LEVELS OF AIRBORNE CONTAMINATION WHILE HANDLING ^{125}I AND ^{131}I AND ^{99m}Tc UNSEALED SOURCES IN MEDICAL DIAGNOSTIC PROCEDURES [x]

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INTRODUCTION

The use of radioactive substances in nuclear medicine is well-known to involve some radiation hazard to both patients, staff members and a fraction of population. With commonly used radioisotopes of ^{125}I and ^{131}I the hazards from the inhalation of contaminated air are not only detectable but also significant [1].

The present studies were aimed at determining the various forms, aerosol aerodynamic size distributions, levels and localizations of airborne radioiodine and technetium in a well-equipped diagnostic nuclear medicine unit of a 1500-bed university hospital. This information helps to reduce the personnel and population radiation hazard /in agreement with the ALARA principle/.

MATERIAL AND METHODS

In RIA Lab. 1 commercially available "kits" were used for thyroid function determinations. 330 samples were automatically prepared daily, i.e. about 80,000 samples per year /total activity: 145 - 185 MBq of ^{125}I/. In RIA Lab.2 under a chemical hood proteohormones and nucleic acids were iodinated with 1480 MBq of ^{125}I per year /20 procedures/. In a ^{131}I laboratory 120 patients with thyroid cancer and other diseases were administered a total activity of 1665 MBq of ^{131}I per year in capsules and in water solution. In a ^{99m}Tc laboratory 29.6 GBq of ^{99m}Tc was used daily for scanning, i.e. about 7500 patients received 2146 GBq per annum.

Airborne radioiodine sampling was carried out:

/1/ in two RIA Labs /RIA 1 and RIA 2/ with unsealed ^{125}I sources. Simultaneously individual ^{125}I levels in the inhaled air by staff members were monitored by IDF. For comparison air under the hood was also sampled,

/2/ in the application room and in 4 out-patients diagnosed with ^{131}I, whose exhaled air as well as that inhaled /determined by the IDF/ was also monitored,

/3/ in the ^{99m}Tc pipetting room and in the scanning room.

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For airborne ^{125}I, ^{131}I and ^{99m}Tc sampling the following methods were used:

/1/ a standard May-pack filter packet method [2],

/2/ personal IDF method [3], and

/3/ apparatus for measuring ^{131}I activity /in Bq m^{-3}/ in the air exhaled by diagnostic patients [4].

To determine the activity vs. aerosol size curve a five--cascade impactor was used.

In parallel measurements the air sampling time used by the standard, personal IDF and impactor methods corresponded to that spent by the personnel working with unsealed ^{125}I, ^{131}I and ^{99m}Tc sources /only standard and impactor methods/.

RESULTS AND DISCUSSION

The selected results of the mean and individual ^{125}I, ^{131}I and ^{99m}Tc concentrations at the Diagnostic Nuclear Medicine Dept., University of Göttingen are shown in Table 1 and Fig. 1.

The mean airborne ^{125}I concentrations in RIA Lab. 1 at the working sites using unsealed sources, in the centre of the labelling room at the automatic gamma counter and its vicinity ranged from 0.02 to 0.08 Bq m^{-3}. Elevated concentrations in the range of 0.2 ÷ 0.3 Bq m^{-3} were only found in the nearest vicinity of the automatic pipetting device; there the contribution from the elemental ^{125}I was also predominant /i.e. 69 ÷ 82%, mean: 77%/, while that at the automatic gamma counter was 51%. In the doctor's room the organic form of $CH_3{}^{125}I$ was predominant /86%/. ^{125}I activity distributions vs. aerosol size for two days /A_1, A_2/ are shown in Fig. 1a.

The mean airborne ^{125}I concentrations in RIA Lab. 2 during manual iodination under a chemical hood were 0.5 Bq m^{-3} /55% $CH_3{}^{125}I$/ and fell to 0.2 Bq m^{-3} 21 hrs after the completion of iodination. It was 10-fold higher than that in RIA Lab. 1 but comparable with that found in the vicinity of the automatic pipetting device in Lab. 1. Under the hood airborne ^{125}I concentrations during ^{125}I procedures ranged from 177 to 5076 Bq m^{-3} /30 ÷ 74% I_a and 24 ÷ 48% I_2/ depending on the labelling technique used. It fell rapidly to 1.8 Bq m^{-3} and 0.03 Bq m^{-3} 72 hrs after the completion of iodination. The corresponding aerosol distribution /B/ is shown in Fig. 1a.

Airborne ^{125}I concentrations for individual people handling unsealed sources in RIA Lab. 2 were found to vary from 13 to 302 Bq m^{-3} /working time varied between 0.25 and 4.7 hrs/ and were much higher than those while operating the automatic pipetting device in RIA Lab. 1, i.e. 0.3 ÷ 0.5 Bq m^{-3} for 32 to 68 hrs, resp.

