

# **Evaluation of Internal Exposure of Nuclear Medicine Staff Working with Radioiodine and Technetium**

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## **Abstract**

The I-131 and Tc-99m content in the thyroid of staff members working with this radionuclides has been measured in ten Departments of Nuclear Medicine performing therapy and diagnosis of thyroid disease in Poland . The measurements were performed with portable detection unit for „in situ” measurements of radioiodine and technetium.

All individuals actively working with iodine and technetium show measurable amounts of this isotopes in their thyroids. The average measured activity in the thyroid of the nuclear medicine staff was found to be equal at average 550 Bq within the range from 30 Bq to 70 kBq. The average and range of I-131 activity measured in thyroids for all medical units were: 1400 Bq, (100 Bq – 70 kBq Bq), 400 Bq, (30 Bq - 3000 Bq), 140 Bq, (50 Bq - 1000 Bq) for technical staff, nuclear medicine staff and hospital services staff respectively. There is no apparent correlation between the measured I-131 levels and risk categories. Nevertheless the technical and nuclear medicine staff show higher I-131 thyroid level comparing to hospital services staff.

Base on results of measurements, the Effective Dose Equivalent for particular person due to inhalation of I-131 and Tc-99m was calculated.

Calculated average Effective Dose Equivalent for particular exposed person is below 50 per cent of 20 mSv/year.

## **Key Words**

Occupational exposure, radioiodine I-131, technetium Tc-99m

## **Introduction**

In 1997 the Central Laboratory for Radiological Protection set up programme “The Laboratory for monitoring of radioiodine in thyroid for population in emergency situation”. The main goal of this program was to establish monitoring assembly and develop risk assessment methods for internally contaminated people with I-131 in the event of a nuclear accident or radiological emergency. This Laboratory programme takes advantage of unique opportunity for testing monitoring devices and dose estimation methods on the base of measurements of activity of radioiodine and technetium in thyroid of occupationally exposed workers.

## **Material and methods**

The monitoring assembly of the Laboratory consists of two independent measuring units:

Stationary Unit for measuring I-131 and Tc-99m with low limit of detection,

Portable Unit for “in situ” measurements of I-131 and Tc-99m. It has been mainly foreseen for fast screening population in radiological emergency situation, or for monitoring occupationally exposed people far away from Laboratory.

The measurements of iodine and technetium content of occupationally exposed personnel were performed with portable detection unit (prod. Canberra-Packard) (Fig.1.) , which is consist with scintillation detector NaI(Tl) (size 76 x 76 mm, resolution 9%) - battery-powered, portable tube base Multichannel Analyzer Canberra UniSPEC, paired with the notebook computer and Genie-2000 Basic Spectroscopy Software.

In the period 2008-2011 the measurements of I-131 and Tc-99m content in the thyroid of staff members working with radioiodine and technetium has been measured in ten Nuclear Medicine Units performing therapy and diagnosis of thyroid disease in Poland. The measurements were performed with portable detection unit.

The counting configuration for monitoring personnel was identical to that used in the calibration procedure. Typically, detector set at a neck - to - detector distance of 10 or 15 cm, using a 300 seconds counting time. The background was measured with detector placed 15 cm away from the available RSD neck phantom, prior to or just following the count performed on the person. The measurements were performed in selected as low as possible background places. The MDA for mobile unit ranges from 10 – 50 Bq at the time measurement of 300 seconds and depends on background condition in particular units.

The measured personnel can be divided into some categories according to internal contamination risk to unsealed sources of I-131 and Tc-99m:

1. Technical staff mainly performing routine diagnostic investigation,
2. Nuclear medicine staff (physician, nurse) working with in vivo administration of I-131 or Tc-99m to patients,
3. Hospital services staff (orderlies, cleaners) performing auxiliary activities to the patients (cleaning of the rooms, changing of bedclothes).

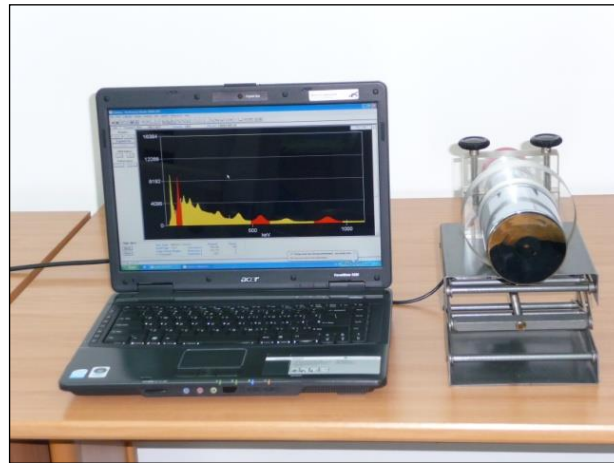
## **Results**

The measurements of radioiodine content in the thyroid were performed in six medical units that use I-131 for therapy and diagnosis of thyroid disease. About of one hundred exposed persons were investigated. The results of measurements are presented in Table 1.

