OCCUPATIONAL EXPOSURE OF NURSING STAFF WORKING WITH RADIOIODINE THERAPY DURING 11 YEARS*

José Ulisses Manzzini Calegaro[1], Sandra Mara Pessano Teixeira[2]

Abstract **OBJECTIVE: The present study was aimed at evaluating the occupational exposure of nursing staff in charge of inpatients undergoing ^{131}I therapy during 11 years. MATERIALS AND METHODS: The exposure situations were classified according to a questionnaire answered by three nursing attendants, correlating the procedures with activities, distances and amount of time in the iodotherapy room. Records of received doses by two types of dosimeters were evaluated over two subsequent periods. In both periods the nursing attendants received instructions about radiological protection. RESULTS: In usual situations, their amount of time in the iodotherapy room was in compliance with the standard time established by the service. In unusual situations, where the patient needed assistance for mobility, the exposure period was above the standard. However, this exposure occurs casually (only one or two times a year). During the period between 1993 and 1999 (dosimetric films) there were ten dose records, all of them at record level. From 2000 to 2003 (thermoluminescent dosimeters) ten dose records were also obtained, with only one of them at the investigation level. During this study period, the mean ^{131}I activity was doubled. CONCLUSION: Despite the increased levels of activity there was no significant increase in dose to nursing attendants.**

Keywords: Occupational exposure; Effective dose; External individual monitoring; Iodo-therapy.

Resumo *Avaliação da exposição ocupacional de auxiliares de enfermagem na iodoterapia durante 11 anos.*
OBJETIVO: O objetivo deste estudo foi avaliar a exposição ocupacional de auxiliares de enfermagem encarregados da assistência aos pacientes internados para terapia com ^{131}I, num período de 11 anos. MATERIAIS E MÉTODOS: As situações de exposição foram classificadas de acordo com as respostas de três atendentes a um questionário que relaciona os procedimentos realizados às atividades administradas, às distâncias e aos tempos de permanência na enfermaria. Os registros das doses recebidas em dois tipos de dosímetros, em dois períodos subseqüentes, foram analisados. Em ambos os períodos os atendentes receberam instruções de proteção radiológica. RESULTADOS: Nas situações comuns o tempo de permanência na enfermaria está dentro do tempo de referência utilizado. Nas situações não-comuns, quando o paciente necessita de auxílio na locomoção, o tempo de exposição está acima do tempo de referência, no entanto, essa exposição ocorre somente uma ou duas vezes por ano. No período de 1993 a 1999 (filme dosimétrico) houve dez registros de doses, sendo todas ao nível de registro. No período de 2000 a 2003 (dosímetro termoluminescente) houve dez registros de doses, sendo uma delas situada no nível de investigação. Nesse período a atividade média utilizada duplicou. CONCLUSÃO: Não foi observado aumento significante nas doses dos atendentes.

Unitermos: Exposição ocupacional; Dose efetiva; Monitoração individual externa; Iodoterapia.

INTRODUCTION

In the last decade, total thyroidectomy has been adopted as an initial modality for management of differentiated thyroid cancer, contemplating its variable multicentricity. The ^{131}I ablation of the remaining tissue allows the utilization of suppressive hormone therapy to avoid the proliferation of further residual nuclei of cancerous cells, as well as to follow-up the progress of the disease through the serum levels of thyreoglobulin[1]. For these reasons, there has been a considerable increase in the utilization of ^{131}I as complementary therapy.

Some routine procedures are performed by nursing assistants who attend to one or two inpatients during the ^{131}I therapy, and therefore they are exposed to radiation emissions from these patients. This exposure is variable according to the number of inpatients, procedures performed, the distance kept from the patient, and amounts of time in the ambulatory.

The present study is aimed at evaluating the exposure circumstances and effective doses to nursing assistants involved in the administration of ^{131}I therapy in the period between 1993 and 2003, with two types of individual monitoring devices: dosimetric films and thermoluminescent dosimeters[2,3].

