 - 2.0); 8-11 days (range 0.2 - 1.2)

Distance 0.3 meters:

2-4 days (range 1.0 - 13.2); 5-7 days (range 0.5 - 7.8); 8-11 dias (range 1.6 - 5.8)

The corresponding average rate of External Exposure (mR / h), are represented as the mean ± standard error of measurement:

Table 1.-Average rate external exposure (mR/h)

DISTANCE M	DAY 0	DAY 2-4	DAY 5-7	DAY 8-11
1,0	1,4 ± 0,3	0,6 ± 0,4	0,3 ± 0,2	-
0,6	-	1,8 ± 1,0	1,0 ± 0,5	0,6 ± 0,3
0,3	-	6,6 ± 3,3	4,2 ± 1,8	2,6 ± 1,2
(N)	(21)	(16)	(15)	(14)

(N) is the number of patients; and, (mR / hr) ± SD is the exposure rate with the corresponding standard deviation

Table 2.-Proposal for a guide for patients receiving maximum dose of 8 mCi, and can resume contact post hyperthyroid therapy (restrictive limit: 1.8 mR / h)

DAYS/PDA	0,3 m	0,6 m	1,0 m
0-1	RMT	ARMTN y G	NRMT
	RMT	NRMT	NRMT
	RMT	NRMT	NRMT
2-4			
5-7	ARMTN y G	NRMT	NRMT
8-11			

RMT : Restrictions on the amount of time .

NRTM : No restrictions on the amount of time .

ARMTN y G: Some restrictions on contact with small children and women in gestation.

#### **IV. ANALYSIS AND DISCUSSION OF RESULTS**

For therapeutic doses ranging between 3mCi to 8 mCi, 44% of patients registered dose rates 1.8 mR / h during 2- 4 days, at a distance of 0.6m. While 13% (2-4 days), 6% (5-7days) and 43% (8-11días) patients registered dose rates 1.8 mR / h, distance of 0.3 m. The other remaining cases, 100% rate registered 1.8 mR / h.

Table 1 shows the average and deviation, for doses between 3mCi - 8mCi, with rates restrictive 1.8 mR / h. The results are consistent with those reported by Cheryl et al for therapeutic doses between 3mCi a 12 mCi, and restrictive dose rates 2.0 mR / h. [5].

NCRP recomienda que los miembros de familia de un paciente irradiado reciban menos de 0,5 rems en cualquier año, y para una mujer fértil con respecto al feto reciba menos de 0,5 rem en el periodo de gestación. Usando la tasa de dosis externa máxima medidas a 0,3 m de todos los pacientes a 2-4 días, 5-8 días, y 8-11 días PDA (13,2 mR/h; 7,8 mR/h y 5,8 mR/h respectivamente) y estimando la tasa de exposición debido a 8,0 mCi de actividad para los días 0 y 1 PDA, una persona continuamente expuesta (24 h/día para 11 días) recibirá 3,5 rems aproximadamente. Una persona expuesta a estas tasas de dosis para 4hs/día recibirá 0,5 rads en 11 días.

NCRP recommends that family members of a patient irradiated receive less than 0.5 rems in any year, and for fertile women with regard to the fetus receives less than 0.5 rem in the gestation period. Using the maximum external dose rate measures 0.3 m of all patients 2-4 days, 5-8 days, 8-11 days and PDA (13.2 mR / h; 7.8 mR / h 5, 8 mR / h respectively) and estimating the exposure rate of 8.0 mCi of activity for the first day (day 0 and 1 PDA), a person continually exposed (24 h / day for 11 days) will receive 3.5 rems approximately. A person exposed to these dose rates to 4hrs / day will receive 0.5 rads in 11 days.

The guidelines developed so that patients can resume contact within certain distances are given in Table 2.

The criterion to eliminate the restriction occurs when the average measurement is the exposure rate of 1.8 mR / h. A person continuously exposed to 1.8 mrem / h (ie 24 hr / day) for 10 days would have a cumulative dose of 0.43 rems, which is less than 0.5 rem as recommended dose limits for the general public.

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