Journal of Radiation and Nuclear Applications
*An International Journal*

http://dx.doi.org/10.18576/jrna/060208

# Release Timing of Thyroid's Carcinoma Patients from the Hospital after Radiodine (I-131) Therapy based on Dose rate Measurements

*M.S. El-Sayed Mansour*[*]

Radiation Protection Dosimetery, National Center for Radiation Research and Technology, Atomic Energy Authority, Egypt.

Received: 4 Jan.2021, Revised: 22 Feb.2021, Accepted: 19 Mar.2021.
Published online: 1 May. 2021.

**Abstract:** The therapeutic treatment of thyroid cancer generally comprises total or hemisphere thyroidectomy and oral administration of radioactive iodine (131I). One consideration in this therapy is the radiation exposure dangers, which have been leeding to the Regulatory Authority to guide line criteria on releasing patients from hospitals when the therapy procedure involves 131I activities as greater than 0.91GBq (30mCi). This study was administered to assess the time dependent rate following the administration of 131I activities and estimate the radioiodine effective half-life (Teff) inside the patient's body, which would be useful for releasing patients from hospitals and guide radiation protection recommendations also . Patients were divided into two groups the ablation group (A) and the follow up group (FU). Furthermore, Dose rate, was measured at 1.0 meter. Per administrated Activities was 3700MBq, (100mCi). Patients were measured post 2h after 131I administration and at 24hour intervals up to 96hours. The results demonstrated a bi-exponential radioiodine clearance pattern up to five days with effective half-life Teff values of 15.9 and 25.3hours within the two phase, respectively. Also, majority of the patients follow up could be released from the hospital after 72 hours post-therapy administration as they reach the dose rate limit recommended by the regulatory authority by this time.
**Keywords:** thyroid cancer, patient release, effective half-life, radioactive iodine-131.

## 1 Introduction

The greatest potential radiation hazard encountered in the practice of nuclear medicine arises from the administration of radioiodine Precautions are advised to limit the radiation exposure of member of the public and staff, with whom a treated patient may come into contact. However, recommendations are usually based on measurement of iodine retention or instantananeous dose rate treatment at home has been advocated but the majority of patients who receive high dose of radioiodine are isolated in hospital for a period of time for radiation protection purpose Iodine-131 has been used for radionuclide therapy for cancer thyroid since 1942. Iodine-131 emits both beta rays with maximum energy of 606KeV, which travel a maximum distance of 3mm in tumor tissue and thereby ensure local treatment of the thyroid tissue. It also emits 364KeV gamma rays used for imaging. Its physical half-life of 8.04 days enables long-term irradiation of the target tissue includes guidelines for patients and all persons that may receive radiation exposures from patients under treatment, under all circumstances. Implementation of radiation protection guidelines to protect the surroundings of the patient is necessary. The International Commission on Radiological Protection (ICRP) and the National Council on Radiation Protection and Measurements (NCRP), adopted this; these recommend exposure doses to the public of 1mSv/y. i.e., ICRP (1991) and NCRP (1993). Assessing this radiation exposure or the dose rate permits estimation of radioactive iodine inside a patient's body as a function of time post-therapy administration this helps the licensee to calculate the potential of radiation dose to others by means of 131I effective half-time (Teff) inside a patient's whole body. The objective of the present study was to assess the time dependent dose rate following131I administration in thyroid cancer treatment to estimate the Teff and establish recommendations regarding the time necessary for the patients to be hospitalized in isolated wards. **2**

### *2.1 Materials and Methods*

This study included the selection of 25 patients with cancer thyroid Patient's ages were between 27-57 years. Diagnosis told of papillary and follicular carcinoma. Patients were

