STUDIES ON THE RADIATION BURDEN USING ^{131}I FOR THYROID THERAPY *

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The ever increasing use of unsealed ^{131}I sources in the diagnosis and treatment of thyroid disorders (1) at nuclear medicine establishments throughout the world and the growing realisation of the radiation hazards associated with low doses of ionising radiation have led to studies on airborne contamination (2, 4, 7).

The present study aimed at establishing the levels of exposure to personnel from iodine-131 inhaled from unsealed radioactive sources and those to the personnel and non-isotope patients from ^{131}I exhaled by patients treated with doses of radioiodine ranging between 148 and 444 MBq. Variations in ^{131}I concentrations in the air exhaled were also investigated.

MATERIALS AND METHODS

Airborne ^{131}I concentrations were measured in the application room during laboratory and clinical procedures involving between 300 and 1000 MBq, and at 2-3 and 24 hrs after application in the ward room where the patients remained for 3-4 days after having been given ^{131}I for therapeutic reasons.

Airborne ^{131}I concentrations in the application room were found to range between 22 and 1358 Bq/m^3, whereas those in the ward ranged between 17 and 197 and 7 and 17 Bq/m^3 at 2-3 hrs and 23-24 hrs after application, respectively.

^{131}I was found in various form in the application room: that adsorbed on aerosols from 1 to 22%, in elemental state from 3 to 76% and in organic compounds from 18 to 96%, whereas in the ward room its percentage ranged from 1 to 15%, from 14 to 64%, and from 25 to 93%, respectively.

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The apparatus for detecting airborne ^{131}I equipped with a May-pack filter (3) is described in (4) and is shown in Fig. 1. The sensitivity of detection ranged from 0.87 to 2.67 Bq/m^3.

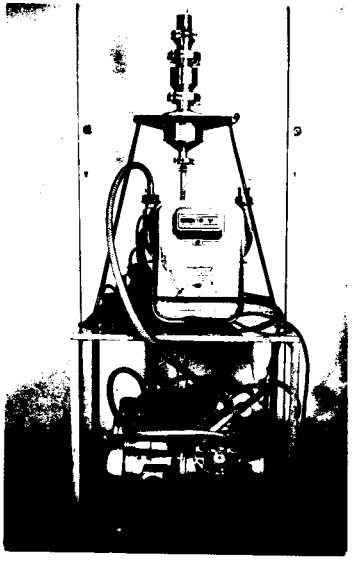

Figure 1. Assembly for sampling airborne ^{131}I in application and adjacent room.

Figure 2. Apparatus for sampling airborne ^{131}I exhaled by patients.

In order to study the concentration of ^{131}I exhaled by 19 patients treated with ^{131}I for hyperthyroidism and by a small group of 6 euthyroids a special assembly was made /Fig. 2/. It consisted of a glass tube with a Petrianov's fiber filter and two 2.5 cm thick NORIT CGI charcoal filters impregnated with 1% of KI. The tube is joined with a flexible tube inserted into a 24 l or 80 l plastic bag.

The ^{131}I concentrations in the air exhaled by patients were measured 2, 3, 5, 24 and 48 hours after oral administration of ^{131}I. Five patients apart from being clinically euthyroid had their 24-hour uptakes below 50%, which is assumed in Poland to represent the mean value for euthyroids and ^{131}I was administered to them to lower their metabolism in coronary insufficiency.

TABLE 1. The exposure per year of personnel and other persons during therapy with ^{131}I

Persons exposed, category of exposure and site of exposure	Ratio of ^{131}I concentration measured to the permissible levels for a given category of exposure	Estimation of the absorbed dose /per year/		
		Real time of exposure per year [h]	Activity inhaled A_i [kBq]	$\frac{A_i}{A_{MPA}}$ **
physicist, A				
application room	1.89	104	81.8	
adjacent room	0.01	1456	7.4	
			89.2	0.10
laboratory technicians, B				
adjacent room during laboratory procedures	0.18	104	2.6	
adjacent room	0.04	1976	10.1	
			12.7	0.05
physician, A				
ward room	0.18	312	22.8	0.03
nurse, A				
ward room	0.18	312	22.8	0.03
non-isotope patient, C				
ward room	5.26	216*	0.52	0.01

* the mean time of patient's stay in the hospital

** A_{MPA} = Maximum Permissible Absorption of ^{131}I through lungs for a given category of exposure

The kinetics of the ^{131}I exhalation in the hyperthyroid patients was found to consist of two widely different exponential processes (5) : one of a short half-life, $T'_{1/2} = 1.43 \pm 0.9$ hrs and the other, $T''_{1/2} = 17.5 \pm 8.6$ hrs.

The kinetics of the ^{131}I exhalation in euthyroids was, however, different, consisting of a sharp rise, with the maximum concentration occuring at 3-4 hours, and a fall faster than that in the hyperthyroid group /$T''_{1/2} = 5.53 \pm 1.03$ hrs/.

The exponential functions calculated from the following shape for hyperthyroid patients:

$$S/t/ = 0.93\, e^{-0.635\, t} + 0.06\, e^{-0.046\, t}$$

DISCUSSION

From the analysis of the exposure of the personnel /Table 1/ the ratio of the ^{131}I concentrations in the air to those permissible for a given category of exposure (6) were found to be exceeded in the case of a physician, and in that of an imaginary non-radioisotope patient placed in a radioisotope therapy room by a factor of 2 and 5, respectively. If, however, the real exposure time is taken into consideration, and the activity of ^{131}I in the body and that taken up by the thyroid is roughly estimated on a yearly basis, the ratio of the activity absorbed through the lungs to that permissible for a given category of exposure is not higher than 10%. The kinetics of the ^{131}I exhaled by hyperthyroid patients seems to be complementary to that of ^{131}I concentration changes in the blood and the curves for hyperthyroid patients can be expressed by two-component exponential equations.

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