Evaluation of nasal swab method to assess occupational internal contamination with I-131, I-123, and Tc-99m (#142)

Abdalkader Bitar, Maysoun Maghrabi, Bilal Youssef, Hisham Al-Hinawy

Atomic Energy Commission of Syria- Dpt of Protection and Safety- P.O. Box 6091, Damascus, Syria

abitar@aec.org.sy

1. Introduction

Unsealed sources of radionuclides, such as (I-131, Tc-99m, I-123), are extensively used in nuclear medicine and may enter the body of workers during preparation and handling. The volatility of some radionuclides during the preparation of radiopharmaceuticals may cause internal contamination and increases the inhalation hazards for workers. However, the nasal swab is a simple and quick test to detect whether significant intakes have or have not occurred before applying, if needed, other bioassay methods.

Our internal dosimetry laboratory tested the nasal swab method to screen any potential internal radioactive contamination. The present study investigates also any correlation between activities measured in nasal swab versus other bioassay methods.

2. Materials and methods & Dose assessment

2.1. Materials and methods

The nasal swab method was evaluated for workers at Al-Bairouni nuclear medicine centre in Damascus, Syria.

Nasal swabs were collected from workers preparing radioactive materials. In addition, the collected data from nasal swabs was associated with in vivo (thyroid) and / or in vitro (urine) measurements.

Nasal swabs and bioassay measurements were collected from 15 workers for 92 expected intake cases. The samples were collected by inserting a clean cotton swab (moistened with water) about 2 cm into each nostril in a circular motion.

The committed effective doses were estimated for all measurements and were compared with each other. The measurements of nasal swab and urine samples were carried out by using stationary N-type HPGe detector, whereas thyroid counting was done by using portable unit of HPGe detector.

2.2. Intake and dose assessment

The International Standard Organization, ISO 20553:2006, has recommended certain methods for the assessment of occupational exposure. In the case of iodine 131, the recommended methods include nasal swabs in addition to urine analysis and thyroid counting.

Anterior nasal passages, thyroid, and urine are the three compartments of interest for special monitoring and dose evaluation according to the biokinetic models suggested by ICRP 67. Aerosol size of 5 µm was assumed as recommended by ICRP for occupational exposure.

The AIDE Software (Activity and Internal Dose Estimates) was used for the evaluation of in vivo and in vitro methods developed in this work, as well as, for the interpretation of bioassay data based on the measurement of I-131, Tc-99m, I-123 in nasal swabs, thyroid, and urine samples.

The values of m(t) were generated using the software AIDE for specific exposure scenarios and times after intake.

In order to estimate the intake (I), the measurement value of the activity in the thyroid or excreta, M, is divided by the retention or excretion fraction m(t) of the radionuclide in the body in time t after the intake:

$$I = M / m(t) \quad (1)$$

The committed effective dose (E(50) or CED) was calculated by multiplying the intake by the dose coefficient (e50):

$$E(50) = I \cdot e(50) \quad (2)$$

3. Results and discussion

Nasal swabs were collected from workers in situ along with bioassay measurements (urine analysis and/or thyroid counting). The measured value, M, was considered to be significant if it exceeds the decision threshold (DT) of the said measurement method. The value of DT equals half the value of detection limit (DL) according to ISO 11929:2010. The values of DT and DL are shown below.

Isotope	Measurement method	Detection limit	Decision threshold	Unit
^{131}I	Nasal swab	2.62E-02	1.31E-02	Bq/sample
	urine analysis	6.60E-02	3.30E-02	Bq/24h
	Thyroid counting	5.50E+00	2.75E+00	Bq/thyroid
^{123}I	Nasal swab	2.15E-02	1.8E-02	Bq/sample
	urine analysis	1.19E-01	5.95E-02	Bq/24h
	Thyroid counting	5.25E+00	2.63E+00	Bq/thyroid
^{99m}Tc	Nasal swab	5.20E-02	2.6E-02	Bq/sample
	urine analysis	1.96E-01	9.8E-02	Bq/24h
	Thyroid counting	3.0E-01	1.5E-01	Bq/thyroid

The dataset contained 33 cases where significant activities for both nasal swabs and other bioassay methods have been observed.

The ranges of results were summarized in a table for the three radionuclides.

