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A Contribution to the Study of the Physicochemical Parameters in Iodine-131 Metabolic Radiotherapy - Assessing and Forecasting Treatment Response

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Abstract

The objective of this study is twofold: first, determining methods for setting parameters which describe thyroid gland responses at the initial stages of a given iodine-131 metabolic radiotherapy, and second, predicting treatment outcome. Radioactivity measurements were taken on patients suffering from hyperthyroidism. Two physicochemical parameters were analyzed and studied: iodine-131 thyroidal uptake and effective half-life. We thus achieved a much higher rate of success with minimal reverse results. The effective half-life, combined with thyroidal uptake, led to better predictions of success or failure for a given treatment. These set procedures allowed us to describe beforehand thyroid gland responses to metabolic radiotherapy as compared to the conventional methods exacting periods of more than six months.
Keywords: Thyroidal uptake, effective half-life, iodine-131, hyperthyroidism, thyroid function.

Introduction

Thyroidal uptake tests are normally conducted for purposes of exploring thyroid function in patients treated with tracer doses of iodine-131, such as 1, 2 or 3.7 MBq [1, 2]. Activity of an administered radiotracer is contingent upon the available detector's NaI(Tl) sensitivity. As far as metabolic radiotherapy with iodine-131 is concerned, therapeutic doses administered to patients are extremely high, i.e. one hundred times more than the diagnostic tracer dosage [3-8]. Using a regular NaI(Tl) detector to measure high dosage in « counts per minute » isn't so easily feasible. Such radioactivity rates readily provoke detector oversaturation in the initial time range following the administration of iodine-131.

This study therefore demonstrates that it is possible to use similar equipment available for iodine-131 tracer dosage as for therapeutic fixed dosage which, as we know, produces detector oversaturation when radiotherapy is initially applied, i.e. in the early stages representing at the most four days after initially administrating iodine-131 [9]. Two problems have been raised during the course of this study. First, would it be possible to formulate technical procedures to allow measurement of thyroidal uptake from patients who have received set therapeutic dosages of 370 MBq… and, at the initial stages of metabolic radiotherapy moreover? Second, would it be possible, on the basis of data obtained during the initial stages of the thyroidal uptake, to assess and predict the response of treatment given to patients?

Our overall objective is to contribute to the optimal therapeutic care of Congolese patients afflicted with hyperthyroidism. Yet our specific objectives throughout this work is to continuously standardize thyroid uptake tests at the initial stages of therapy and to use the results of the physicochemical parameters thus obtained for the sole purpose of judging patient response to a given treatment, as well as predicting success or failure of such treatment. As well, the hypothesis of this work is to determine the physicochemical parameters of iodine-131 linked to metabolic radiotherapy, and to subsequently use these parameters for purposes of judging a patient's response to treatment and of predicting its success or failure.

The selected physicochemical parameters which constitute the focus of this study are commensurate with the amount and duration of stay of iodine-131 which has a role to play in the biochemical reactions taking place in the thyroid follicles (Figure-1) [3, 5-6]. The higher the amount and duration of stay in the thyroid cells, the greater the impact on thyroid function.

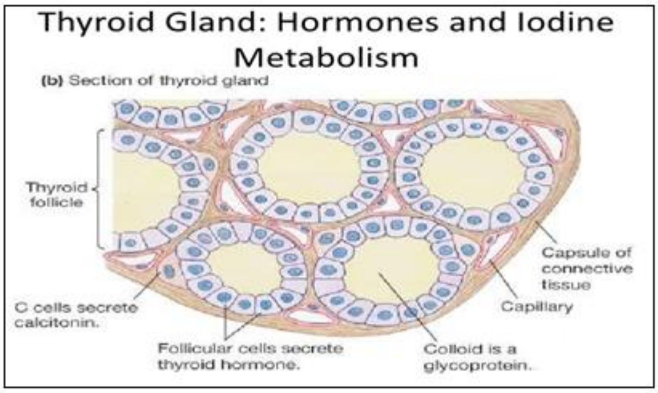

Fig-1: Thyroid follicles [10]

The thyroid gland is composed of a large number of follicles approximately 200 micrometers in diameter. They contain a substance similar to jelly called colloid, which makes up the greater amount of the thyroidal mass. It is basically composed of an iodine compound, called thyroglobulin. This glycoprotein has a molecular weight of 660,000 and plays an essential role in the biosynthesis of the T_3 and T_4 hormones, namely Triiodothyronine and Thyroxin [11-15].

