International Conference on
RADIATION PROTECTION IN MEDICINE
Setting the Scene for the Next Decade

3–7 December 2012
Bonn, Germany

Organized by the

IAEA
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through the

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SESSION 3:

"Radiation protection of patients and staff in diagnostic nuclear medicine and hybrid imaging"

Summary of Contributed Papers:

Ana María Rojo

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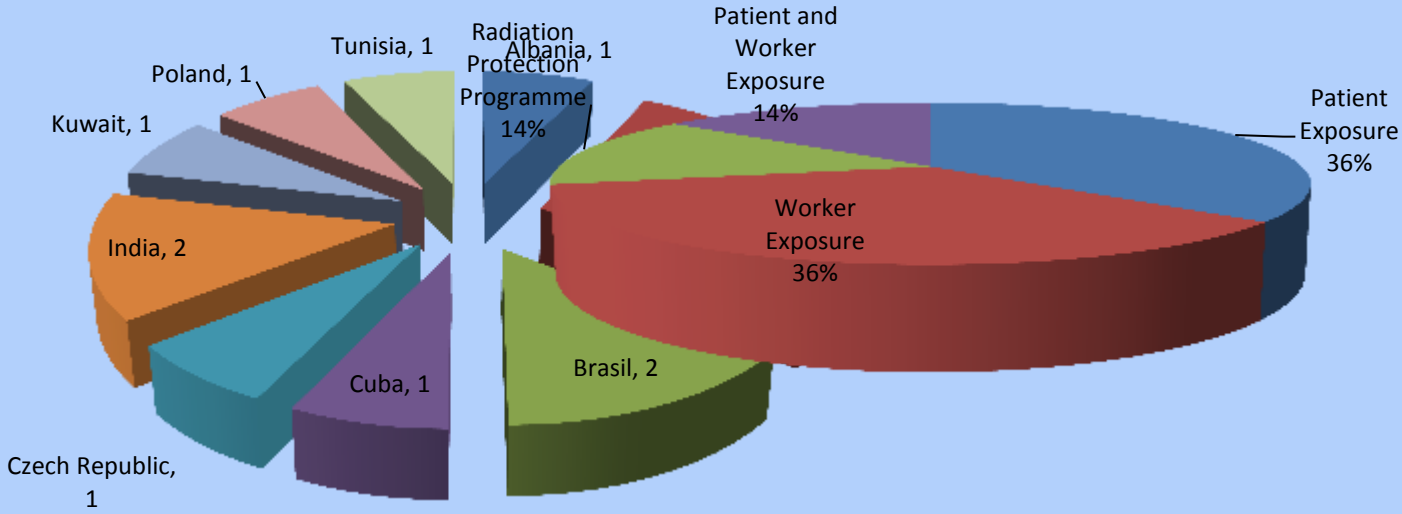
SESSION 3:

“Radiation protection of patients and staff in diagnostic nuclear medicine and hybrid imaging”

14 Papers from 9 countries



OPTIMIZATION OF CARDIOLOGIC PROTOCOLS IN NUCLEAR MEDICINE EXAMINATIONS

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To optimize the protocol for women evaluating:
the influence of different activities and acquisition times on image quality

- Gamma camera VentriTM (GE Healthcare), FOV: 37×19 cm², crystal thickness: 9.5 mm, two detectors at 90º
- Sestamibi®: 555 MBq, 740 MBq and 925 MBq
- Status: stress with cardiac capitation of 2% of the radiotracer, and rest with 4%;
- Silicone breasts phantoms: small, average and large
- A lesion insert inside the heart wall, to simulate a coronary artery disease

Left: anthropomorphic torso phantom. Medium: breast silicone phantoms of different sizes. Right: the phantom all set.

