

Radiation Exposure to Relatives of Patients Treated with Iodine-131 for Thyroid Cancer at Siriraj Hospital

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Objective: Thyroid cancer patients treated with I-131 are potential source of radiation exposure to relatives who are knowingly and willingly exposed to ionizing radiation as a result of providing comfort to patients undergoing I-131 therapy. This study aims to determine radiation dose received by relatives who care for non self-supporting I-131 patients at Siriraj Hospital.

Material and Method: Twenty caregivers of 20 patients underwent I-131 therapy for thyroid cancer with a standard protocol were given specific instructions with regard to radiation safety and provided with electronic digital dosimeter to continuously measure radiation dose received on daily basis, three days in the hospital. On the day patient is released, thyroid uptake estimates were performed to assess internal radiation dose received by caregivers.

Results: The 3-day accumulative doses to caregivers to patients receiving 150 mCi (n = 11) and 200 mCi (n = 9) of I-131 ranged from 37 to 333 μ Sv and 176 to 1,920 μ Sv respectively depending on the level of supports required. Thyroid uptake estimates in all caregivers were undetectable. Dosimeter indicated a maximum whole-body dose of 1.92 mSv was more than the public dose limit of 1 mSv but within the dose constraint of 5 mSv for caregivers.

Discussion: Radiation dose to caregivers of a non self-supporting hospitalized patient undergoing I-131 therapy were well below the limits recommended by the ICRP. The patients can be comforted with confidence that dose to caregivers will be less than the limit.

Conclusion: This study provides guidance for medical practitioners to obtain practical radiation safety concerns associated with hospitalized patients receiving I-131 therapy especially when patient needs assistance.

Keywords: Radioiodine therapy, Caregivers, Dose constraints

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The use of I-131 for treatment of benign and malignant thyroid disease is common practice worldwide. Benefits to patients treated with radioiodine-131 must be balanced against radiation exposure to family member or relatives who designated to care for patients who are non self-supporting and occupational workers. The treatment may be performed with either the patient admitted to hospital or as an outpatient. Under standard guidelines, patients receiving less than 1,100 MBq do not require hospitalization⁽¹⁾. However, radioiodine treatment at high dose on inpatient basis may pose risk to both hospital staffs and patient's relatives knowingly and willingly incur an exposure to ionizing radiation in the support or comfort of patients who is undergoing medical exposure⁽²⁾. The potential

risks are from both external irradiation and contamination. Doses to these caregivers must be kept as low as reasonably practicable, and must never exceed the general dose constraint of 5 mSv with a consideration of time, distance, and shielding. The International Commission on Radiological Protection (ICRP Publication 105) recommended a dose constraint of 5 mSv per episode for carers while young children and infants, as well as visitors not engaged in direct care or comforting, should be treated as members of the public and to keep their dose within the 1 mSv/year⁽³⁾. The ICRP Publication 94⁽⁴⁾, IAEA Safety Report Series No. 63⁽⁵⁾ and European Commission⁽²⁾ recommended dose constraints per procedure per episode of 0.3-1 mSv for pregnancy, children and members of the public; 3 mSv for adult and 15 mSv for adults older than 60 years. Whereas the USNRC recommended dose base of 5 mSv per episode in all age⁽⁶⁾. The purpose of this paper is to present the results of measurements of external and internal dose to caregivers who cared for inpatient treated with

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radioiodine during 3-day isolation at the radionuclide therapy ward, Siriraj Hospital.

Material and Method

Dosimeter and gamma spectrometer

1) Electronic personal dosimeter, ALOKA MyDose MiniModel PDM-112.

2) Thyroid uptake system, Atomlab 950, Microprocessor-controlled 1024 channel Multi-Channel Analyzer with 2"x2" NaI (TI) detector, flat field collimator IAEA standard and a personal computer interface, Model Biodex Medical Systems.

Patients

Twenty patients (3 male and 17 female), older than 60 years old, were admitted to the radionuclide therapy ward between December 2010 to December 2011 at Siriraj Hospital. They were physically unable to take care for themselves without assistance from comforters or carers. Most of them had difficulty to walk to the bathroom. Nine received 200 mCi and 11 received 150 mCi.

