Whole body clearance rate determinations for post-surgical DTC I-131 treatment patients

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Abstract

Whole body clearance rate for post-surgical DTC I-131 treatment patients have been investigated using a real-time based dosimeter with a video display from a remote location. This radiation monitoring system (RMS) is mainly used for checking environment dose rate at a 1-meter distance from the body before releasing a patient (< 70 μSv/h). This RMS detector can also be used to determine dose rates time-profile of a patient after I-131 is orally administered. A larger source-to-detector (STD) distance is preferred to minimize the I-131 bio-distribution uncertainty from time to time. Due to the maximum room size constraint, a 3-meter fixed STD distance is established for this whole body clearance rate study. Among accumulated 10 patient studies, the whole body clearance rate measurements yield an average effective half-live of 10.6 +/- 3.1 hours. First 24-hour period whole body clearance rate is then estimated to be 79.2%, ranging from 61.1 to 89.1%.

Keywords: I-131 clearance rate, DTC patient

Introduction

Iodine-131 whole body clearance rate measurement in post-surgical thyroid cancer patient has been investigated by a real-time based, environmental radiation monitoring system (RMS). Most recently, larger dosages, up to 200 mCi (7.4 GBq) I-131, have been routinely administered for post-surgical thyroid patients for the remnant ablation purpose.[1] Efficacy of the Iodine-131 dose delivered to thyroid cancer patient is closely related to the retention time in the post-surgical remnant organs. Whole body clearance rate is also an important issue for the blood toxicity and other non-targeted organs, including salivary glands, gastric mucosa, and lactating mammary glands, etc.[2,3] The whole body effective half-life in this study is conducted by an energy-compensated G-M dosimeter with video cameras within our heavily shielded I-131 therapy ward. The accuracy of the RMS dosimeter used in this study has been cross-checked by a certified pressurized ion chamber dosimeter. The detector full range isotopic calibration has also been conducted earlier for the high rate operations by a decaying source method.

Materials and methods

Vendor-supplied radiation monitoring and room image system (RMS) is used for this whole body clearance rate study. Its built-in energy-compensated G-M dosimeter inside the I-131 shielded ward can be operated remotely by a control/display unit located at our Nuclear Medicine Department (NMD). The installed RMS is mainly used for checking environment dose rate at a 1-meter distance from the body before releasing a patient (< 70 μSv/h).[4] The dosimeter of this RMS can also be used to determine dose rates of a patient after I-131 is orally administered in a real-time basis. This adopted RMS G-M detector is a wall-mounted device that is situated at 1 meter above the ground floor inside the heavily shielded I-131 wards. The ambient radiation background has been evaluated previously at a 0.2 μSv/h level by a certified hand-held pressurized ion chamber dose rate meter when an I-131 therapy patient is presented in another adjacent ward. The layout of the shielded I-131 ward is shown (3x4 meters) in the Figure 1. The RMS built-in dosimeter is hidden inside the wall-mounted box on top of the desk.

Figure 1. Room layout of the heavily shielded I-131 therapy ward.

If a detector is used to quantify total I-131 activity of a human body, a larger source-to-detector (STD) distance is preferred to minimize the I-131 bio-distribution uncertainty from time to time. A bio-distribution gamma scan of a post-surgical DTC I-131 treatment patient is illustrated in Figure 2. Due to the I-131 ward maximum size constraint, we have established a 3-meter fixed STD distance for these whole body clearance rate measurements. After I-131 is orally administered, the patient would stand up at the 3-m red-marked line on the floor for 1-minute data acquisition at some specific times. These dose rates time profiles that are mostly affected by the patient's thyroid tissue remnant uptake, renal function, the rhTSH usage, and frequency of bath-room trips, etc.

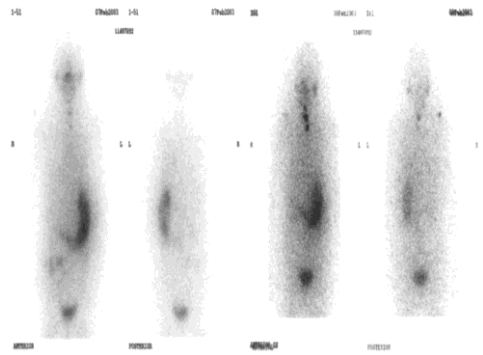

Figure 2. Gamma camera image of thyroid scan patient with multiple metastases. (3 mCi scan, female, 70, total thyroidectomy & LN dissection, neck hot spots remnant, papillary carcinoma, R/O liver meta)

Results and discussion

Before the patients were discharging from the I-131 therapy ward, usually less than 2 days, we have conducted a total of 10 cases with post-surgical I-131 treatment DTC patients that had I-131 dosages at least of 100 mCi (3.7 GBq) or more. These 10 patient data are listed in Table 1 for comparison purpose. Based on these results, the whole body clearance rate measurements yield an average effective half-live of 10.6 +/- 3.1 hours. First 24-hour period whole body clearance rate is then estimated to be 79.2%, ranging from 61.1 to 89.1%, among these 10 patients.

Table 1. Effective half-life measurements by the RMS dosimeter.

Patient ID	Dose rate at t1* (μSv/h)	Dose rate at t2 (μSv/h)	Time elapsed = t2 – t1 (hrs)	Effective half-live calculated (hrs)
1	53.03	12.83	18	8.79
2	35.08	9.734	18	9.73
3	24.35	6.98	17	9.43
4	40.73	12.73	18	10.7
5	44.67	22.16	19	17.6
6	30.15	5.71	18	7.50
7	43.53	16.23	20	14.1
8	61.2	18.26	18	10.3
9	29.1	8.73	17.5	10.1
10	22.33	4.50	18	7.79

* The dose rate at time t1 is about 30 minutes after the I-131 dosages are orally administered.

Conclusions

In this study, we have demonstrated that the I-131 effective half-life measurements can be done quickly with the environmental RMS installed in our I-131 therapy ward. These results are quite close to the previous report that has to be evaluated by several invasive tests and more tedious measurements.[1] These whole body clearance rate data can also be used for our I-131 ward in-hospital management to predict when we can release an I-131 treatment patient in a timely manner for the regulatory compliance.[4]

References

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