- the injected activity in the patient can be reduced by 40%,(from 925 to 555 MBq) without significant loss of contrast
- the position should be prone, due to breast attenuation

DOSIMETRIC EVALUATION OF EXTRAVASATED ACTIVITY IN NUCLEAR MEDICINE SCANS

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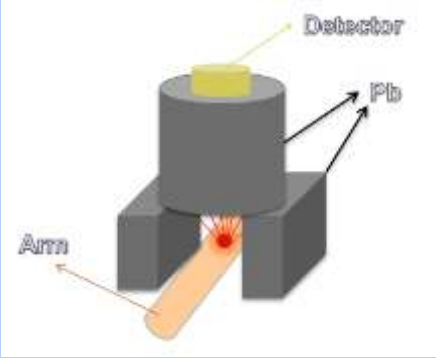
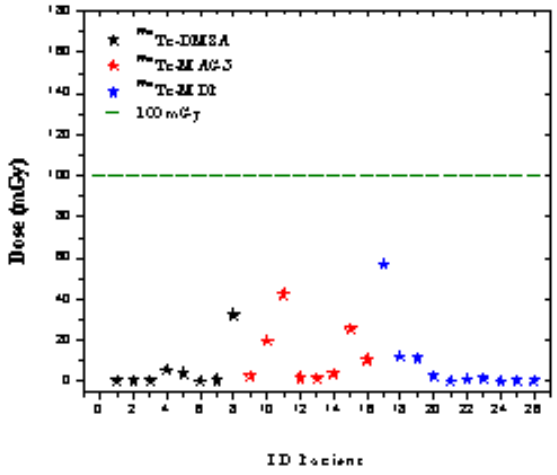
Experimental set-up for the measurement of the remainder activity in the patient's arm after the radiopharmaceuticals administration



Scintigraphy Study	Age Groups	Extravasated Patients (> 2%)	Complete Extravasated Patients (100%)	Extravasated frequency (%)
^{99m}Tc-DMSA	Older than 10 years	3	0	14
	1 - 10 years	10	3	71
	Younger than 1 year	8	3	100
	Total	*21*	*6*	*48*
^{99m}Tc-MAG3	Older than 10 years	2	-	25
	Total	*2*	-	*18*
^{99m}Tc-MDP	Older than 10 years	4	-	20
	Total	*4*	-	*19*



The extravasation frequency is not negligible in the case of children. Canalization is recommended prior to administration. A very well trained personnel is essential

RADIATION PROTECTION IN KUWAIT NUCLEAR MEDICINE DEPARTMENTS

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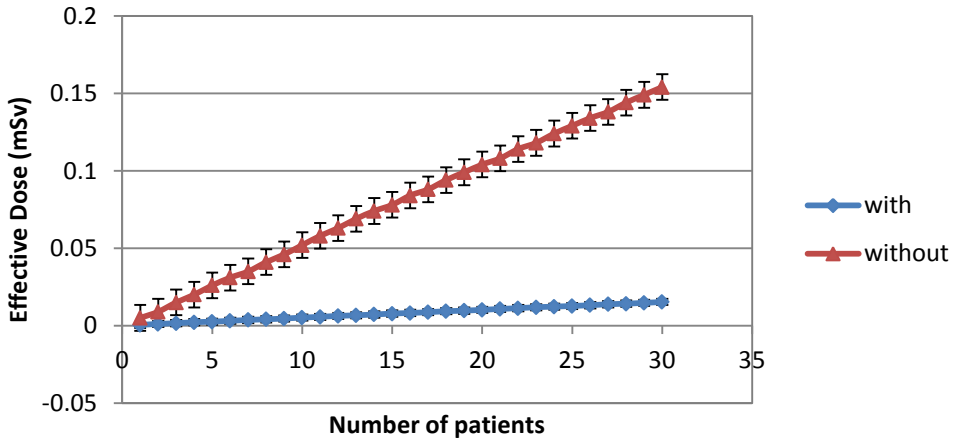
Current status and Actions to improve the Radiation Protection of patients, personnel, public and environment