Caregivers

Caregivers (2 male and 18 female), aged over 40 to 66 years, of twenty patients hospitalized in the radionuclide therapy ward after high-dose radioiodine therapy (5.55-7.40 GBq) were instructed to strictly comply with radiation safety instructions. The radiation risks are discussed and the radiation protection requirements were reviewed to both the patients and the caregivers. Caregivers were required to sign an undertaking that he/she will abide by radiation safety guidelines. Emphasis was placed on advising the caregiver to minimize contact with patients and stay behind the lead barrier, with exceptional circumstances, for example more spending time than recommended with a seriously ill patient.

Procedures

During the period of this study, caregivers are provided with an electronic pocket dosimeter (EPD), ALOKA MyDose MiniModel PDM-112. Cumulative radiation dose throughout a period of 3 d following the administration of I-131 were recorded. Each identified caregiver was instructed to wear the dosimeter clipped to a breast pocket or inserted in a pocket. At night, the dosimeter was to remain at the bedside table of the caregiver. The dosimeter was returned to the Section of Nuclear Medicine after 3 d and the recorded data were analyzed.

In vivo thyroid bioassay

On day of discharge, thyroid screening measurements were performed on caregivers to monitor the intake of volatile radioiodine following the criteria suggested in the IAEA Safety Guide RS-G-1.2⁽⁷⁾. A thyroid uptake unit, Atomlab 950 PC Medical Spectrometer was used for measuring radioiodine in the thyroid.

The protocol was approved by the Siriraj Institutional Review Board and a written informed consent was obtained from each subject.

Statistical analysis

Statistical analysis was done using SPSS version 13.0 (SPSS Inc., Chicago, Illinois, USA) software. Comparisons of doses were performed with the unpaired t-test. Data were reported as the maximum, minimum. Statistical significance was set at $p < 0.05$.

Results

The cumulative doses to caregivers over 3 days from patients treated with 150 mCi ($n = 11$) and 200 mCi ($n = 9$) of I-131 ranged from 37 to 333 μ Sv and 176 to 1,920 μ Sv respectively (Table 1). A significant difference ($p = 0.03$) was observed between doses to caregivers from patients administered 5.55 and 7.4 GBq. Fig. 1 shows that dose received by 18 caregivers (90%), were less than a dose limit of 1 μ Sv for general members

Table 1. Dose received from caring patients administered 5.55 and 7.4 GBq therapeutic dose of I-131

Caregivers	Dose received (mSv)	
	5.55 GBq	7.4 GBq
1	333	1,920
2	326	1,254
3	183	677
4	157	636
5	141	410
6	135	388
7	117	237
8	81	185
9	70	176
10	38	
11	37	
Mean	147.1	653.7
SD	101.7	582.7
Min	37	176
Max	333	1,920

of the public. The other 2 caregivers of 7.4 GBq patients (10%) received an external dose between 1 and 2 μ Sv.

Examples of supporting and caring activities when patients need help and approximate time spent in vicinity of the patients was summarized in Table 2. A maximum dose received in the first 24 hour was 340 μ Sv and the maximum dose received in close contact to the patient was 365 μ Sv of which approximately 11 μ Sv was from helping patient to bathroom, 4 μ Sv from tube feeding and 28 μ Sv from changing diapers for bedridden patient, assisting patients with bathing and emptying and replacing a urinary bag.