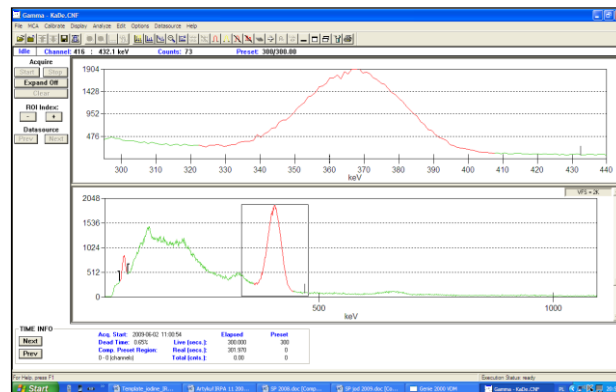
All individuals actively working with iodine show measurable amounts of the radioiodine in their thyroids (Fig.2.). The average measured activity in the thyroid of the nuclear medicine staff was found to be equal at average 550 Bq within the range from 30 Bq to 70000 Bq. The average and range of I-131 activity measured in thyroids for all medical units were: 1400 Bq, (100 Bq - 70000 Bq), 400 Bq, (30 Bq - 3000 Bq), 150 Bq, (30 Bq - 1000 Bq) for ) for categories 1, 2, 3 respectively.

Nevertheless the 1 and 2 categories show higher I-131 thyroid level comparing to category 3.

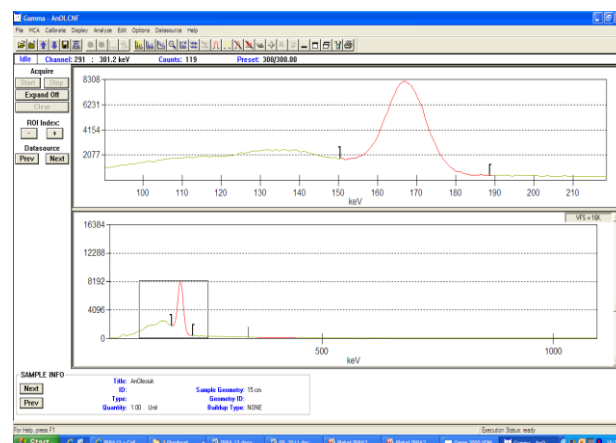
The mean value of Tc-99m content in thyroid of nuclear medicine staff (category 2) was about 1500 Bq (range from 100 Bq to 17000Bq).



**Fig. 1. The portable unit with scintillation detector NaI(Tl) for measurement of I-131 and Tc-99m.**



**Fig. 2. Spectrum of I-131 with photopeak of 364keV collected at thyroid of exposed worker in Medical Unit**



**Fig. 3. Spectrum of Tc-99m with photopeak of keV collected at thyroid of exposed worker in Medical Unit**

**Table 1. The I-131 and Tc-99m content and effective doses assessment for personnel of Nuclear Medicine Units**

Medical Unit No.	Category	Range of I-131 content in thyroid [Bq]	Mean value of I-131 content in thyroid [Bq]	Effective dose equivalent from inhalation of I-131 [mSv]	Mean value of Tc-99m content in thyroid [Bq]	Per cent of occupational exposure limit
1	1	50 - 100	70	0.40	< MDA <sup>*)</sup>	2
	2	50 - 70	60	0.35	< MDA	
	3	50 - 60	60	0.35	< MDA	
	All	50 - 100	65	0.40		
2	1	60 - 80	70	0.38	< MDA	2
	2	50 - 75	60	0.35	< MDA	
	3	60 - 80	70	0.38	< MDA	
	All	60 - 80	70	0.38		
3	1	70 - 400	250	1.50	< MDA	4
	2	50 - 180	120	0.70	2000	
	3	60 - 100	80	0.40	< MDA	
	All	50 - 400	150	0.80		
4	1	60 - 200	150	0.80	< MDA	4
	2	60 - 220	180	1.05	< MDA	
	3	70 - 180	120	0.70	< MDA	
	All	60 - 220	150	0.80		
5	1	80 - 70000	23000	125.00	< MDA	250
	2	170 - 35000	1000	6.00	< MDA	
	3	100 - 5000	2300	12.50	< MDA	
	All	80 - 70000	9000	50.00		
6	1	70 - 200	150	0.80	< MDA	4
	2	100 - 200	170	1.00	1500	
	3	80 - 180	135	0.78	< MDA	
	All	70 - 200	150	0.80		
7	1	50 - 150	120	0.70	< MDA	4
	2	60 - 200	150	0.80	4800	
	3	100 - 200	160	0.90	< MDA	
	All	50 - 200	150	0.80		
8	1	60 - 210	160	0.90	< MDA	4.5
	2	100 - 260	180	1.10	3000	
	3	90 - 200	140	0.75	< MDA	
	All	60 - 260	160	0.90		
9	1	70 - 400	250	1.50	< MDA	6
	2	100 - 400	300	1.60	5500	
	3	80 - 180	120	0.70	< MDA	
	All	70 - 400	210	1.30		
10	1	70 - 200	150	0.80	< MDA	5
	2	100 - 350	220	1.30	1800	
	3	80 - 220	160	0.90	< MDA	
	All	70 - 350	170	1.00		

<sup>\*)</sup>MDA (minimum detectable activity) for Tc-99m equal 45 Bq

## **Conclusions**

The results of I-131 content in the thyroid of staff members working with radioiodine in ten Departments of Nuclear Medicine do not show any correlation between the measured I-131 levels and risk categories. The averages of I-131 thyroid contents calculated for the particular medical unit item differ remarkably. These differences do not necessary depend on I-131 usage in the particular medical unit but rather on its specific and complex work conditions, staff training and so on.

Base on results of measurements, the Effective Dose Equivalent for particular person due to inhalation of I-131 was calculated with somewhat a conservative assumption that I-131 thyroid content remains constant during the whole year. For the occupational exposure limit of 20 mSv it gives the reference I-131 thyroid level is equal to 7 kBq. Calculated average Effective Dose Equivalent for particular medical is below 50 per cent of 20 mSv/year.

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