[*]Corresponding author e-mail: medhatshaban@yahoo.com

divided into two groups the ablation group (A) and the follow up group (FU). The initial assessment for both groups included measurement of serum thyrotropin (TSH), thyroglobulin performed two weeks after surgery, and Imaging ran with iodine I-131 of thyroid remnants or metastasis. If no remnants are present, patients were not treated with radioactive iodine I-131 and were not started on L-thyroxin (T4) replacement therapy. For ablation of residual thyroid tissue, patients were treated with single dose corresponding to 3700MBq (100mCi) I-131. Patients are isolated in special wards for 4-5 days before discharge from hospital. The environmental background of the survey in the absence of patients was evaluated to be 0.214± 0.032 µSv/h, gamma specific constant and correction for the conversion ratio of 0.869 between exposure in R and dose in rad= rem and then in µSv. Original values in Roentgen, corrected by ×0.87 to get rad, and ×10 to get µSv. Average dose rates were measured daily for 5 days for all patients at 0.1m, 0.5m and 1m from the midline abdomen interiorly, Posterior. in addition, lateral direction of the back, at mid trunk and laterally axially line of patients . Averages of readings were calculated giving Mean, Standard deviation,. The instrument used was RDS-120 Universal Survey Meter (Turku, Finland). The detector is energy- compensated two halogen quenched Geiger Mueller tubes with a referred accuracy of <± 5%. All the measurements were taken after emptying the bladder and background radiation was subtracted from the data. The average value for each data set (dose rates from all directions) was used in Teff and 131I activity calculation as this methodology seems less sensitive to iodine distribution inside a patient's body. The average dose rate (µSv/h) measurements by the dosimeter were corrected for environmental background in-patient at distance 1.0 meters post 2 hours to discharge patients after 96 hours.

## 3 Results and Discussion

Twenty- five therapies selective patients were administrated during the study period, this study divided patients into two groups: Ablative group: included 10 patients (group A), and Follow up groups: included 15 patients group (FU). All patients aged between (27-57) years, mean ± standard deviation(41.9±9.2) furthermore dose rate, was measured at 1.0 meter. The mean 131I activity administered to the patients was 3.7GBq. Table 1 shows the mean dose rates measured at 1.0 m from the patients and at different times of post-131I administration. All the patients were released from the hospital on the 3rd day. One example of the variation of the dose rate with time is given in Figure 1. This figure indicates that the dose rate decays in a bi-exponential manner where a fast clearance phase is followed by a slower one. The mean Teff to all patients obtained by means of MATLAB software were 15.8 (± 3.1) and 25.5 (± 5.8) hours for the initial fast and the second slower clearance phase, respectively. The Teff values calculated for each patient are given in Figure 2. It is possible to extract from this figure, that for the initial phase 58% of the patients had a Teff value between 11 and 15 hours, and 32% between 16 and 20 hours. For the slower phase these values are 43% between 21 and 25 hours and 42% between 16 and 20 hours, respectively. A comparison between the mean Teff for all the patients and previously reported values are given in Table *2.*

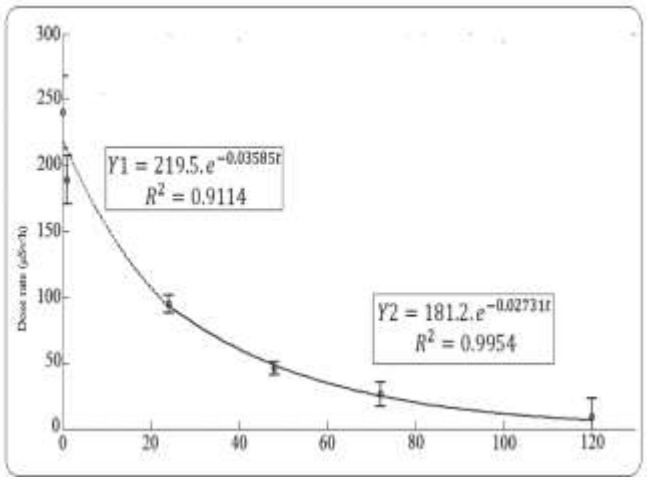


**Fig. 1**: Pattern of clearance of body burden with administered $^{131}$I Post administration time (h).

**Table 1**: dose rate (µSvh$^{-1}$) measured at 1.0 m from patients (n=25) as a function of time of post $^{131}$I activity administration.

| Time | 4h | 24h | 48h | 72h | 96h |
|---|---|---|---|---|---|
| **Dose rate** | 274±34 | 137±23 | 103±20 | 78±19 | **65±14** |
| **Range** | 103-137 | 45-78 | 48-65 | 17-53 | **11-37** |