Once the iodine (in the form of iodide I^-) is carried to the colloidal mass via the blood, oxidation takes place, transforming the iodide to neutral iodine I^0 . This reaction is then catalyzed by the peroxidase enzyme containing a heme group, a process which takes place on the basal surface of the follicular cell. Peroxidase has a molecular weight of 60,000 and requires hydrogen peroxide (H_2O_2) as an oxidant produced by a NADPH-dependent enzyme (Nicotinamide Dinucleotide Phosphate), likened to cytochrome C reductase [14, 16].

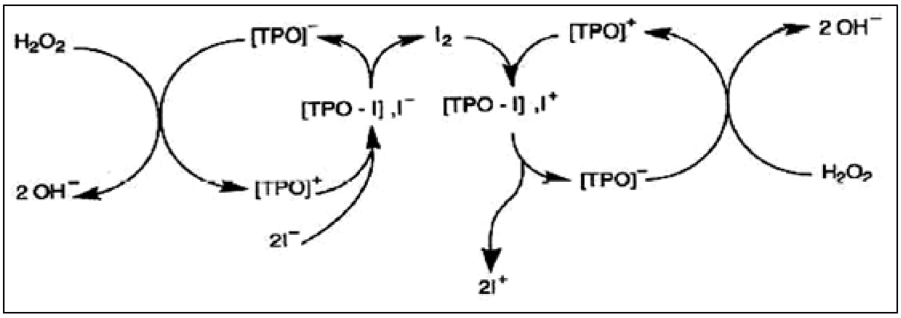

Fig-2: Oxidation of iodide [14]

The peroxidase/iodine activated complex reacts with the tyrosine component of thyroglobulin to form Monoiodothyrosine (MIT) and Diiodothyrosine (DIT). The T_3 and T_4 hormones (still linked to the polypeptide chain of the thyroglobulin) therefore are the result of the coupling of iodothyrosines as illustrated in figure 3 [17-20].

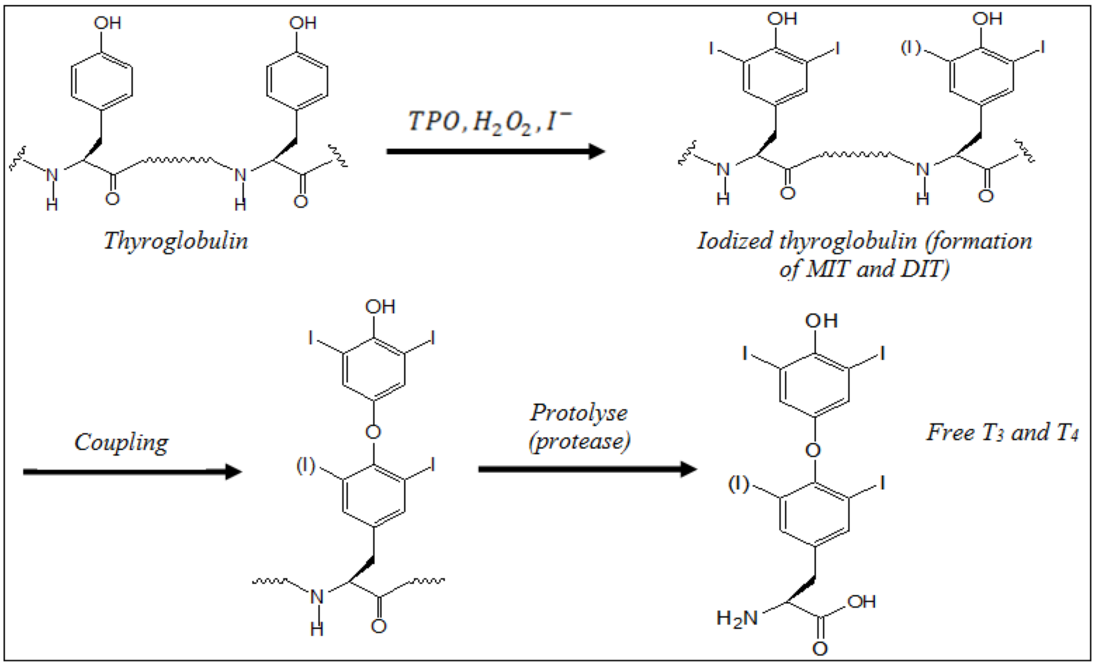

Fig-3: Simplified synthesis of iodothyronines [14]