Experiments carried out to study :

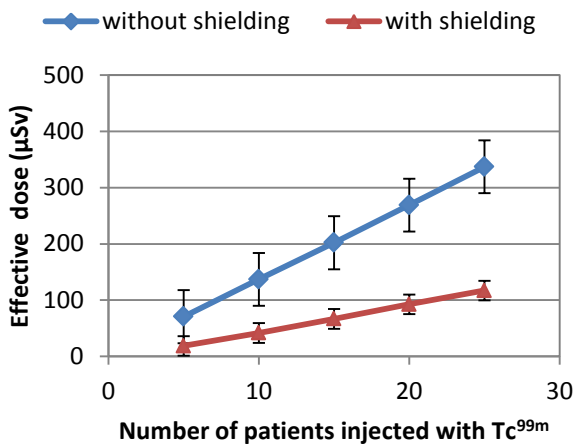
1.- The effect of 5 mm lead shield
between the patient and the technologist

Tc-99m MDP whole body bone scan



Effect of technologist shielding during examination

2.- The effect of shielded syringe in reducing finger dose
- electronic personal dosimeter on wrist
- tungsten thickness : 2 mm



Effect of syringe shielding

Current efforts are focusing on :

> Training in radiation protection (nurses)
> Enhancement the medical physicists role

RADIATION DOSES TO STAFF IN THE NUCLEAR MEDICINE DEPARTMENT (SZCZECIN, POLAND) IN YEARS 2008-2011

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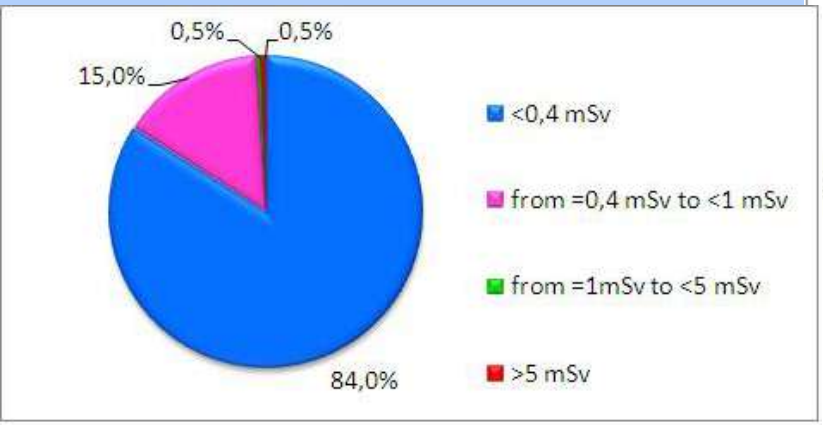
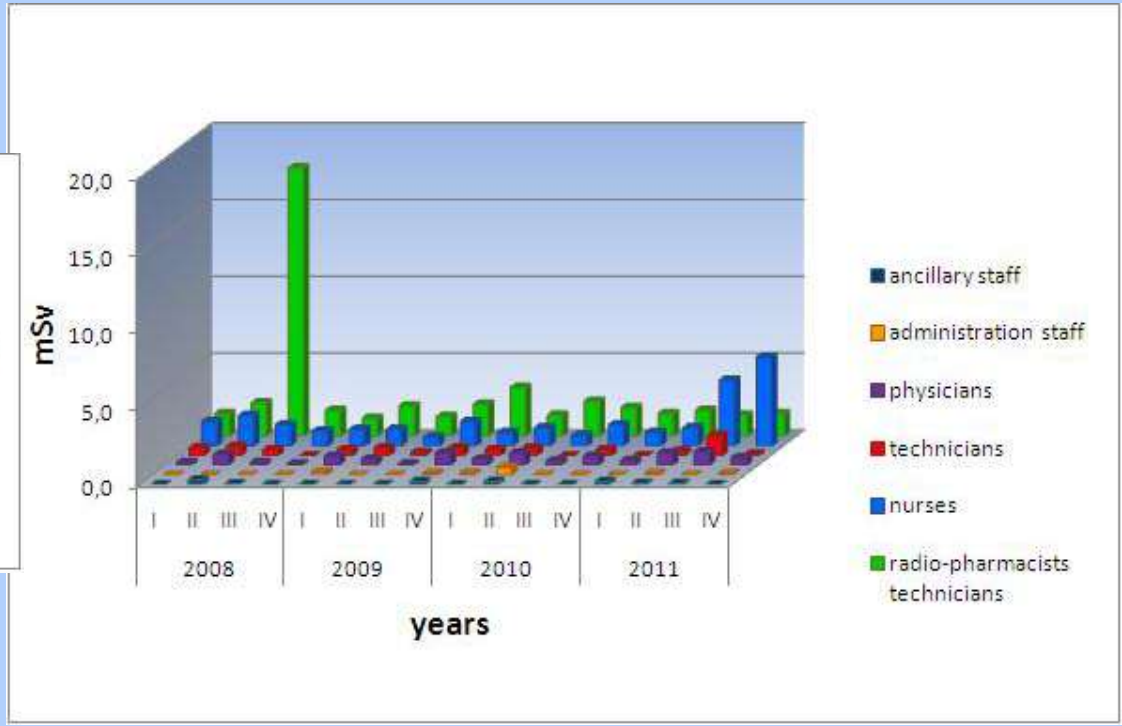
To assess workers' external radiation exposure



