

Research Article

Guidelines on the Release of Patients Treated with Iodine – 131 for Thyroid Cancer in Nuclear Medicine: Case of Madagascar

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Abstract

The most frequently used radiopharmaceutical for treatment of thyroid cancer is the radioactive iodine (RAI). Patients treated with RAI therapy cause risk of external radiation exposure to the public and family members. While the therapeutic use of iodine-131 for thyroid carcinoma patients offers enormous benefit to them, it contributes also significantly to the radiation exposure of individuals and population. Patients treated with radioiodine present a radiation hazard and precautions are necessary to limit radiation dose to the relatives and the members of the public. The study aims to develop guidelines for the release of thyroid cancer patients treated with I-131. For this purpose, simulations were performed for estimating suitable period of restriction during which close contact with the patient should be disallowed and limited. These simulations are based on the French working Group and the recommendations of the International Commission on Radiation Protection. The study was carried out at the Isotopes Laboratory (LRI), Department of Nuclear Medicine in Antananarivo, Madagascar. According to the current regulation in radiation protection in Madagascar, the dose limit for the members of the public is limited to 1 mSv. Guidelines for discharge from the hospital are as follows. Patients can travel using public transportation up to 15 minutes. Patients are suggested to sleep apart and restrict contact with partner for 4 days after leaving the hospital. Contact with children should be restricted according to their ages. Time to restrict contact with child ranging from 3 to 10 years is limited to 4 days, and up to 7 days for younger children. This guideline is based on the retained activity of 800 MBq or the external dose rate is less than 40 μ Sv/h at 1 m. For public transportation, the suggested travel times for thyroid cancer are similar to those recommended by the French group. The length of time for which patients are in contact with children in this study is widely less than recommendations by French Group.

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Keywords

Thyroid Cancer, Iodine - 131, Patient Release, Guidelines

1. Introduction

Thyroid cancer represents the most common endocrine malignancy and ranks 11th place in terms of diagnostic and mortality in 2020 (586,202 new cases and 43,646 deaths in 2020) [1]. The most frequently used radiopharmaceutical for treatment of thyroid cancer is the radioactive iodine (RAI). Patient treated with RAI therapy cause risk of external radiation exposure to the public and family members [2]. Following a therapeutic administration of iodine – 131, the patient becomes a potential hazard to other individuals: firstly, radiation is emitted from radioactivity in the patient, and secondly, radioiodide is secreted in body fluids such as breast milk, sweat and saliva. Once a patient has left hospital, members of the public who could be at risk are passengers, drivers, colleague at work, and family members, particularly partners, parents and young children. Although no adverse effect has been demonstrated in these individuals [3, 4], there remains a requirement to comply with statutory dose limits. The International Commission on Radiological Protection (ICRP) has recommended an annual dose limit of 1mSv [5]. According to the current regulation in Madagascar, the annual dose limit for the public is 1mSv, and there is no dose constraint.

Exposure of members of public to a I-131 patient is controlled in Madagascar by keeping the patient in hospital until the retained activity reaches a specific limit. The patient is released when the dose rate of at 1 meter is 40 μ Sv/h. Then, instructions for limiting this exposure are given to patient. These instructions could include the patient delaying their return to work, limiting the time spent in public places, sleeping alone, and avoiding non-essential contact with young children. The criteria governing the issue of these instructions are based on different levels of retained activity in the patient. According to the Poland law [6], patient after radioiodine administration should be isolated in the rooms. In India [7], it is suggested that with good practice and thorough safety instructions to patients and their relatives, patients treated with radioactivity dose up to 1,110 MBq (30 mCi) of I-131 can be discharged safely after 2 hours of administration of I-131 as outpatients. As implementation of radiation protection guidelines in Egypt [8], all the patients are released from the hospital on the 3rd day of I-131 post –therapy administration as they reach the dose rate limit recommended by the regulatory authority by this time.

This study was undertaken to derive specific guidelines as to when I-131 treated thyroid cancer patients may resume close contact with the public and their children family following hospital discharge based on the retained activity in the patients.