The patients who had received diagnostic ^{131}I capsules constitute airborne contamination sources. Thus

/1/ Within 48 hrs a patient exhales about $3 \cdot 10^{-4}$ of the activity

administered to him, which corresponds well to the previous work of Krześniak et al. [4] ,

/2/ The mean individual airborne concentration during 24 hrs in the patient's nearest vicinity is of the order of 20 Bq m^{-3}, as measured with the personal IDF, whereas it drops to 6 Bq m^{-3} during the period between 24 and 48 hrs,

/3/ The mean airborne concentration in the room during 48 hrs is 3 Bq m^{-3} as measured with the standard method,

/4/ The percent contributions of all the three forms of ^{131}I during 48 hrs were:

	air exhaled	air in the room
I_a	1 - 27%	12 - 47%
I_2	4 - 66%	11 - 46%
CH_3I	12 - 96%	37 - 76%

The above distribution of the three forms of airborne ^{131}I depends on that found in the air exhaled by the patients. The relative aerosol probabilities in air samples also vary as a function of the aerodynamic diameter of aerosols. For the first few days after the oral administration of ^{131}I, as shown in Fig. 1 /curves A_1 and B_1/, they are similar, and the corresponding aerodynamic diameters are given in Table 1. Similar measurements for ^{99m}Tc are presented in Table 1. Airborne ^{99m}Tc concentrations were found to be of the order of 1 Bq m^{-3}. The behaviour of ^{99m}Tc in the air is not known, yet its percent contributions on the three layers of the May-pack filter are: 28.17 and 57 resp. The activity distributions vs. aerosol aerodynamic diameter in the Tresorraum and patients waiting room are shown in Fig. 1c.

RESULTS

/1/ In spite of better ventilation in RIA Lab. 2 individual airborne ^{125}I concentrations during handling unsealed ^{125}I sources are comparable to those in other laboratories,

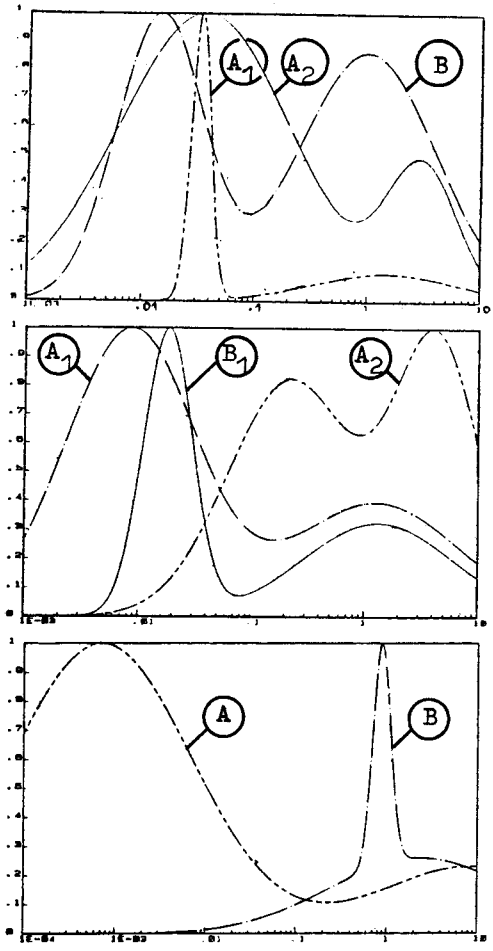
/2/ Individual airborne ^{125}I concentrations are much higher than the mean concentrations in rooms,

/3/ Workers are exposed to ^{125}I inhalation only during actual handling procedures,

/4/ An automatic pipetting device together with good ventilation allows the mean airborne ^{125}I concentrations to drop considerably,

/5/ ^{125}I and ^{131}I activity distributions as a function of the aerodynamic aerosol diameter may be described by two normal-log curves, the median values at 0.02 /um and 1 ÷ 5 /um while those for ^{99m}Tc have medians at 0.001 /um and 1 /um.

/6/ The patients who had received diagnostic ^{131}I capsules constitute airborne contamination sources.



a/ ^{125}I

A_1, A_2 - in air RIA Lab. 1 1^{st} and 2^{nd} day;

B - in air RIA Lab. 2.

b/ ^{131}I

A_1, A_2 - in air Lab. ^{131}I 1^{st} and 2^{nd} day /patient D.M./;

B_1 - as above, in air 1^{st} day /patient M.A./.

c/ ^{99m}Tc

A - Waiting room,

B - Tresorraum.

Fig. 1. Log-normal particle size distribution of radioactive aerosol in rooms as a function of the Aerodynamic Diameter.

LITERATURE

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