Distribution of individual doses (2008-2011)



The average quarterly doses for employees divided into six occupational groups for consecutive 4 years

This 4-years study showed compliance with the annual dose limit of 20 mSv

Evaluation of Effective Doses for Occupational Staff and Patients in examinations with 99Mo-99mTc in Nuclear Medicine in Albania

Luan QAFMOLLA, *Vladimir TITKA

Center of Applied Nuclear Physics, *HYGEIA Private Hospital, Nuclear Medicine Lab, Tirana, Albania

The most important nuclides used:

^{99m}Tc and ^{131}I

The mean number of patients diagnosed and treated annually in the country: 3000

80% of nuclear medicine examinations: ^{99m}Tc

The annual effective dose, average annual dose and collective dose calculated for occupational staff and patients are lower than other EC countries

PEARLS AND PITFALLS OF THE NUCLEAR MEDICINE RADIOPROTECTION PROGRAMME IN ARGENTINA

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Topics analysed:
Radiation Protection; QC programmes; Medical Physicists role; Teaching programmes

Instrumentation
A survey results including 28 Nuclear Medicine Departments:
69% instruments with less than 5 years BUT **32% older than 5 years**
79% had satisfactory performance

Radioprotection
Radioprotection Officer : **Medical Physicist only in PETs**

Education and training
Workshops to update general knowledge

Regulatory Control

some missing points :

- Maximum admissible age for the instruments;
- Studies for which "old" instruments are useful
- The Medical Physicist´s role in the implementation of the QC programme

IAEA Projects´ have determined a positive impact in the improvements of the QC program, Radiation protection programmes, Instrument quality control, Personal dosimetry, Patient specific dosimetry

Radiation Exposure of Patients Undergoing Whole-Body 18F-FDG PET/CT *An Argentinean Survey*

M. Namías[a], J. Arashiro[b], S. Mosconi[c] and M. Cabrejas[d]

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c Fundación Escuela de Medicina Nuclear de Mendoza, Mendoza, Argentina
d Fundación Científica del Sur, Lomas de Zamora, Argentina

10 hospitals with different equipment : 13 PET/CT scanners + 12 dedicated PET scanners

Survey main questions:

- Purpose of CT scans (i.e.: full diagnostic quality CT, chest CT)
- Average DLP (dose length product) values and / or average CTDI vol (Volumetric Computed Tomography Dose Index) values for each series
- Dose scheme for PET scans (weight based scheme or fixed activity)
- Automatic Exposure Control (AEC) for CT scan
- The use of endovenous Contrast Agents (CA)

Patient effective doses were estimated by using 18F-FDG dose coefficients, and *DLP* and *CTDI vol* conversion factors :

$$E[mSv] = DLP[cGy\,cm] \times 0.015\,mSv/cGy\,cm \qquad E[mSv] = CTDI[cGy] \times 1.47\,mSv/cGy$$

Results

	Effective dose [mSv]				
Scan type	Mean	STD	Min	Max	Coeff of Variation (%)
Entire PET/CT examination	31	11	12	52	35
Whole Body CT Scan	16	6	10	28	39
Chest Scan	8	2	4	10	30
18F-FDG PET scan	6	1	5	7	14
Late PET/CT imaging (dual time)	5	1	4	7	28
Low dose CT	7	N/A	N/A	N/A	N/A

- Whole body CT: protocols should be optimized

- CT doses: could be reduce (by the incorporation of iterative reconstruction of CT images)

- PET/CT: Local Reference Levels should developed

- The Certified Medical Physicists role:

  - To optimize PET/CT protocols, and
  - To promote the report of patient doses (local reference dose levels)

Optimization of imaging and radiation protection protocols is a key to safety of both patients and workers in medicine: a practical and validated approach in a high volume PET center in India

A.GUPTA, P.S. CHOUDHURY, P.K. SHARMA, R. SENGUPTA, V. CHAUHAN, A. PRUTHI
Rajiv Gandhi Cancer Institute & Research Centre, Delhi, India

Radiation protection approach for both patients and radiation workers

(4000 PET/CT studies in one calendar year)

- After including PET/CT facilities the workers exposure can be kept within acceptable limits

-For successful implementation of this programme the optimization is required

-A clinical protocol should be optimized

EVALUATION OF SPECT-CT DOSIMETRY FOR SOME ROUTINE NUCLEAR MEDICINE EXAMS

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[a] Nuclear Medicine Department, Salah Azaiez Institute, Tunis, Tunisia

[b] Biophysic Departement, Faculty of Medicine, Tunis, Tunisia

To evaluate effective doses received by 80 patients who underwent SPECT-CT and to analyze parameters involved

•Dual-headed SPECT unit with an integrated 2-slice CT scanner (Symbia T, Siemens Medical Systems, Erlangen, Germany)

		Average whole body effective dose in routine nuclear medicine examinations			Average effective dose for the CT portion of the routine nuclear medicine examinations		Average effective dose for the total SPECT-CT effective dose	% increase in effective dose by the inclusion of the CT
Type of study	No. of patients	Average activity (MBq)	Dose per unit activity (mSv/MBq)	Average effective dose (mSv)	Average effective dose (mSv)	Range effective dose	Total effective dose (mSv)	
^{99m}Tc-MDP	20	740	0.0057	4.2	3.5+/-1.2	0.3-6.5	7.7	83%
^{99m}Tc-MIBI parathy	20	925	0.009	8.3	2.3+/-0.7	1.0-3.5	10.6	28%
^{111}In-octreotide	10	185	0.054	10	2.7+/-1.3	1.9-5.4	12.7	27%
^{131}I post therapy scan	30	3700	0.52	1924	2.9+/-1.9	1.2-5.9	1926.9	0.15%
^{123}I-MIBG	10	185	0.013	2.4	3.0+/-1.1	1.4-5.8	5.4	125%

Indication of SPECT-CT must be clearly justified and optimized, particularly for **children**

Radiation Protection in Diagnostic Nuclear Medicine in Argentina:
Current status and future recommendations

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c Universidad Nacional de San Martín, San Martín, Buenos Aires, Argentina

Situation

It is presented a diversity of issues ranging from regulations to human resources development:

Regulations:

- Radionuclides (Nuclear Regulatory Authority) meanwhile X ray (Ministry of Health)
- Only in PET or PET/CT: the medical physicist is required

Dosimetry: There are different options: film, TLD and OSL dosimeters

Current challenges

•medical physicists role:
The participation in the design and optimization of PET and PET/CT working protocols should be increased

•nuclear medicine training:
The technologists programmes should be improved

•QA programs:
The frequency of auditories should be increased

Proposed solutions and further recommendations

A revision of the accreditation process of medical physicists and technologists

Categorization based on the age of the equipment their performance, image quality and the quality of medical reports

Dosimetry Services should be audited

A DOSIMETRIC STUDY IN PET/CT

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Brazil has 50 PET/CT units in operation and the request of this diagnostic technique is increasing quickly

Effective dose estimation for PET/CT examinations and their comparison with those provided by the equipment

- 65 patients (34 female and 31 male)

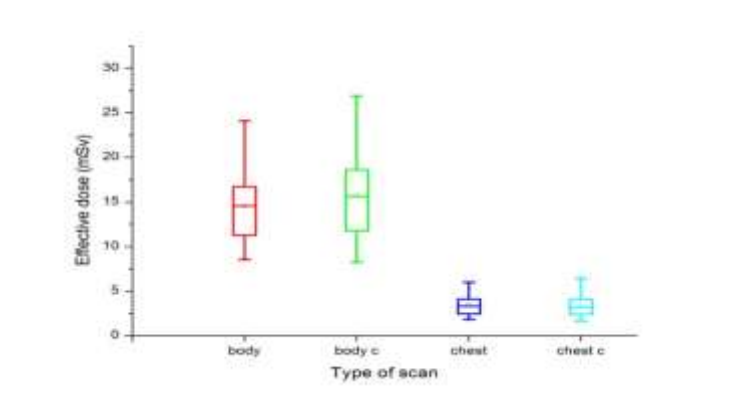
Doses Assessment

PET (ICRP 80) CT (Phantom/AAPM k factors)

Effective dose estimate for measurements (body, chest) and ***displayed on the console (body c, chest c)*** for each type of scan

Effective Dose

Exam	E_{mean} (mSv)	$Value_{min}$	$Value_{max}$
PET	7.5 ±1.2	4.7	10.5
CT	18.2 ±5.0	10.5	30.3
PET + CT	25.7 ±5.3	16.4	40.2