2. Materials and Methods

The study was carried out at the Isotopes Laboratory (LRI), Department of Nuclear Medicine in Antananarivo, Madagascar. The administrated activity used for cancer treatment at LRI are 1850 and 3700 MBq. Dose rates at 1 meter were calculated as a function of activity. Then, dose rates at different distance can be derived from this value according to the inverse square law. After release of patient treated with I-131 from hospital, dose rates received by individuals in contact with patient were calculated. Then, simulations were performed for estimating suitable period of restriction during which close contact with the patient should be disallowed and limited. These simulations are based on the French working Group [9, 10, 11] and the current recommendations of ICRP [12]. Several contact patterns were tested: public transportation, sleeping with partner and close contact with children. The dose constraints were based on dose limit for the members of the public according to the current regulation in radiation protection in Madagascar.

Simulation is based on the following assumptions. Dose rate from I-131 is 0.05 μ Sv per hour and per MBq at 1 meter [13]. Doses rate for other distances were calculated using inverse square law. The following assumptions [14] were adopted with regard to contact between a treated patient and members of the family and the public.

- 1) For travel by public transport, the patient was at distance of 0.1 m and 1 m from passengers.
- 2) The periods of spent by a child in close contact with a patient were assumed to be governed by the age of the child in three groups: (a) the young infant (0-3 years) is in contact with the patient during 30 min and 5 times per day for a distance of 0.3 m; (b) the 3-10 year-old child is in contact with the patient 2 times during 1 hour (0.5 m) and one time during 1 hour (1m); (c) the school-child age more than 10 years-old spend 3 hours at 1m.
- 3) At home, the patient spend 8h at 0.5 m from the partner.

3. Results

Public transport: Dose to others during patient travel

After leaving hospital, suggested travel times of patient treated with I-131 with public transportation as a function of the retained activity in order to limit the dose to 1mSv are shown in tables 1 and 2.

Table 1. Suggested travel times (h) for thyroid cancer patients in order to restrict the public dose to 1 mSv (1m).

Retained activity (MBq)	Dose rate at 1m ($\mu\text{Sv/h}$)	Travel time (h)
100	5	200
200	10	100
400	20	50
600	30	33
800	40	25

Table 2. Suggested travel times (h) for thyroid cancer patients in order to restrict the public dose to 1 mSv (0.1m).

Retained activity (MBq)	Dose rate at 0.1m ($\mu\text{Sv/h}$)	Travel time (h)
100	500	2.0
200	1000	1.0
400	2000	0.50
600	3000	0.33
800	4000	0.25

Table 3. Suggested guidelines for thyroid patients to restrict dose to 0.3 mSv to relatives.

Retained Activity (MBq)	Time to sleep apart and restrict contact with partner (days)	Time to restrict contact with child (0-3 years) (days)	Time to restrict contact with child (days) (3-10 years)
100	1	4	1
200	2	5	2
400	3	6	3
600	4	7	4
800	4	7	4

There are no restrictions for infant aged of more than 10 years.

In January 2009, dose rates were measured on two patients during administration. Results are given below.

Table 4. Dose rate at various distances during I-131 administration.

Distance (m)	Dose rate [$\mu\text{Sv/h}$]	
	Distance (m)	Dose rate [$\mu\text{Sv/h}$]
0.5	181.81	136.36
1	127.27	65.45
3	18.18	10.09

4. Discussions

International Commission on Radiological Protection [5] has revised the radiation exposure dose considered to be acceptable for the safety of the public and defined the annual dose limit of 1mSv. Especially children are more sensitive to ionizing radiation [15, 16]. The exposure risk for the relative

of patient after releasing hospital is an important issue that needs to be considered [17].

For the processes after discharge, the patient socio-economic conditions must be evaluated, information about transportation and home conditions should be asked, and for patients who have difficulties with limitations, if necessary, the duration of hospitalization should be determined accordingly [13].

The release from hospital of patients treated with radioactive iodine-131 (I) remains a controversial issue as a result of the range of guidelines implemented by national regulatory bodies responsible for radiation protection in various countries worldwide.