Discussion

Hospitalization of non self-supporting patients for several days can increase exposure of family members designated as caregivers or occupational exposure of hospital staff. The major source of radiation dose to the caregivers is from external exposure. In this study, all caregivers received dose within limit of the IAEA and the European Commission guidance that proposed dose constraints for family and close friends

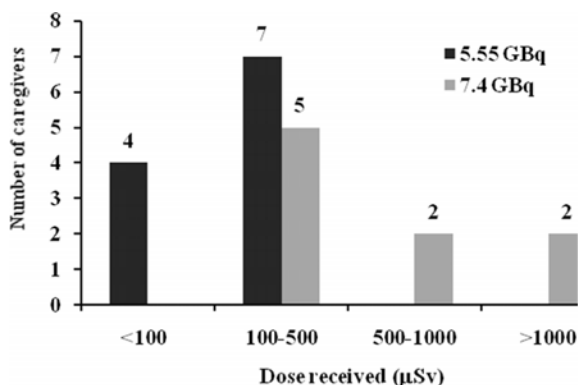


Fig. 1 Distribution of caregivers' dose from patients received 150 and 200 mCi of I-131.

per treatment with I-131 of 3 mSv to adults up to 60 years old^(2,5). Dose limit and dose constraint from the patients after radionuclide therapy has been discussed over many decades. Until lately, the recent publication of the ICRP Publication 94 and IAEA Safety reports series 63⁽⁵⁾ recommended a dose constraint to carers and comforters of 5 mSv/episode. Previously, the U.S. Nuclear Regulatory Commission (USNRC), allowing the release of patients immediately after I-131 therapy if the total effective dose equivalent from the patient to an individual does not exceed 5 mSv in any 1 year. With this change, a patient can be treated with a higher amount of I-131 as an outpatient with proper instructions to keep the radiation exposure to other individuals as low as it is reasonably practicable. Radiation dose to caregivers ranging from 0.37 to 1.92 mSv reported in this study are agreeable with many publications.

Grigsby et al⁽⁸⁾ reported radiation dose to 65 household members ranged from 0.01 mSv to 1.09 mSv from patients received I-131 doses ranging from 2.8 to 5.6 GBq. Rutar et al⁽⁹⁾ measured radiation doses to family members ranging from 0.17 to 4.09 mSv to caregivers in caring of patients received administered activities from 0.94 to 4.77 GBq. Barrington et al⁽¹⁰⁾ reported that the cumulative dose to nursing staff depended on patient mobility and was estimated at 0.08 mSv for a self-caring patient to 6.3 mSv for totally helpless patient. If no restriction is applied, as high as 132 mSv may be obtained. Marriott et al⁽¹¹⁾ reported the maximum penetrating dose of 0.283 mSv to caregivers to 25 self-help patients receiving 3.7 GBq radioiodine outpatient therapy for differentiated thyroid carcinoma for 1 week. Williams and Woodward⁽¹²⁾ estimated an effective dose of 3.4 mSv over 7 days to nursing staff on dealing with helpless patient undergoing 1 GBq radioiodine therapy. The results of this study and many other studies suggest that radioiodine can be a very safe treatment if

Table 2. Dose received from supporting and caring patients

Caring activities	Dose received (mSv)	Time spent (min)
1. Helps patient to bathroom	11	10-40
2. Tube feeding	4	15-30
3. Changing diapers for bedridden patients*	28	15-30
4. Assisting patients with bathing*		
5. Emptying and replacing a urinary bag*		
6. Maximum dose received in the first 24 hour	340	
7. Maximum dose received in close contact to patient	365	

* Activities 3, 4, 5 shared similar radiation dose and time spent

safety instructions and practices are provided during and after I-131 treatment.

Conclusion

The radiation doses to caregivers from comforting and caring of hospitalized in-patients treated with I-131 for thyroid cancer increased with increasing administered dose to the patient. However, they are well below the dose constraint of 5 mSv. This demonstrated that the given radiation precaution instruction is adequate. Radiation dose received depends mostly on the degree of patient's care requirements and time spent in close contact to the patient. Moreover, dose received by caregivers may be adjusted on caregivers' decision in compliance with the safety instruction.

What is already known on this topic?

With remarkable increase in our thyroid cancer cases, most of the radioiodine treated patients may be able to carry on a normal life and some will need care and assistance with daily tasks especially during their hospital isolation e.g. mobility and feeding. Caregivers often involves close contact with the patient, sometimes for prolonged periods of time and the radiation doses they receive may be higher than the dose limit that would normally apply to members of the public. External radiation doses to caregivers from radioiodine treated outpatients have been reported in several studies but no evidence of such reports from hospital isolation patients. This study measured for the first time, radiation exposure to family caregivers caring for radioiodine treated patients during their stay in the hospital isolation ward.