Considering the high molecular weight and volume of thyroglobulin, diffusion from the follicles into the circulatory system would be unlikely. Under endocytosis, follicular cells stock the thyroglobulin in the vesicular cavity. A protease then acts upon the thyroglobulin, which frees up MIT, DIT, T_3 and T_4. These products break free from the follicles to travel through the epithelial cells of the thyroid to subsequently enter the blood flow. The iodotyrosines (MIT and DIT) then lose their iodine by means of a specific enzyme called « desiodase ». This allows the enzyme to recycle the iodine and tyrosine in the synthesis of new hormones, as illustrated in figure 4 [21-24].

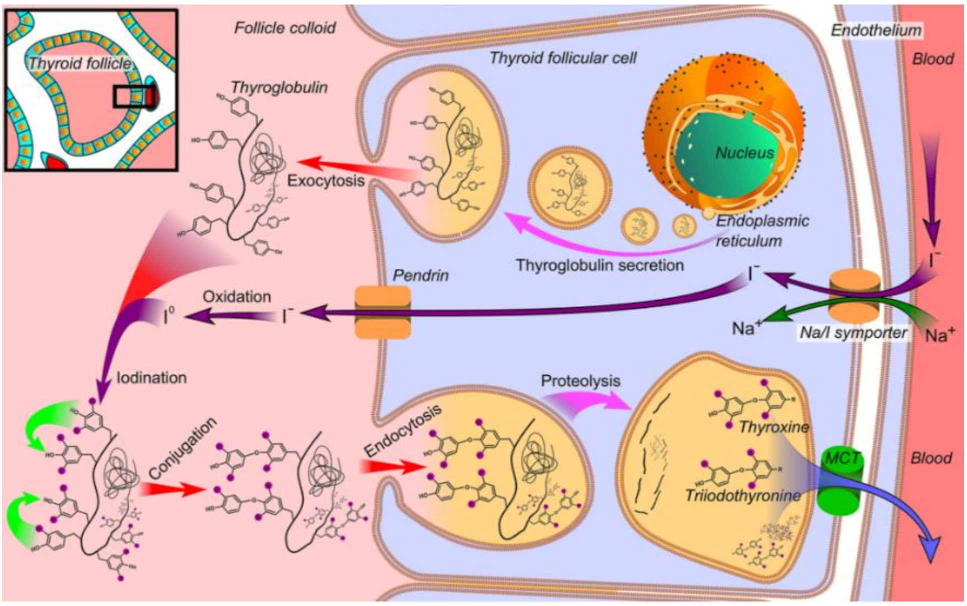

Fig-4: Metabolism of iodine through the thyroid cell [25]

Metabolic radiotherapy is based on the iodine-131 metabolism within the thyroid cell. This is supported by the fact that stable iodine (or iodine-127) has the same chemical properties as iodine-131, and as a consequence, does not allow the thyroid cell to differentiate between the two isotopes. The β^- particles the iodine-131 emits (at an energy rate of 606.3 keV and 89.9 % of emission rate) produces a number of ionization reactions. This has a destabilising effect on the thyroidal cell biochemistry, and as a result, is instrumental in the latter's destruction followed by a follicle rupture [26-31].

By the same token, hyperthyroidism is characterized by the hyperfunctioning of the thyroid gland, the effect of which increases the production of T_3 and T_4 hormones beyond standard limits, i.e. over 2.8 and 150 nmoles/L respectively. In addition to these values, we account for the associated concentration of thyreostimuline (TSH or pituitary hormone) which plays a major role in controlling the quantity of hormones secreted by the pituitary gland. As to hyperthyroidism, the concentration remains lower than 0.4 mUI/L [3, 32-35].

Metabolic radiotherapy with iodine-131 is based upon introducing iodine-131 into the hyperactive thyroid cells and upon damaging and destroying these cells by emitting β^-particles, thereby causing follicle rupture. The effect is a reduction in the number of follicles and a decrease in T_3 and T_4 concentrations below 2.8 and 150 nmoles/L respectively. Conversely, the TSH increases to over 0.4 mUI/L [36-38].

