125 I AIRBORNE CONTAMINATION LEVELS IN VITRO RADIOMETRY LABORATORIES

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Some recent publications have considered subjects relating to the quantity of airborne radioiodine when used in nuclear medicine, metabolic radiotherapy and protein labelling. The aim of this study is to determine the airborne concentrations of 125 I in in-vitro radiometry laboratories where millions of test tubes, containing altogether - in different solutions and concentrations - activities of the order of 4 GBq, are manipulated every year.

To evaluate the degree of radioactive contamination present in the air, a sampling device was set up, consisting of a glass cylinder within which three separate layers of active carbon were placed. Upstream, a millipore type prefilter was fitted to hold back, if necessary, any particles of 0.8 μm or larger. The active carbon filter (10-18 mesh) has a dry retention efficiency in excess of 95% (2-4).

Using the filter described, samples lasting five hours were taken on different days of the week and at various periods of the year inside a laboratory (100 m3), the number of air changes being limited to 2 per hour. The aim was to keep count of the possible variability in the quantities of manipulated radioiodine as well as of climatic conditions.

TABLE 1

PERIOD	CONCENTRATION Bq/m3 (± 10%)
APRIL	
TUESDAY	7.3 (-2)
WEDNESDAY	2.2 (-1)
THURSDAY	9.8 (-1)
FRIDAY	1.2
JULY	
TUESDAY	1.6 (-1)
WEDNESDAY	1.3 (-1)
THURSDAY	6.6 (-2)
FRIDAY	1.5 (-1)
SEPTEMBER	
TUESDAY	1.1 (-1)
WEDNESDAY	6.6 (-2)
THURSDAY	7.3 (-2)
FRIDAY	1.5 (-1)

Number in parenthesis represent powers of 10

Table 1 Concentration values in air taken in 3 different weeks during a year.

In order to effect evaluation of an equivalent dose to the thyroid following only the chronic inhalation of airborne 125 I, a discontinuous transfer function from the environment to the worker

was assumed.

The compartmental analysis carried out took into account the models presented by the ICRP 30 and, as far as inhalation is concerned, those of the 1966 Task Group (3-5-6). The compartments participating in the metabolism of iodine are shown in Fig. 1.

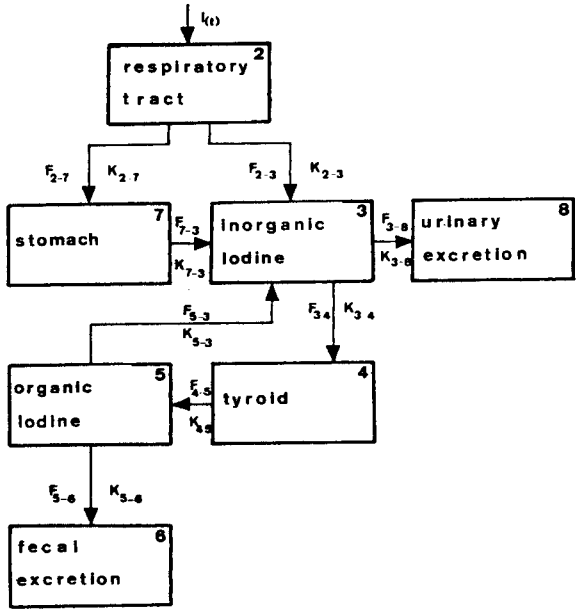

FIGURE 1 Mathematical model used to describe the kinetics of radioiodine in the body.

Transfer of the iodine, I(t), from the environment to the respiratory apparatus, is described by equation /1/ considering the prevalently gassy nature of the contaminant and its total absorption in the respiratory tract :

$$I(t) = Ca(t) * Vi * Fa \qquad /1/$$

where : Ca(t) = concentration in air of the radioisotope (Bq/m3)
Vi = inhaled volume in a unit of time (m3/h)
Fa = deposited fraction

The kinetics of iodine is described for the model presented by a system of differential equations:

$$dQ2(t)/dt = I(t) - (K2-3 + Lr) * Q2(t) \qquad /2/$$

$$dQ7(t)/dt = F2-7 * K2-7 * Q2(t) - (K7-3 + Lr) * Q7(t) \qquad /3/$$

$$dQ3(t)/dt = F2-3 * K2-3 * Q2(t) + K7-3 * Q7(t) + F5-3 * \qquad /4/$$
$$* K5-3 * Q5(t) -(Lr + K3-4) * Q3(t)$$