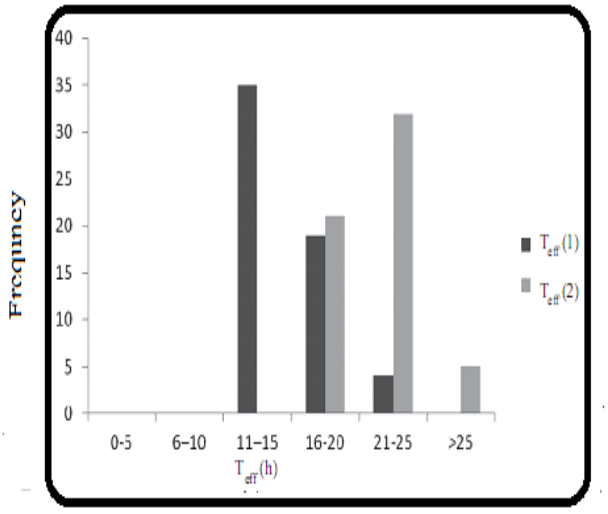


**Fig. 2:** distribution of effective half-life ($T_{eff}$) for two phases.

**Table 2:** comparison of $T_{eff}$ from this study and from others studies.

| | First phase $T_{eff}$ (h) | Second phase $T_{eff}$ (h) |
|---|---|---|
| **Current study .(n=25)** | 15.9 | 25.3 |
| **Ravichandran et al.(n=69)** | 14.4 | 22 |
| **Barrington et al.(n=86)** | 12.0 | 101.7 |
| **Tabei et al.(n=562)** | 11.76 | 38.64 |

n=number if subjects studied

## 4 Conclusions

Surgical resection of the thyroid gland followed by131I therapy has long been the standard treatment for differentiated thyroid cancer. The 131I Teff in total body of the patients with intact thyroid gland is generally estimated as 5.5d (132h), but in thyroidectomized patients this value is much shorter. The method used in this study estimation the Teff was based on dose rate measurements performed during treatments of patients. This method is somewhat crude compared to bio kinetic studies where the metabolized and eliminated iodine is accounted. The mean dose rate measured at 1.0 m are presented with a range of values (Table 1) as a consequence of many variables involved such as the administered 131I activity, different patients' gender, age and body weight. However, these dose rates constitute important information for radiation protection purposes because they are directly linked to the risk involved in the management of thyroid cancer patients after receiving 131I therapy. Dose rate from patients decreased in a bi-exponential pattern, where there is a slow clearance of radioiodine in the first day post-131I administration and a slower clearance after this time. Also the rapid clearance in the first phase corresponds to the urinary excretion of radioiodine, whereas the second phase corresponds to the organified 131I with a fast excretion, In a similar study by Barrington et al. (1996) with 86 patients, a bi-exponential pattern was found that the correspondent values for Teff in the first and second phase were 0.50(± 0.09) and 4.28 (± 1.55) days, respectively. In past study by Ravichandran et al. (2010), the values were 14.4 and 22.0 hours, respectively. The results from this study, i.e. 15.9 and 25.3 hours, respectively (Table 2), are in approach with both these studies. Some researchers have revealed that a tri-exponential clearance pattern on differentiated thyroid cancer patients (Castronovo et al., 1983; Sasikala et al., 1996), but such a difference in the clearance model may be related to the data sets used for Teff calculation, the methodology applied for dose rate measurement, population size, patients' characteristics and other factors. moreover, it is possible that the Teff value not increase in both phases according to the 131I activity administered to patients as reported by Tabei et al. (2012) in a study with 562 patients and dosages corresponding to activities of 131I ranging from 3.7GBq (100mCi) to 9.25GBq (250mCi). It was not possible to show this difference in our study due to the small sample size. According to Pacilio et al. (2005), about 80% of the administered 131I activity is eliminated from a patient's body within 48 hours, while Thompson (2001) reported that between 35% and 75% is eliminated within the first 24 hours post administration in all most of patients. At the National Cancer Institute (NCI) of Egypt, all the patients are discharged from the hospital only when the dose rate measured at 1.0 m

## References


[1] D.B. Payne and H.G. Gunhold. Digital sundials and broadband technology, in Proc. IOOC-ECOC., 557-998(1986).