Materials and Methods

The trials were carried out on 52 Congolese patients suffering from hyperthyroidism. They were all treated at the Nuclear Medicine Center located at the University of Kinshasa's Teaching Hospital. The breakdown is as follows: 19 % of patients were male and 81 % female whose ages ranged from 13 to 71 years; for most patients (56 %), the range went from 37 to 49 years. Before administering iodine-131, patients were treated with doses of synthetic antithyroid (strumazol) which were suspended 10 days before receiving a dosage of 370 MBq of iodine-131 in sodium iodide form. Patients had to be constantly hydrated with at least 1.5 liters of water. The patients were kept under isolation for a period of three days. Dose Calibrator, CAPINTEC CRC-15R, has been used for the Iodine-131 radioactivity measure and Quality control. By Gamma spectrometry, iodine-131 gamma rays have been checked.

Gamma rays of Iodine-131 at 360 keV emitted from patients are measured after 24, 48 and 72 hours following each treatment by means of a thyroid gamma counter (Probe counter Mark MED Nuklear-Medizintechnik Dresden GmbH) at 1.5 meters from the NaI(Tl) crystal. The thyroid gamma counter is pre-calibrated with 370MBq of iodine-131. The «Thyroid program upt2000, version 1.1.1.2» software calculates the thyroid uptake [39].

To this effect, the thyroid uptake is the ratio of the residual radioactivity in the thyroid gland with respect to radioactive dosage administered. The second parameter, the effective half-life, is defined as the time taken to decrease radioactivity by half within the thyroid gland. It is calculated in accordance with the principle of radioactive disintegration.

$$A_t = A_0 \times e^{-\lambda t} \qquad (1)$$

Where,

A_t is the radioactivity of the source at time t

A_0 is the original radioactivity of the source (at time t=0)

λ is the constant of radioactive disintegration.

Given that

$$\lambda = \frac{\ln 2}{T_p} \qquad (2)$$

If the iodine-131 decrease is considered between two times (t_1 et t_2), the radioactive decrease equation is as follows:

$$A_2 = A_1 \times e^{-\frac{ln2}{T_{eff}}\times(t_2-t_1)} \qquad (3)$$

Where T_{eff} is the effective half-lifve. If we introduce the mathematical expression of thyroid uptake, the above equation is as follows:

$$T_{eff} = \frac{ln2 \times (t_2 - t_1)}{ln\frac{C_1}{C_2}} \qquad (4)$$

With C_1 et C_2 representative of the respective thyroid uptake at times t_1 and t_2.

Given that

$$C_t = \frac{A_t}{A_0} \times 100 \qquad (5)$$

The clinical assessment protocol (a conventional method used until now) indicates that the outcome of metabolic radiotherapy with iodine-131 can be described by the radioimmunoassay results of the T_3, T_4 and TSH hormones. These results are considered within a framework covering a period of 6 to 12 months after having administered iodine-131. The respective results of patients' hormone testing can be found in their clinical files as these have been compared to thyroid uptake values and effective half-life. Such comparisons allow us to determine and assess the established protocol with a view to predicting the success or failure of metabolic radiotherapy.

For purposes of calculating trends, averages and medians were entered using Microsoft software, which was also instrumental for entering data dispersion by way of standard deviations [40-41].

RESULTS AND DISCUSSION

The chemical reactions of iodine-131 within the thyroid gland of hyperthyroid patients observed in this study do not all reflect the same intensity for each with respect to thyroid uptake behavior or evolution as noted below in Table-1 over a three-day period of hospital care.

Table-1: Thyroid uptake evolution

Time (hours)	Uptake (%)				Standard deviation (%)	Relative Error (%)
	Maximum	Median	Mean	Minimum		
24	98.1	71.9	70.2	28.5	17.2	24.5
48	90.8	66.3	64.2	21.9	16.3	25.3
72	77.6	58.9	55.2	18.4	15.5	28.0

The above table demonstrates that the sampling under study is not homogeneous, hence the disparity of observed results. This is quite apparent as relative errors are superior or equal to 25 %. Many factors must be taken into account as to interference with respect to iodine-131 metabolism. Among those parameters, we can mention:

- Thyroid gland volume;
- The proportion of hyperthyroidism cells in relation to the number of normal cells within The thyroid gland;
- The concentration of stable iodine (captured as a result of ingested foods or other products) within the thyroid cells at the moment iodine-131 is administered;
- The concentration of perchlorate and thiocyanate in the body ;
- The concentration of TSH in the body;
- Residual concentration of anti-thyroidal drugs absorbed by the patient prior to administering iodine-131;
- The radio-sensitivity or radio-resistance of thyroid cells.