MATERIALS AND METHODS

Surveys were performed to evaluate the circumstances of the radiation exposure of nursing assistants, as well as doses received while assisting inpatients submitted to ^{131}I therapy. In order to delineate the situations where nursing assistants were exposed to

* Study developed in the Centro de Medicina Nuclear do Hospital de Base do Distrito Federal, Secretaria de Estado de Saúde (State Secretariat of Health), Brasília, DF, Brazil.

1. MD, Head for the Centro de Medicina Nuclear do Hospital de Base do Distrito Federal, Secretaria de Estado de Saúde, Brasília, DF, Brazil.

2. Medical Physicist, Centro de Medicina Nuclear do Hospital de Base do Distrito Federal, Secretaria de Estado de Saúde, Brasília, DF, Brazil.

Mailing address: Dr. José U.M. Calegaro. AOS 6, bloco D, ap. 604. Brasília, DF, Brazil, 70660-064. E-mail: jcalegaro@uol.com.br

Received October 30, 2006. Accepted after revision February 5, 2007.

radiation, a questionnaire on tasks description was elaborated to be answered by them (Chart 1). This questionnaire asked the respondents to describe their routine tasks — common situations —, and situations where patients presented some locomotion difficulty — uncommon situations. There were questions about frequency of events, distances kept, and mean amount o time in the therapy room for the each task performance, considering two inpatients, during two days. The situations description and estimates can be found on Table 1. The percentages of common and uncommon situations were estimated with basis on the service records.

The amount of time spent in tasks during patients' stays was compared with the amounts of time in the therapeutic ambulatory utilized as a reference in the service[4], considering the activities and percentages of occurrence of these radiation doses. These comparative results can be found on Table 2.

The effective doses in two consecutive periods and in two types of individual monitoring devices were compared to the required maximum limits of annual doses[5] (Figure 2). For this purpose, a survey was conducted to determine the activities involving ^{131}I therapy in the period between 1993 and 2003 (Figure 1), and the effective dose to the three nursing assistants in charge of the inpatients (Table 3). In the period between 1993 and 1999, the individual monitoring method utilized was the dosimetric film supplied by the Laboratory of Radiological Protection of Department of Nuclear Energy – Universidade Federal de Pernambuco. In the 2000–2003 period, thermoluminescent dosimeters (Sapra Landauer Ltda.) were utilized.

Dosimetric film consist of a radiographic film utilized to differentiate the several radiation energies, whose blackening is caused by the incidence of ionizing radiation through several filters, allowing the estimation of the radiation dose received by the user[3]. The dosimetric films sensitivity is intermanufacturer variable, but the minimum dose limit is 0.20 mSv[2].

The thermoluminescent dosimetry utilizes small lithium-fluoride crystals where radiation deposits its initial energy and that generate light. This is measured by a photomultiplier tube, and the amount is utilized to estimate the radiation dose[3]. Thermoluminescent dosimeters are considered as more sensitive than dosimetric films, because their lower limit is about 0.10 mSv[2].

In the two above mentioned periods, the nursing assistants were given instructions regarding the main measures of radiological protection: distance, as feasible, use of shielding (barriers or lead apron) during

Chart 1 Questionnaire for nursing assistants.

1 – List and describe the routine tasks performed in the ambulatory for inpatients submitted to ^{131}I therapy.
2 – Estimate the time spent for each of the above described tasks.
3 – Estimate the approximate distance between the patient and you during each of the above described tasks.
4 – List and describe uncommon exposure situations (for example, patients who need assistance to go to the toilet: disabled persons, elders, etc.) as well as their frequency.
5 – Estimate the time spent with each of the above described tasks.
6 – Estimate the approximate distance between the patient and you during each of the above described tasks.

Table 1 Description of procedures performed by nursing assistants for ^{131}I therapy in two inpatients.