Good agreement between measurements and display values

A 10-YEAR RETROSPECTIVE STUDY OF RADIATION EXPOSURE OF THE STAFF AT NUCLEAR MEDICINE DEPARTMENT

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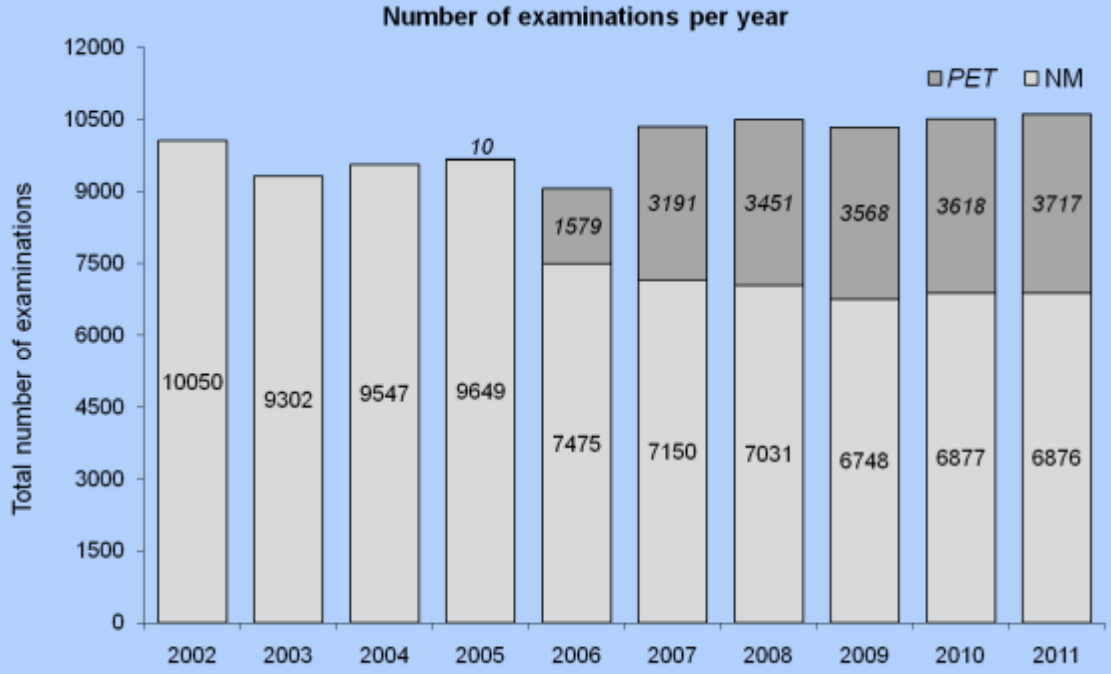
It involves physicians, technicians and radiopharmacists (2002−2011)

- 2001 two new SPECT
- 2005 PET/CT
- 2010 SPECT/CT

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
F-18	0	0	0	14	1260	3686.5	4067.7	4170.7	4416.0	4445.0
Ga-67	19.1	16.2	22.0	10.4	7.2	2.9	0.1	0.1	0	0
Y-90	1.1	4.1	3.7	8.7	19.7	21.9	20.5	25.8	20.5	14.6
Tc-99m	4086.0	3942.0	4805.0	5734.0	5723.0	6095.0	5782.0	6543.0	5175.0	5832.0
In-111	0.5	0.2	1.9	1.9	2.2	2.4	4.3	4.8	9.6	2.8
I-131	465.0	484.0	511.0	661.0	531.0	560.0	714.0	732.0	704.0	679.0
Tl-201	14.2	11.3	19.7	20.2	18.8	16.6	18.9	13.0	17.3	0

Total processed activity (GBq)



It is presented:

Annual collective and
average Effective Doses

Annual collective and
average equivalent doses to the hands
(technologists, physicians ;radiopharmacists)

The Effective and Equivalent Doses in all categories of workers are well under the permitted annual limit

RADIATION DOSE TO OCCUPATIONALLY EXPOSED WORKER FROM A PATIENT UNDERGOING NUCLEAR MEDICINE SCAN - RELATION TO ICRP RECOMMENDATION FOR PREGNANT WORKERS

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Serial No.	Type of study	No. of patients	Age of patient	Administered activity	Dose to technologist	Time spent with patient per study	Type of equipment
1.	Tc-99m liver scan	10	28-62 years	111-185 MBq	Below detectable limit	8-10 min.	Single head gamma camera
2.	Tc-99m gastroesophagal reflux study	17	19 days - 9 months	18.5 MBq	Below detectable limit -	20-25 min.	Single head gamma camera
3.	Tc-99m DMSA renal scan	12	2 months - 15 years	111-185 MBq	Below detectable limit	10-15 min.	Single head gamma camera
4.	Tc-99m hepatobiliary scan	12	2 months - 3 years	185 MBq	Below detectable limit	10-15 min.	Single head gamma camera
5.	Tc-99m renogram with DTPA	11	3-61 years	74-185 MBq	Below detectable limit	30-40 min.	Dual head gamma camera
6.	Tc-99m whole body	11	22-60 years	555-740 MBq	Below detectable limit -	20-25 min.	Dual head gamma camera
7.	I-131-whole body scan*	10	28-60 years	2.7-6.66 GBq	1-2 µSv	30-45 min.	Whole body rectilinear scanner
8.	FDG whole body with contrast	23	26-64 years	303-370 MBq	1-2 µSv	30-60 sec	PET-CT
9.	Gallium whole body with contrast	3	21-36 years	111 MBq	1 µSv	20-30 sec	PET-CT
10.	F-18 bone scan	4	17-38 years	370 MBq	1 µSv	20-30 sec	PET-CT
11.	NH3 cardiac scan	3	48-62 years	314-444 Mbq	1-2 µSv	10-20 sec	PET-CT