The thyroid uptake corresponds to the amount of iodine determined by the thyroid gland. High values of thyroid uptake point to the appreciable numbers of thyroid cells (follicles) which have absorbed iodine for the synthesis of thyroid hormones (T_3 and T_4). The result over time is the destruction of cells and consequently, a reduced production of T_3 and T_4 hormones [5].

In essence, a follicular cell can be considered as a unit producing thyroidal hormones. Iodine-131 metabolic radiotherapy however is geared to the destruction of follicular cells. Hyperthyroidism is characterized by an excessive production of hormones at concentrations higher than 4.5 nanomoles per liter for total T_3 and higher than 150 nanomoles per liter for total T_4. A reduction in the concentration of T_3 and T_4 to values lower than those indicated above is indicative of a successful outcome in healing or treatment. This is the objective of metabolic radiotherapy. To that end, the thyroid uptake must point to maximum values. On the other hand, the minimal values of thyroid uptake correspond to the small amount of iodine-131 as determined by the thyroid gland. Consequently, very low numbers of follicular cells absorb the radioisotope which spells their destruction. Given the high numbers of follicular cells which remain hyperactive, concentrations could remain higher than 4.5 nanomoles per liter for free T_3, and 150 nanomoles per liter for free T_4, This translates into treatment failure.

Median values of thyroid uptake tend to stray from minimal values and gravitate towards maximal values. Figure-5 expresses this tendency quite well. In other words, a large proportion of patients presented thyroid uptake values which favored the maximum. Given that the probability of successful treatment is contingent upon thyroidal uptake gravitating towards the maximum, we are in a position to positively forecast successful treatment for this particular category of patients suffering from hyperthyroidism. As the median curve strays from the minimal values of thyroid uptake, it translates into a small proportion of patients presenting adverse fixed-dosage effects of iodine-131. As to the outcome for this particular group of patients, the chances of metabolic radiotherapy success are quite slim. In the course of a prospective and qualitative study of cases conducted at the Center for Nuclear medicine (CUK) from 1980 to

2007 on patients' response to iodine-131 metabolic radiotherapy in relation to assessment parameters on regression of goiter mass and exophthalmos, we noted approximate rates of 70 % success [3].

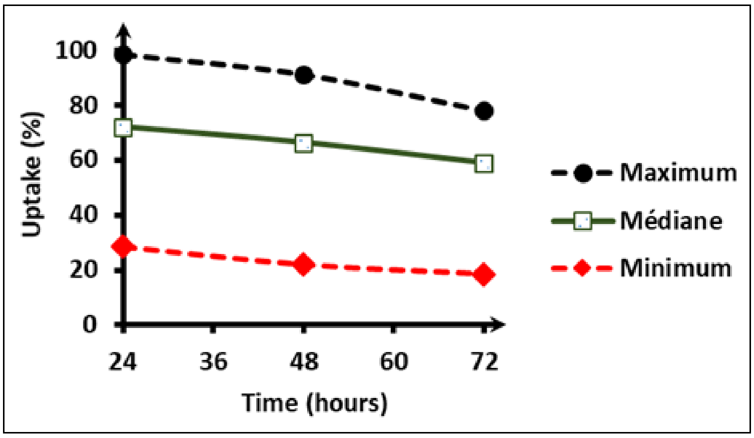

Fig-5: Median evolution of uptake

Having observed a few patients six months after administering iodine-131, and in classifying them according to thyroid uptake, margins representing probable successful response to treatment have been estimated. Table-2 reflects the breakdown of patients with respect to thyroid uptake 24, 48 and 72 hours after administering iodine-131.