Situations / Occurrence (%)	Description	Frequency	Time (min)	Distance (m)
Common / 98	Rounds	10	1	4.0
	Medicines administration	1	2	1.0
	Arrange sheets in the shielded container	1	3	1.0
	Patients assessment	1	4	1.0
	Blood pressure measurement	4	1.25	0.5
Amount of time		–	24	–
Uncommon / < 2	Rounds	10	1	3.0
	Assist the patient to go/come back from the toilet	10	4	0.3
	Medicines administration	1	2	1.0
	Arrange sheets in the shielded container	1	3	1.0
	Patients assessment	1	5	1.0
	Blood pressure measurement	1	4	0.5
	Solucionar problemas	3	5	3.0
Amount of time		–	79	–

Table 2 Comparison between the amount of time in the therapeutic ambulatory in common and uncommon situations, and the reference time utilized in the service, considering the percentages of administered doses and the 1-meter distance from the patients.

Activity (MBq/mCi)	Percentage of administered activities (%)	Reference time (min)	Amount of time in the therapeutic ambulatory	
			Common situations (min)	Uncommon situations (min)
1850/50.0	1.09	108	24	79
2970/80.3	1.09	66	24	79
3700/100.0	80.89	54	24	79
4650/128.7	0.20	43	24	79
5570/150.5	5.08	36	24	79
7402/200.0	7.93	27	24	79
9252/250.0	2.03	18	24	79

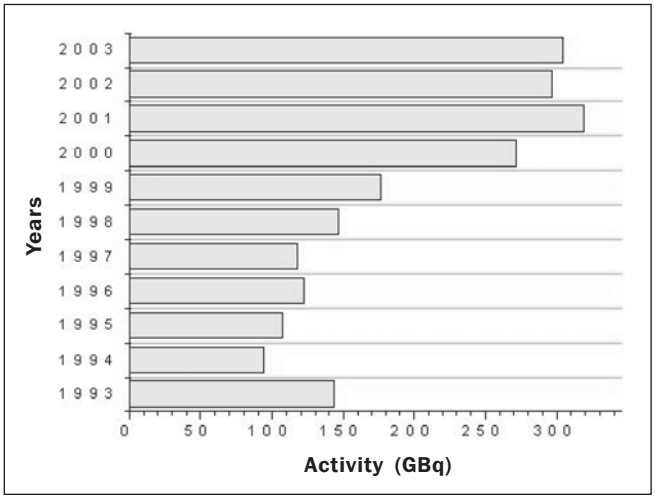

Figure 1. Mean administered activity in the 1993–2003 period.

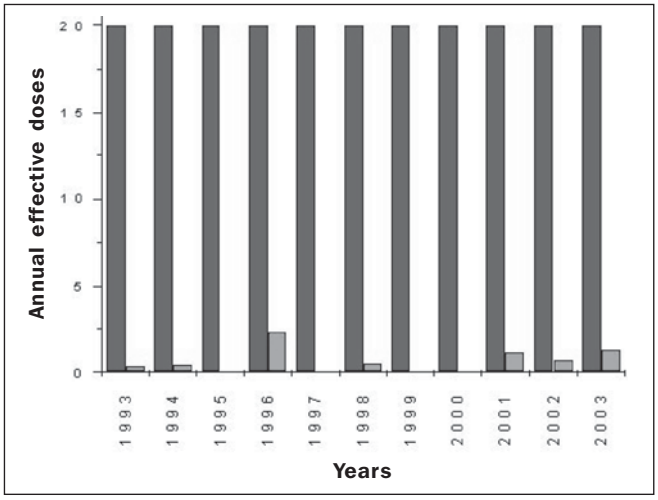

Figure 2. Comparison between annual dose limits (dark gray) and annual doses recorded (light gray) in the 1993–2003 period.

long-duration procedures and maximum amount of time at a 1 meter-distance from the patients[4]. Also, instruction was given for routine or emergency procedures not to be performed within 30 minutes following the dose administration[6], and for them to avoid procedures in front of the patient, because, in this positioning, the area of exposure is larger than in the lateral positioning[7,8].