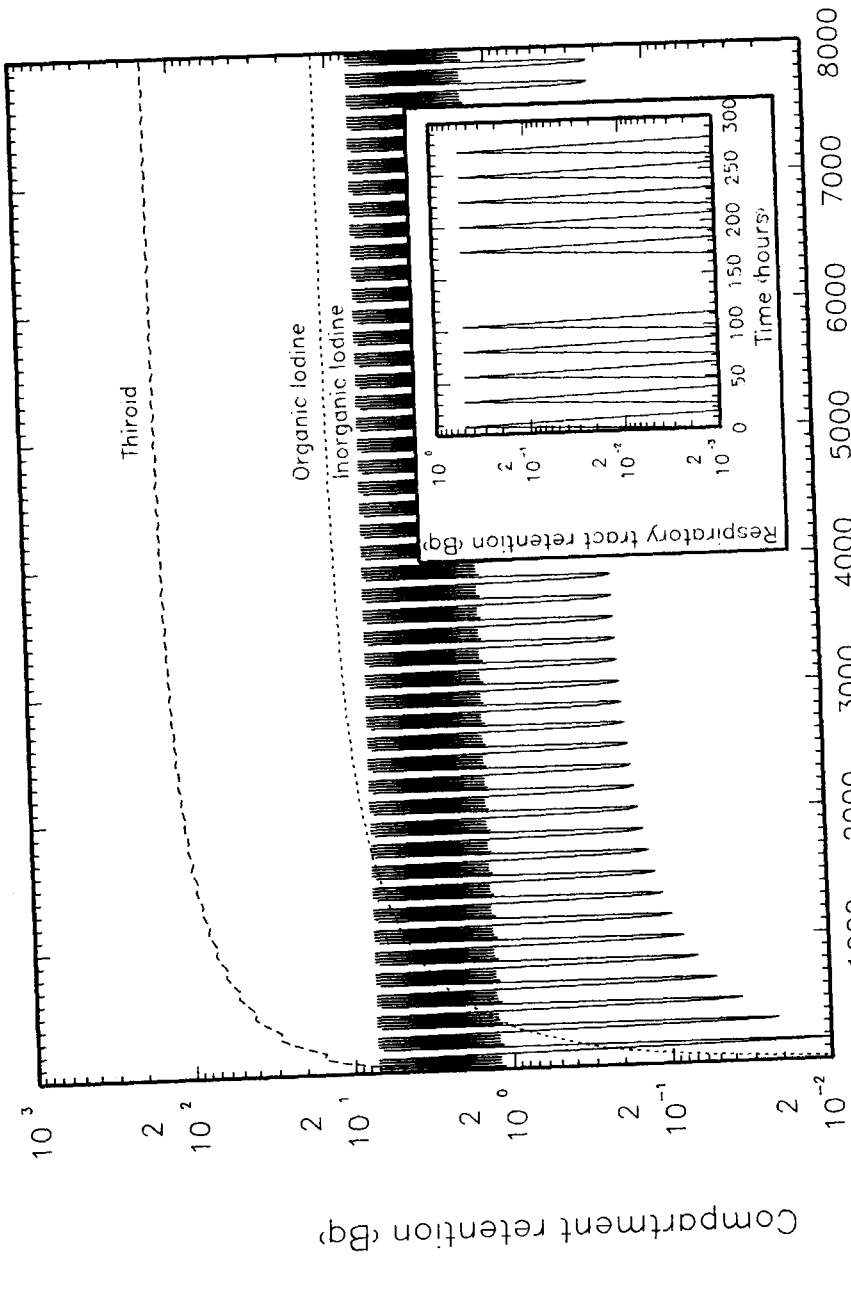

Fig 2 - Quantity of 125 I deposited in the affected compartments in terms of time

$$dQ4(t)/dt = F3\text{-}4 * K3\text{-}4 * Q3(t) - (Lr + K4\text{-}5) * Q4(t) \qquad /5/$$

$$dQ5(t)/dt = K4\text{-}5 * Q4(t) - (Lr + K5\text{-}3) * Q5(t) \qquad /6/$$

where: Lr = radionuclide decay constant.

Fig. 2 graphically represents - correspondingly to the maximum concentration value in air - the analytical solutions of the system for the most interesting compartments. The inset indicates the course of the activity in the respiratory tract in terms of time.

By means of equation /7/, knowing the quantity Qj of radio compound present at equilibrium in the j-th compartment, it is possible to calculate the annual dose in the same:

$$Dj = Kc * Qj \qquad /7/$$

where: Dj = annual dose to the j-th compartment (μSv/year);
Kc = 7.06 μSv/Bq/year, conversion factor between the present activity and the annual dose.

From what has been said above, the annual dose to the thyroid can be evaluated as 700 μSv.

In the light of the dose value obtained, it is reasonable to affirm that the radioprotection classification of the staff must, considering the almost total absence of external radiation, rule out the possibility of operators belonging to group A and, consequently, these laboratories should not be thought of as a controlled zone.

If what has been said is valild for the activities of the order of those considered by us, even more so can this classification be applied to personnel operating in laboratories where lesser quantities of radioactivity are employed.

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