Table-2: Breakdown of patients in relation to thyroid uptake during hospitalization

Uptake (%)	Number of patients			Proportion (%)		
	24 hours	48 hours	72 hours	24 hours	48 hours	72 hours
100-91	6	0	0	11.8	0.0	0.0
90-81	9	5	0	17.6	9.8	0.0
80-71	14	12	6	27.5	23.5	12.8
70-61	9	18	14	17.6	35.3	29.8
60-51	5	6	15	9.8	11.8	31.9
50-41	4	4	3	7.8	7.8	6.4
40-31	3	4	5	5.9	7.8	10.6
30-21	1	2	3	2.0	3.9	6.4
20-11	0	0	1	0.0	0.0	2.1
10-0	0	0	0	0.0	0.0	0.0

We have defined in 24-hour parameters three zones of influence based on the degree of success in administering metabolic radiotherapy: high probability, mean probability and low probability zones. The thyroid gland response which points to a high probability of successful treatment is in relation to a thyroid uptake of more than 70 %. Conversely, the thyroid gland response leading to a negative outcome corresponds to a thyroid uptake lower than 60 %. For thyroid uptake representing a margin of 60 to 70 %, successful treatment may be influenced by another parameter other than thyroid uptake; we refer here to the "effective half-live". For that matter, the latter is closely related to thyroid uptake in keeping with the relation equation (4) as illustrated below.

On the second day of the treatment, i.e. 48 hours after administering iodine-131, thyroid uptake normally decreases. For this purpose, follicular cells capture the administered iodine to produce T_3 and T_4 hormones. Results have shown that some of the T_3 and T_4 hormones were discharged into the circulatory system thus contributing to the metabolism of other organs. Also, iodine-131 not recycled by the follicular cells was excreted via the urinary system. This reduced the thyroid uptake. Thyroid uptake however can also effectively be diminished as a result of the radioactive decrease of iodine-131. Consequently, thyroid uptake zones which correspond to the 24-hour period subsequent to the administering of iodine-131, undergo a slight shift at the 48-hour mark. Thus, 48 hours after having administered iodine-131, a thyroid gland response which results in a highly probable positive reaction to treatment represents a thyroid uptake exceeding 60 %. Conversely, a thyroid gland response which negatively influences treatment success corresponds to a thyroid uptake lower than 50 %. For any thyroid uptake situated within a 50 to 60 % zone (48 hours after administering iodine-131), treatment success is governed by another parameter called "half-life time" as stated above.

However, for a thyroid uptake zone situated between 50 and 60 % (48 hours after an administered dosage), successful treatment may not be as probable as compared to a corresponding 24-hour zone which follows an administered dosage. As a matter of fact, the thyroid gland sets a maximum iodine dosage within a scale of 24 to 48 hours. It is during this period that high concentrations of iodine can be found in the circulatory system. The presence of this iodine reserve reaches its highest peak between 24 and 48 hours. This can have a positive effect on thyroid uptake 48 hours after administering a given dosage. As it so happens with some patients, we have recorded higher thyroid uptake at 48 hours than at 24 hours.

On the third day of treatment (72 hours after administering iodine-131), thyroid uptake normally decreases. We also note a decrease in concentrations of iodine-131 in the circulatory system. Therefore, the radioactive decrease of iodine-131 spells a reduction in thyroid uptake. As a result, zones of thyroid uptake reflecting a 24-hour period following the administering of iodine-131 are expected to noticeably shift at the 72-hour mark. It therefore goes without saying that at the 72-hour mark where iodine-131 is administered, a thyroid gland response which reflects an increased probability of successful treatment corresponds to a thyroid uptake in excess of 50 %. Conversely, a thyroid gland response which negatively influences successful treatment corresponds to a thyroid uptake lower than 40 %. As for thyroid uptakes situated in the 40 to 50 % zone, successful treatment can be influenced by the « effective half-life », as demonstrated in the preceding cases.

If the patients are classified according to effective half-life, zones which correspond to a probability of successful treatment can then be determined. Table 3 presents a patient breakdown in relation to effective half-life calculated as per equation 4 below.

It has been suggested above that the effective half-life can be a contributive factor for successful treatment. Under ideal conditions, if linked to thyroid gland response to a treatment, the effective half-life (T_{eff}) must be equal to the iodine-131 physical half-life T_p (8.02 days). Taking into consideration the mathematical relation 4 of effective half-life

$$\frac{1}{T_{eff}} = \frac{1}{T_p} + \frac{1}{T_b} \qquad (4)$$

where T_b is the biological half-life, it appears that in order to establish an effective half-life equal to 8.02 days, the biological half-life must reflect a very high value (as in a closed system where $T_b = \infty$).

The number of patients and corresponding proportions in relation to effective half-life are recorded in Table-3.