What this study adds?

This study ensures radiation safety to family caregivers of radioiodine therapy patients and confirmed the appropriateness of the instruction provided. All of them received radiation doses allowed, lower than 5.0 millisieverts (mSv), during hospital isolation under current regulations for individuals exposed to radioactive patients.

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Potential conflicts of interest

None.

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ปริมาณรังสีที่ญาติได้รับจากผู้ป่วยที่เข้ารับการรักษามะเร็งไทรอยด์ด้วยไอโอดีน-131 ในโรงพยาบาลศิริราช

สิริพร ตันโนนเชียง, นภมณ ศรีตงกุล, พจี เจาทะเกษตริน, มลลดี ตันหาวิรุพท์

วัตถุประสงค์: ผู้ป่วยที่ได้รับการรักษามะเร็งต่อมไทรอยด์ด้วยไอโอดีน-131 จำเป็นต้องแยกตัวจากบุคคลอื่นโดยเข้าพักรักษาเป็นผู้ป่วยในของโรงพยาบาล ในกรณีผู้ป่วยไม่สามารถช่วยเหลือตนเองได้ ผู้ให้การดูแลผู้ป่วยจะมีความเสี่ยงจากการได้รับรังสีจากตัวผู้ป่วย การศึกษานี้มีวัตถุประสงค์เพื่อวัดปริมาณรังสีที่ผู้ให้การดูแลผู้ป่วยได้รับขณะพักอยู่ในโรงพยาบาล

วัสดุและวิธีการ: โดยติดเครื่องวัดรังสีชนิดพกพาที่อ่านค่าได้ทันทีให้กับผู้ดูแลผู้ป่วย 20 ราย มีการให้คำแนะนำเรื่องความปลอดภัยทางรังสี การบันทึกกิจกรรมการดูแลผู้ป่วยและปริมาณรังสีที่ได้รับ ก่อนผู้ป่วยกลับบ้านผู้ดูแลจะได้รับการตรวจวัดปริมาณไอโอดีน-131 ที่อาจประอะเปื้อนเข้าสู่ต่อมไทรอยด์ด้วยเครื่องวัดการจับไอโอดีนรังสีของต่อมไทรอยด์

ผลการศึกษา: ปริมาณรังสีที่ผู้ดูแล 20 คน ได้รับจากผู้ป่วยที่ได้รับการรักษาด้วยไอโอดีน-131 ขนาด 150 มิลลิวรี (11 คน) และ 200 มิลลิวรี (9 คน) มีค่าระหว่าง 37 ถึง 333 ไมโครซีเวิร์ต และ 176 ถึง 1,920 ไมโครซีเวิร์ตตามลำดับ ขึ้นกับระดับความช่วยเหลือที่ผู้ป่วยต้องการ ไม่พบปริมาณรังสีสะสมภายในต่อมไทรอยด์ ปริมาณรังสีสูงสุดที่ได้รับ 1.92 มิลลิซีเวิร์ต เกินขีดจำกัด 1 มิลลิซีเวิร์ตต่อปีสำหรับประชาชนทั่วไป แต่ไม่เกิน 5 มิลลิซีเวิร์ตสำหรับผู้ให้การดูแลผู้ป่วยตามข้อกำหนดของคณะกรรมการป้องกันอันตรายจากรังสีระหว่างประเทศ (ICRP)

สรุป: คำแนะนำการปฏิบัติตัวที่ให้กับผู้ดูแลผู้ป่วย ทั้งโดยการบอกเล่าและเอกสารประกอบในการศึกษานี้ใช้เป็นแนวทางการดูแลความปลอดภัยทางรังสีให้กับผู้ดูแลผู้ป่วยรังสีที่ต้องการความช่วยเหลือได้อย่างเหมาะสมตามมาตรฐานสากล