In general, release criteria are based on physical half-life, activity or dose rate. Based on these criteria, the International Commission on Radiological Protection recommends patients to be released from hospital if their residual activity of I-131 is less than 800 MBq [12].

In Japan, a guideline [18] for the release of patients administered I-131 was issued by the Ministry of Welfare on June 1998. According to this guideline, the dose rate for discharge as set to 30 $\mu\text{Sv/h}$ at 1 meter or the activity in the body is less than 500 MBq. In the United States, patients' release criteria are defined by the US Nuclear Regulator Commission [19]. The American Thyroid Association [20]

created a task force to develop recommendations that would inform medical professionals about attainment of radiation safety for patients, family members, and the public. In Oman [21], patients left the hospital with mean administered dose in the range of 520 – 862 MBq and mean radiation exposure dose levels in the range 13 to 42 $\mu\text{Sv/h}$ at one meter from the patient. In India [22], a patient is released if the retained activity at discharge is less than 500 MBq or a dose rate level of 30 $\mu\text{Sv/h}$ at 1 meter, whereas in Pakistan [23], a retained activity of 370 MBq is allowed with a dose rate of 10-30 $\mu\text{Sv/h}$ at 1 meter.

Some Researchers [24] suggested that a female patient treated with 5550 MBq for thyroid cancer should not hold her newborn child for at least 15 days following hospital discharge. The South African Department of Health [25] gave conditions for using radioactive nuclides. These conditions state that patients must be hospitalized when the dose rate at 1 m is above 25 $\mu\text{Sv/h}$, or more than 555 MBq of iodine-131 was administered to the patient.

In this study, the patient is released when the dose rate of at 1 meter is 40 $\mu\text{Sv/h}$.

For public transportation, the suggested travel times for thyroid cancer showed in table 1 are similar to those recommended by the French group [9]. In the United Kingdom [26], for a dose limit of 1 mSv, individuals are permitted to take a public transport journey lasting up to 0.5 hours after receiving a dosage of 800 MBq. This value is higher than the findings indicated in this study.

The length of time for which patients are in contact with children in this study is widely less than recommendations by French Group.

According to the results showed on table 4, the dose rate from I-131 at 1 meter is around 0.035 μSv per hour and per MBq. In this study, dose rate from I-131 of 0.05 μSv per hour and per MBq at 1 meter [10] was used. This value is higher than that we have measured at 1 meter of the patient in January 2009. The reason is that majority of I-131 is eliminated from the human body in few days, through natural decay, and through excretion in sweat and urine.

5. Conclusion

Surgical resection of the thyroid gland followed by I-131 therapy has long been the standard treatment for differentiated thyroid cancer. In this study, simulations based on the dose calculated rates at different distance from patients were performed for estimating suitable period of restriction during which close contact with the patient should be disallowed and limited. In Madagascar, patients treated with radioiodine are hospitalised for a few days to avoid unnecessary radiation exposure to others. Patients can be considered for discharge when the residual activity falls below 800 MBq or the external dose rate is less than 40 $\mu\text{Sv/h}$ at 1 m. The guidelines for patients discharge from the hospital, as issued by this study,

are as follows. Patients can travel using public transportation up to 15 minutes. Patients are suggested to sleep apart and restrict contact with partner for 4 days after leaving the hospital. Contact with children should be restricted according to their ages. Time to restrict contact with child ranging from 3 to 10 years is limited to 4 days, and up to 7 days for younger children. There are no restrictions for infant aged of more than 10 years.

This study is based on simulation and dose rates were calculated as a function of activity. However, I-131 is eliminated from the human body not only through natural decay, but also through excretion in sweat and urine. In the future, dose rate measurements should be done during admission to the hospital and at discharge.

Abbreviations

I CRP	The International Commission on Radiological Protection
LRI	Isotopes Laboratory
RAI	Radioactive Iodine

Author Contributions

Marie Jeanne Ramanandraibe: Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Writing – original draft, Writing – review & editing

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Data Availability Statement

The data is available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

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