In both periods, the monitoring devices were kept in a safe place, free from ionizing radiation. The chi-square test was utilized for statistical data analysis.

RESULTS

It could be observed that, in common situations, the mean amount of time of nursing assistants in the therapy room, is about 24 minutes, and is within the maximum amount of time respected by the service[4], and the percentage of patients presenting with no locomotion difficulty is 98%. In uncommon situations, the mean amount of time in therapy room is 79 minutes, a time considered as above the reference time, however, the percentage of patients presenting with locomotion difficulty is lower than 2%, an index considered as extremely low.

In the period evaluated, the percentage of administered doses was 80.89% for doses with 3700 MBq activity; 7.93% for doses with 7400 MBq activity; 5.08% for doses with 5500 MBq activity; 4.07% for doses < 3700 MBq activity; and 2.03% for doses with 9250 MBq activity.

The mean number of patients submitted to iodotherapy in the 1993/1999 period was 30, while in the 2000/2003 period, 73 patients were treated per year. Thus, the mean activity of 1.30×10^5 MBq/year increased to 2.98×10^5 MBq/year, that is to say, the was a 2.3-time increase (Figure 2).

In the 1993/1999 period there were ten dose records on dosimetric films, all of them at record level. M corresponds to doses < 0.20 mSv (Table 3). In the 2000/2003 period, ten doses records also were obtained with thermoluminescent dosimeters, with only one of them at the investigation level (1.30 mSv). In this case, M corresponds to doses < 0.10 mSv (Table 3).

In the first period the percentage of dosimeter readings was 77.6%; in the second period this percentage was 83.3%. It is important to consider that these are reasonable indices for the present study purposes.

Figure 2 demonstrates that the doses records from both dosimetric systems (dosimetric film and thermoluminescent dosimeter) were very below the standard limit[5]. There was no statistical significant difference between the doses recorded.

DISCUSSION

The amount of time of nursing assistants in the therapeutic ambulatory during common situations is within the reference time adopted by the service[4], and the occurrence of higher exposure (uncommon situations) is considered as non-relevant.

During the studied period, the activity of ^{131}I administration doubled, however, the exposure recorded for each nursing assistant has not presented the corresponding increase of 2.3 times. The records do not demonstrate an increase in the results from the individual monitoring performed with thermoluminescent dosimeters during the period where the activity was doubled. It is observed that the number of dosimetric readings was higher.

In the periods evaluated, the doses to professionals were considered as extremely low in relation to the limits required by the regulations in force[5]. In both types of individual monitoring devices the doses recorded were much below the standard annual limits. Thus, we have considered important to elaborate tables including the appropriate times and distances for the different activities of nursing assistants, allowing the management and reduction of the occupational exposure during the assistance to ^{131}I therapy. It may be suggested that services operating with activity equivalent or lower than those found in the present study do not require a mandatory individual monitoring, provided the nursing staff is given instructions about the amount o time in the therapy ambulatory and appropriate distances to be kept from the patients. We emphasize the relevance of a revision in the radiological protection regulation requirements that should be directly related to the

Table 3 Records of monthly and annual radiation doses in mSv, on dosimetric films (1993–1999) and thermoluminescent dosimeters (2000–2003).

