INDIVIDUAL MONITORING OF INTERNAL AND EXTERNAL CONTAMINATION IN DIAGNOSTIC/ THERAPEUTIC USE OF RADIONUCLIDES IN MEDICINE

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Purpose

The aim of this study was to develop in nuclear medicine triage procedures performed at the workplace by local staff using standard laboratory equipment to detect whether potential intake has occurred following :

ISO/DIS 16637, draft 2014

“Monitoring and internal dosimetry for staff exposed to medical radionuclides as unsealed sources”

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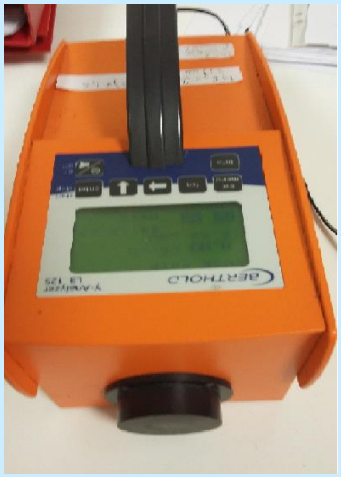
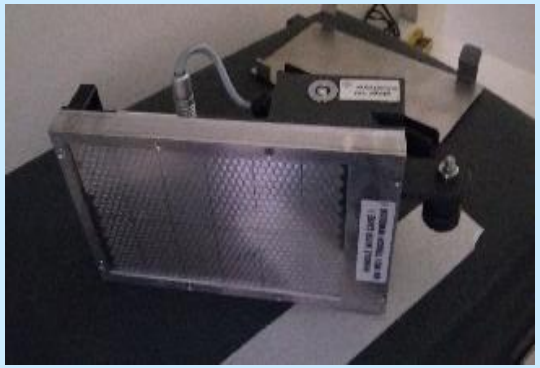
Methods

Daily measurements of the ambient dose rate with scintillation detector and surface contamination monitor in front of the abdomen, thyroid and hands are carried to detect whether potential intake or superficial contamination has occurred.





Such measurements (triage monitoring) do not enable to determine the committed effective dose, but are adequate to verify that a **given threshold is not exceeded**

Triage monitoring for gamma emitters (^{99m}Tc) and ß$^{+}$ emitters (^{18}F)

It was assumed that after a few hours these radionuclides are concentrated mainly in the stomach and therefore it was decided to place a dosemeter in front of the abdomen (stomach level) as a triage methods with daily screening interval (**τ** =8 h and 4 h for ^{99m}Tc and ^{18}F)

Threshold values (activity) are **35000 Bq for 99mTc and 10000 Bq for 18F** determined according **Equation (1)** for **E(50)** = 1 mSv/year, **N(τ)** =50 is the number of measurements taken in a year, **m (τ / 2)** =0.5 is the fraction of activity remaining in the body at the time τ/2 from intake and corrected for decay $\mathbf{e}_{inh}$ is the coefficient of effective dose for inhalation