[2] K. Choeung; I. Reiko; N. Kodai; F. Naoko; M. Miwa; M. Naoki and K. Takashi., Radiation Monitoring of an Isolation Room for 131I Therapy After the Patients Were Released Health Physics., **117(4)** , 419-425( 2019).

[3] R. m. Naalini ; R.M Naalini and D.K.A. Perera. Releasing thyroid cancer patients from the hospital based on dose rate measurement after 131I activity administration Receiving Radiodine- 131. Journal of Nuclear Medicine. (2017).

[4] P.W. Grigsby, B.A. Siegel S. Baker and J.O. Eichling Radiation exposure from outpatient radioactive iodine (131I) therapy from thyroid carcinoma. Journal of the American Medical Association., **283**, 2272 − 2274 (2000).

[5] H. Hanscheid, M. Lassmann, M. Luster, S.R. Thomas, F. Pacini, C. Ceccarelli, P.W. Ladenson and R.L. Wahl Iodine biokinetics and dosimetry in radioiodine therapy of thyroid cancer: procedures and results of a prospective international controlled study of ablation after rh TSH or hormone withdrawal. Journal of Nuclear Medicine., 47, 648 − 654 (2006).

[6] International Commission on Radiological Protection. (ICRP).Release of patients after therapy with unsealed radionuclides. Annals of ICRP 34 (v-vi): 1 − 79. (2004).

[7] H.R. Maxon and H.S. Smith. Radioiodine-131 in the diagnosis and treatment of metastatic well differentiated thyroid cancer. Endocrinology Metabolism Clinics of North America., **19**, 685−719 (1990).

[8] M. Pacilio, L. Bianciardi, V. Panichelli, G. Argiro and C. Cipriani. Management of 131I therapy for thyroid cancer, cumulative dose from in-patients, discharge planning and personnel requirements. Nuclear Medicine Community., **26**, 623−631 (2005)

[9] R. Ravichandran, J. Binukumar and A.A. Saadi. Estimation of effective half life of clearance of radioactive Iodine (131I) in patients treated for hyperthyroidism and carcinoma thyroid. Indian Journal of Nuclear Medicine., **25**, 49 –52. DOI: http://dx.doi.org/10.4103/0972-3919.72686 (2010).

[10] A.C. Sasikala, E.R. Radhakrishnan, P.N. Rao, S Devaru. U. Jayasree, S.S. Supe and R. Ravichandran Clearence of 131I and hospital discharge 141 June 2014.

[11] Assessment of patient radioactive body burden of I - 131 in the management of thyroid cancer. Indian Journal of Nuclear Medicine., **11**,151−156 (1996).

[12] F. Tabei, I.N. Asli, Z. Aziz mohammadi, H. Javadi and M Assadi. Assessment of radiation clearance in patients with differentiated thyroid cancer. Radiation Protection Dosimetry., 152(4), 323 − 327. DOI: http://dx.doi.org/10.1093/rpd/ncs063(2012).

[13] M.A. Thompson Radiation safety precautions in the management of the hospitalized (131I) therapy patient. Journal of Nuclear Medicine Technology., **29**, 61 − 66 (2001).

[14] C.D. Venencia, A.G. Germanier Germanier, S.R. Bustos, A.A. Giovannini and E.P. Wyse Hospital discharge of patients with thyroid carcinoma treated with 131I. The Journal of Nuclear Medicine., **43**, 61- 65 (2002).

[15] P.B. Zanzonico, J.A. Siegal and J. St Germain A generalized algorithm for determining the time of release and the duration of post-release radiation precautions following radionuclide therapy. Health Physics., **78**, 648−659 (2000).

[16] J.C. Chung, and L. Hong Clinical outcomes and associated factors of radioiodine-131 treatment in differentiated thyroid cancer with cervical lymph node metastasis. Int J Cancer., (2020).