Table-3: Patient breakdown in relation to effective half-life

Effective half-life (days)	Number of patients	Proportion (%)
8.0-7.0	14	28.6
6.9-6.0	6	12.2
5.9-5.0	14	28.6
4.9-4.0	4	8.2
3.9-3.0	6	12.2
2.9-2.0	4	8,2
1.9-1.0	1	2.0
0.9-0.0	0	0.0

In other words, the thyroid gland must retain for the longest period a large portion of the administered iodine. As the thyroid gland is an open system, follicular cells discharge the fixed thyroidal hormone iodine into the circulatory system so as to ensure the metabolism of other organs. These follicular cells have to subsequently access as many sites as possible so as to quickly recycle discharged iodine in the circulatory system. This is conditional on the thyroid gland storing appreciable amounts of hyper-thyroidal cells. It is also contingent upon the follicular cells being sufficiently stimulated by the pituitary hormones, namely the TSH [17].

This therefore allows us to estimate given zones of positive or negative influences on successful treatment. It necessary follows that thyroid gland responses are crucial when focusing on the increased chances of securing successful treatments reflecting effective half-life equal to or greater than 5 days, bearing in mind similar approaches with respect to uptake. Conversely, effective half-life less than 5 days translates into a negative thyroid gland response to metabolic radiotherapy.

Effective half-life moreover can be used other than to prognosticate successful treatment. This parameter must be combined with the thyroid uptake. Hence, the combinations given hereunder are commensurate with favorable thyroid gland response for successful treatment:

- A maximal effective half-life (8.02 days) with a maximal thyroid uptake (approximately 90 %);

- A maximal effective half-life with a mean thyroid uptake;
- An effective half-life equal to or slightly higher than 5 days with a maximal thyroid uptake.

All other combinations one could possibly formulate would neither be possible nor appropriate for purposes of a positive thyroid gland response geared to successful treatment. For example, a thyroid uptake less than 50% (24 hours after administering iodine-131) combined with a maximum effective half-life is an impossible scenario. Conversely, a thyroid uptake for purposes of observing minimal values with an effective half-life under 5 days spells a most unfavorable combination for purposes of successful treatment.

It has been demonstrated that thyroid early-stage uptake and effective half-life measurements within 72 hours following an administered iodine-131 protocol can be useful in predicting « success » or « failure » of a treatment. On the other hand, results obtained from hormone tests show the treatment issue after six, even twelve months after administering iodine-131. This signifies that measurement of treatment success or failure can only be effectively verified at the end of metabolic radiotherapy (i.e. from 6 to 12 months after administering iodine-131). The treatment issue can be a « hyperthyroidism », a « euthyroidism » or a « hypothyroidism ».

Results of hormonal dosages obtained upon completion of the metabolic radiotherapy with respect to 21 consulted patient files are taken up in table 4 below. The table also presents the calculated values of the effective half-life and respective thyroid uptake for each patient. The table allows us to compare the measured results in thyroid uptake, effective half-life and various parameters of thyroidal hormones. The table reveals that in comparing the various parameters (thyroid uptake, effective half-life, and hormonal concentrations) support and confirm the observed facts as mentioned above, thus demonstrating the important link between thyroid uptake and effective half-life as to prognosticating treatment with iodine-131 radiotherapy.

As a result, confirmed as « true » are the supporting back-to-back data with respect to the distinct parameters as given in the table (i.e. thyroid uptake, effective half-life and hormonal concentration):

- If the patient, who was prognosticated a « success », becomes «euthyroid» or «hypothyroid» upon ending metabolic radiotherapy;
- If the patient, who was prognosticated a « failure », remains « hyperthyroid » upon ending metabolic radiotherapy.

Confirmed as « false » are the supporting back-to-back data with respect to the distinct parameters namely, thyroid uptake, effective half-life and hormonal concentration:

- If the patient, who was prognosticated a « success », remains « hyperthyroid » upon ending metabolic radiotherapy;
- If the patient, who was prognosticated a « failure », becomes « euthyroid » or « hypothyroid » upon ending metabolic radiotherapy.

The test results of 21 consulted medical files have produced 19 « true » files and 2 « false » files, in other words 90.5 % and 9.5 % respectively. This study reveals that the two « false » cases refer to hyperthyroid patients with significant thyroid gland growth.

The setting therefore of the probable zones of success or failure with respect to proposed treatment through means of median localization can be considered a prediction of the thyroid gland's response to treatment. The formulated hypotheses as to thyroid uptake and effective half-life data which limit zones of probable success or failure of treatment can be verified by referring to the respective clinical results of tested hormone amounts as given in the 21 medical files available for consultation (Table-4).