Method	Range for ^{131}I	Range for ^{123}I	Range for ^{99m}Tc	Unit
Nasal swab	0.09 - 2.3	0.2 - 11.7	0.1 - 43600	Bq/sample
	3E-6 - 12E-5	8E-8 - 5E-6	9E-9 - 4E-3	mSv
urine analysis	5.3 - 241	1.3 - 8907	1.33 - 335	Bq/24h
	2.0E-4 - 5.32E-3	1.6E-6 - 4.0E-4	6.8E-6 - 1.7E-3	mSv
Thyroid counting	29 - 1467	30 -10650	43 - 16120	Bq/thyroid
	3E-3 - 4.7E-1	8.7E-5 - 3.1E-2	4.8E-5 - 8E-2	mSv

There were 20 cases where nasal samples had significant activity while the measurements for other bioassay methods were lower than the relevant detection limit. On the other hand, 13 cases were found to have no detectable activity in nasal samples whereas other bioassay methods measured activities greater than the detection limit. In other words, the absence of activity in nasal swabs does not constitute sufficient evidence that an inhalation exposure has not occurred.

It had reported previously that nasal swab with NDA (no detectable activity) is necessary, but not sufficient, to negate the need for a follow-up bioassay when conducted following a suspected false alarm. Actually, this may be due to various possible reasons like:

- Some workers were breathing by mouth.
- Nose was self-cleaned if samples were not collected early.
- The worker washed his nose unconsciously before collecting the sample.
- Particle size can significantly affect nasal deposition and clearance.

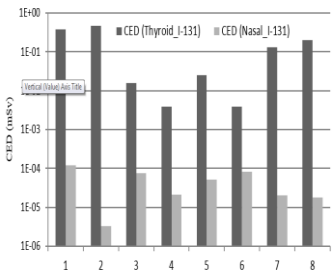
Moreover, in 26 cases, the nasal samples were not considered because nasal samples were not made available timely, although; the measurements from other bioassay methods were used to calculate the CED.

However, all detected activities in nasal swabs corresponded to very low committed effective doses in comparison with those of other methods.

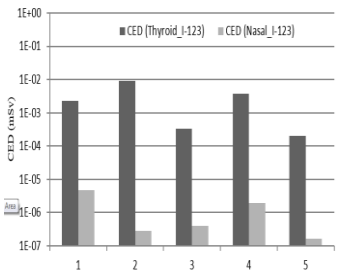
One case of Tc-99m reached the value of 43600 Bq in one nostril (corresponds to about 3.8E-3 mSv) while the measured activity in thyroid was 492 Bq (corresponds to about 1E-3 mSv). This was explained by that the worker may have brushed one side of his nose with a contaminated cloth or hand.

In result, there is a large uncertainty involved in the nasal swab method as no detailed biokinetic model is yet available for the assessment of body burdens from nasal swab samples.

Comparisons between the value of CED obtained from thyroid versus that from nasal swab for the same intake are shown below. It is obvious that the values of CEDs were underestimated when using nasal swab technique.



Comparison of CEDs values for I-131 obtained from thyroid versus those from nasal smear.



Comparison of CEDs values for I-123 obtained from thyroid versus those from nasal smear.

The annual CED was also estimated for 15 monitored workers due to exposures to the three radionuclides. The results of annual CED were discussed according to IDEAS guideline. It was noted that five workers were found to have CED less than 0.1 mSv; classified as no risk, no evaluation of dose is needed, i.e. the measured value should be recorded with respect to further assessments in the future. Nine workers were found to have CED within the range from 0.1 mSv to 1 mSv; simple "reference" evaluation with ICRP defaults used for all parameter values. And one worker was found to have CED greater than 1 mSv; sophisticated evaluation, using additional information from the workplace, is needed to give a more realistic assessment of dose.

4. Conclusions and Acknowledgements

- There was great variability in the relationship between internal dose estimated from nasal swab measurements and those from other bioassay methods. Nasal swab measurements were found to be very poor method for the assessment of internal radioactive contamination because of the large uncertainty involved in the proposed nasal model. Gamma spectrometry measurements of nasal swab samples can provide rapid information on radionuclide composition. In addition, nasal swab sample may be an important and quick method to estimate accidental inhalation exposures in nuclear medicine, but it should be associated with other monitoring techniques.
- The authors would like to thank Prof. I. OTHMAN (DG of AECS) and Dr. M.S. ALMASRI (Head of Protection & Safety Department) for their encouragement and support.