Month	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Jan.	M	M	M	M	M	M	M	M	0.50 0.40	M	M
Feb.	M	M	M	M	M	M	M	M	0.50 0.30	M	M
Mar.	M	M	M	M	M	M	M	M	0.30	M	1.30
Apr.	M	M	M	M	M	M	M	M	M	M	M
May	M	M	M	1.20 1.10	M	M	M	M	M	M	M
Jun.	0.20	0.20	M	1.20 1.10	M	M	M	M	M	0.20	M
Jul.	M	M	M	M	M	M	M	M	0.30	0.30	M
Aug.	0.20 0.30	0.20	M	M	M	M	M	M	M	0.20	M
Sept.	M	M	M	M	M	M	M	M	M	M	M
Oct.	M	M	M	M	M	M	M	M	M	M	M
Nov.	M	M	M	M	M	0.50	M	M	M	M	M
Dec.	M	M	M	M	M	M	M	M	M	M	M
Annual	0.35	0.40	M	2.30	M	0.50	M	M	1.15	0.70	1.30

level of radioactive material activity as well as to the procedures frequency.

Few studies evaluate the occupational radiation exposure of nursing staff. One of them demonstrates the low level recorded: 1.5 mSv/year[9]. Other authors have demonstrated the same finding: the radiation levels are much below the permissible levels[10,11]. Considering that the permissible dose limit for the general population is 1.0 mSv/year; that in certain Brazilian regions the natural radiation level is between 7.0 and 12.0 mSv/year[12]; and that the radiation levels described by the present study are frequently non-relevant, it seems that the current regulation requirements are exaggerated. These considerations lead to the conclusion that an appropriate instruction on radiological protection principles seems to be enough for the effective protection of the nursing staff involved in the assistance to patients submitted to ^{131}I therapy.

CONCLUSION

Occupational ionizing radiation exposure levels are low in nursing assistants who have been appropriately instructed on basic radiological protection procedures. It is possible to suggest that the requirements of external individual monitoring might be less stringent than in other centers where the number of patients is lower than in the Center of Nuclear Medicine at Hospital de Base do Distrito Federal.

REFERENCES

1. Schlumberger M, Berg G, Cohen O, et al. Follow-up of low-risk patients with differentiated thyroid carcinoma: a European perspective. Eur J Endocrinol 2004;150:105–112.
2. Extracts from IAEA's Resources Manual in Nuclear Medicine. World Federation of Nuclear Medicine and Biology. World J Nucl Med 2004; 3:82–104.
3. Phelps ME, Sorenson JA. Radiation safety and health physics. In: Sorenson JA, Phelps MB, editors. Physics in nuclear medicine. 2nd ed. Philadelphia, PA: WB Saunders, 1987;537–538.
4. Riccabona G. ^{131}I therapy for thyroid disease. Innsbruck, Austria: Ed. Oris Group, 1999;10.
5. Comissão Nacional de Energia Nuclear. Diretrizes básicas de radioproteção. Norma CNEN-NN 3.01, Resolução nº 27, 2005, pág.14, seção 5.4.2, subseção 5.4.2.1.
6. Castronovo Jr FP, Beh RA, Veilleux NM. Iodine 131 therapy patients: radiation dose to staff. Radiat Prot Dosim 1986;15:45–49.
7. Castronovo Jr FP, Beh RA, Veilleux NM. Dosimetric considerations while attending hospitalized I-131 therapy patients. J Nucl Med Technol 1982;10:157–160.
8. Andrade JR, Ferlin BL, Spiro MEB, Bernausk MEB, Pinto ALA, Bacelar A. Determinação das curvas de isoexposição em pacientes submetidos a iodoterapia. Porto Alegre, RS: Pontifícia Universidade Católica do Rio Grande do Sul, 2000.
9. Watanabe M, Ishikawa N, Ito K. Examination of occupational exposure to medical staff (primarily nurses) during ^{131}I medical treatments. Kaku Igaku 2004;41:25–31.
10. Siekierzynski M. Problems with radiation protection for adjuvant radiotherapy of thyroid cancer. Wiad Lek 2001;54 Suppl 1:307–311.
11. Williams CE, Woodward AF. Management of the helpless patient after radioiodine ablation therapy – are we being too strict? Nucl Med Commun 2005;26:925–928.
12. Freire-Maia N. Radiogenética humana. São Paulo, SP: Edusp,1972;55–92.