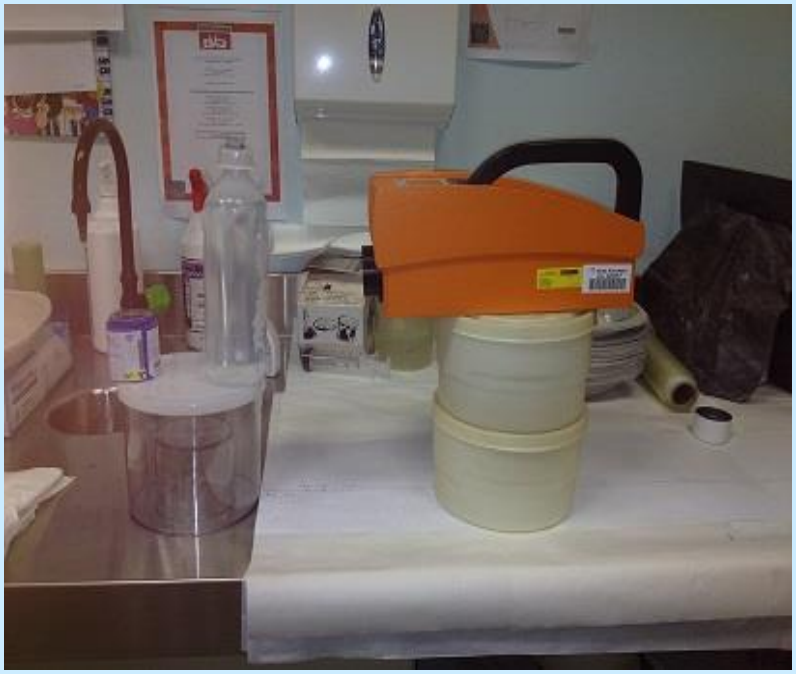
(**Equation 1)**

$$S = \frac{E(50)}{N(\tau)} \cdot \frac{m(\tau/2)}{e_{inh}}$$

$$\dot{H}(10) = \frac{S \cdot \dot{h}(10)}{r^2}$$

h (10) is the coefficient of the rate of effective dose for external irradiation

In the laboratory the response of dosemeter to activities (range 10000-50000 Bq) of 99mTc and 18F dispersed in 600 ml of aqueous solution in a cylindrical container to simulate the stomach contents was analysed experimentally



Triage monitoring for pure ß- emitters (^{90}Y)

Since most radiopharmaceutical labelled with 90Y are non volatile, the triage procedure is based on measurements of hand contamination immediately after each use of the radionuclide.The attention threshold S is calculated in Bq/cm^2 with the hypothesis of ingestion intake of 1%

$$S = \frac{E_{50}}{N(\tau) \cdot e_{ing} \cdot 100} \cdot \frac{1}{1\%}$$

Triage monitoring for ^{131}I

Triage monitoring may be effected by the dosemeter placed in front of the abdomen (stomach level) and thyroid, but the use of pre-packaged capsules 131I has completely broken down the possibility of intake in our structure

Equivalent skin dose evaluation method in external contamination

the conversion coefficient $Bq*cm^2 / s^{-1}$ must be periodically checked

Is necessary to determine the integral time - activity

	Anzeige auf Großflächen-Referenzstrahlern verschiedener Nuklide. Response to large area reference sources of various nuclides.						
Position	α β γ					α	
d	12 mm				Nulleffekt	3.4 mm	Nulleffekt
	$^{90}Sr/^{90}Y$	^{36}Cl	^{14}C	^{137}Cs		^{241}Am	
$T_{1/2}$ [a]	28,8	300000	5730	30,1	Back-	432	Back-
Bq/cm²	5,7	9,65	11,18	5,67	ground	8,88	ground
s^{-1}	720	525	88,5	307	7,5	148	0,02
$(Bq/cm^2)/s^{-1}$	0,0080	0,0186	0,1381	0,0189		0,0600	

CONTAMINATION

Contamination skin dose ($mSv.h^{-1}$)

Uniform deposit (1kBq.cm^{-2})	1.95E+0
0.05 ml droplet (1 kBq)	7.88E-1

Detection

Recommended probes*	
Alpha	
Beta	+
Gamma	+ +
X rays	+ +

Derived limits ($Bq.cm^{-2}$)

Removable contamination	2E+1
Fixed contamination	3E+1

* If no probes are indicated the recommended technique is to use a wipe test in association with a probe or liquid scintillation technique

SHIELDING (mm)

Betas and electrons (Total absorption)

Glass	0.9
Plastic	1.7

Gamma and X rays (half and tenth value thickness)