-Results:

^{99m}Tc:
below the detectable limit

- I-131 and F-18:
1 to 2 µSv per study.

ALARA principle:
a pregnant woman may be given non-active work, if the authorities can find suitable work for her

DOSIMETRY ANALYSIS IN PRODUCTION AND QUALITY CONTROL TASKS IN A RADIOPHARMACEUTICAL LABORATORY WITH ^{18}F-FDG

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[b]Fundación Centro Diagnóstico Nuclear, Ciudad Autónoma de Buenos Aires, Argentina

Facility: 11 MeV Cyclotron and Radiopharmaceutical laboratory
Electronic dosimeters (SAIC, model PD-10i); OSL dosimeters (InLight, by Landauer)

Task	Whole Body		Extremities	
	Hp(10)/A [µSv/GBq]	STD [µSv/GBq]	Hp(0.07)/A [µSv/GBq]	STD [µSv/GBq]
Remove interchange columns	8.6E-04	2.35E-04	2.8E-03	9E-04
Remove separation columns	1.3E-04	2.54E-04	2.5E-03	7E-04
Remove 18-O water	6.2E-04	2.87E-04	9.5E-04	2E-04
Remove trap	2.1E-04	4.23E-04	1.7E-03	1E-03
Load solvents	3.4E-04	6.77E-04	1.7E-03	6E-04
Change dispenser's filter	4.2E-05	8.46E-05	1.2E-03	6E-04
Remove vials	2.9E-04	1.60E-04	8.6E-04	6E-04
Collector stirring (3 times)	4.2E-05	8.46E-05	8.3E-04	7E-04
Place vials, needle and filter	0.0E+00	0.00E+00	4.9E-04	3E-04
Needle calibration	0.0E+00	0.00E+00	4.2E-05	8E-05
Connect new trap	4.7E-04	9.30E-04	9.7E-04	2E-03
Load reagents	1.7E-04	3.38E-04	3.9E-03	1E-03
Transport shielded QC vial	1.1E-03	3.61E-04	1.9E-03	6E-04
Transport shielded external vials	4.5E-02	1.67E-02	1.3E+01	2E-01

DOSES RECEIVED BY WORKERS FROM RADIOPHARMACEUTICAL SYNTHESYS

Year	Average Hp(10) [mSv]	Annual Hp(10) [mSv]	Average Hp(0.07) [mSv]	Annual Hp(0.07) [mSv]
2008	0.08	1.00	0.38	4.60
2009	0.06	0.65	1.22	14.78
2010	0.04	0.26	0.91	10.56
2011	0.12	1.43	0.52	6.20

DOSES USING OSL DOSIMETERS FOR PRODUCTION LABORATORY

Year	Average Hp(10) [mSv]	Annual Hp(10) [mSv]	Average Hp(0.07) [mSv]	Annual Hp(0.07) [mSv]
2008	0.05	0.60	0.13	1.55
2009	0.03	0.15	0.70	4.20
2010	0.01	0.04	0.85	5.13
2011	0.00	0.00	1.03	12.34

DOSES USING OSL DOSIMETERS FOR QUALITY CONTROL TECHNICIANS

A satisfactory optimization in the facility´s design
The highest exposure: **Transport shielded external vials**

The future goal: to train workers to reduce the time taken to transport the vials and to avoid superficial contamination

Thank you!