Table-4: Confronting data between the uptake thyroid, effective half-live and hormonal concentration

Patient N°	Uptake (%)			Effective half-life (days)	Prognosis	Hormone concentration			Time following administered I-131 (months)	Treatment issue	Conclusion
	24 hours	48 hours	72 hours			T_3 (nmole/l)	T_4 (nmole/L)	TSH (mUI/L)			
1	40.3	34.8	31.3	2.7	Failure	7.40	280	0.15	4.2	Hyperthyroid	True
2	59.6	51.9	45.4	5.0	Success	2.10	103	0.90	7.2	Hypothyroid	True
3	85.8	79.9	58.9	3.2	Success	0.80	20	61.00	6.4	Hypothyroid	True
4	69.5	65.2	57.9	7.0	Success	1.00	40	93.00	8.4	Hypothyroid	True
5	75.3	80.2		7.9	Success	1.90	104	1.90	3.9	Euthyroid	True
6	72.2	63.2	61.6	8.2	Success	2.30	106	< 0.15	4.3	Euthyroid	True
7	72.8	67.4	59.4	5.6	Success	2.90	119	0.02	4.9	Euthyroid	True
8	83.0	73.6	66.4	5.7	Success	3.80	162	0.60	3.4	Euthyroid	True
9	50.2	48.7	44.1	8.0	Failure	2.30	189	0.02	9.9	Hyperthyroid	True
10	68.7	63.0		7.7	Success	1.60	125	5.10	9.2	Euthyroid	True
11	71.3	66.9		8.0	Success	2.00	148	0.90	7.1	Euthyroid	True
12	71.5	68.8		8.0	Success	4.50	175	0.20	7.6	Hyperthyroid	False
13	90.7	78.0	73.5	5.2	Success	1.10	399	0.20	8.3	Hyperthyroid	False
14	71.9	66.0	56.7	5.3	Success	1.60	39	29.00	4.7	Hypothyroid	True
15	80.7	69.9	63.2	5.1	Success	1.40	87	19.10	7.8	Euthyroid	True
16		73.2	68.9	8.0	Success	1.50	55	9.80	8.1	Hypothyroid	True
17	79.5	74.3	64.8	5.6	Success	2.50	85	3.60	8.4	Euthyroid	True
18	83.2	69.5	60.8	4.3	Success	1.10	69	3.60	7.9	Euthyroid	True
19	96.6	83.7	73.5	4.8	Success	0.90	63	45.00	10.6	Hypothyrod	True
20	60.7	45.5	21.5	1.1	Failure	4.60	217	0.15	13.8	Hyperthyroid	True
21	53.8	61.4	54.7	8.0	Success	1.90	84	< 0.15	3.9	Euthyroid	True

Standard hormonal values: T_3 : 1.2 – 2.8 nmoles/L; T_4 : 65 – 150 nmoles/L; TSH : 0.4 – 4.5 mUI/L [3]

CONCLUSION

Results produced revealed a disparity in sampling (patients) due to a number of factors. Thus, given the appreciable variables in thyroid uptake values, results indicate that the samples under study were not homogeneous and reacted differently to iodine-131 fixation. We therefore adopted another statistical approach, namely, a median for statistical localization trends. This technical approach corresponds better with the interpretation of results.

Taking into account test results of defined hormones (T_3, T_4 and TSH) for all patients from 9 to 12 months after treatment, clinical assessments have confirmed predictions as to the success or failure of treatment, which were made four days after having initiated the iodine-131 metabolic radiotherapy. Procedures adopted for the assessment of the thyroid gland are admittedly premature at this stage; they nevertheless allow us to pursue treatment of the Congolese hyperthyroid patients under observation.

This study points to the potential use of the available equipment for purposes of both tracer doses of iodine-131 (low radioactivity) and fixed dosage (high radioactivity) treatments which, as we know, leads to detector oversaturation at the early stages of metabolic radiotherapy (a maximum 4 days after having administered the initial dose of iodine-131).

We therefore recommend continuing this study with an increased number of hyperthyroid cases and to link treatment with those cases of simple goiter and thyroid cancer under the auspices of the Nuclear Medicine Center at the University of Kinshasa's Teaching Hospital.

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