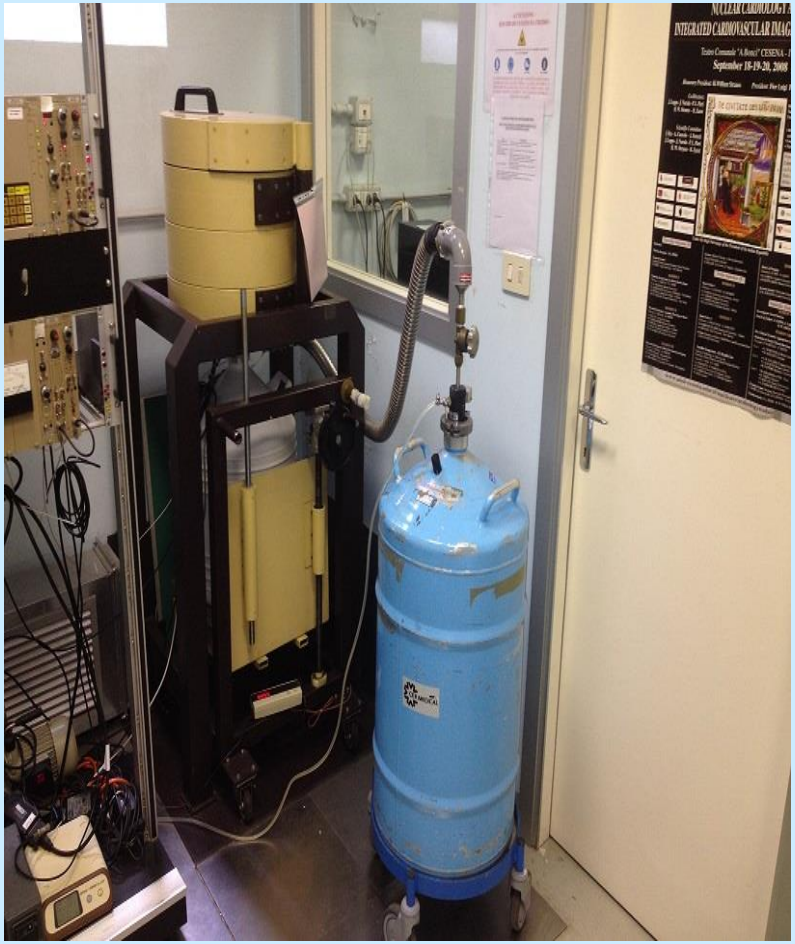
	½	1/10
Lead	6	17
Steel	27	64

e) D. Delacroix, et al.

Confirmatory and special monitoring from urine sample measurements

If the thresholds are exceeded, a urine sample is immediately executed and performed spectrometric analysis; you can evaluate the intake via the **predictive factors** published in

- (a) IAEA Safety Report n.37 for **^{99m}Tc**
- ICRP 78 for **^{131}I**
- (d) Intake risk and dose evaluation methods R.Calandrino et al. for **^{18}F**



Results

as a result of laboratory tests, **threshold values** have been so identified

for 99mTc (35000 Bq) **0,14 µSv/h**

for 18F (10000 Bq) **0,18 µSv/h**

Confirmatory monitoring of controlled operators

Was made a campaign of daily measurements for three months and 98% ratemeter values (at 1 cm in front of the stomach) were not higher than background values (60-80 cps 0.07 µSv/h)

measurement of urine has confirmed absence of intake

Only in three cases occurred values higher than background and near the threshold (0.10 , 0.15 0.16 µSv/h,) and the measurement of urine has confirmed the presence of intake for ^{99m}Tc (44 – 320 - 347 Bq/lt)

Conclusions

Triage measurements for detecting potential radioactivity intake and surface contamination of the hands by nuclear medicine workers are performed with instrumentation available in medical physics laboratories to monitor internal and external contamination. It requires a simple training of operators and helps them to understand and correct the behavioral errors

References

(a) IAEA_SRS_37 http://www pub.iaea.org/MTCD/publications/PDF/Pub1190/Pub1190_web.pdf
(b) Swiss ordinance http://www.admin.ch/opc/it/classified-compilation/19995163/200801010000/814.501.43.pdf
(c) Radiation Protection Dosimetry (2011) Vol 144, N.1-4 pp 464-467 S.Baechler
(d) Health Physics(2009) Vol 97 N.4 pp 315-321 R.Calandrino et
(e) Radiation Protection Dosimetry Vol. 98 No 1, 2002 RADIONUCLIDE AND RADIATION PROTECTION DATA HANDBOOK D. Delacroix, J. P. Guerre, P. Leblanc and C. Hickman