Guidelines to optimize extremity monitoring and to reduce skin doses in nuclear medicine. Results of the ORAMED Project

M. Ginjaume[1], M. Sans Merce[2*], S. Baechler[2], I. Barth[3], A. Carnicer[1], L. Donadille[4], P. Ferrari[5], M. Fulop[6], G. Gualdrini[5], S. Krim[7], F. Mariotti[5], X. Ortega[1], A. Rimpler[3], N. Ruiz[1] and F. Vanhavere[7] www.oramed-fp7.eu

1 Universitat Politecnica de Catalunya (UPC), Barcelona, Spain
2 University Hospital Center (CHUV) and University of Lausanne, Switzerland
3 Bundesamt für Strahlenschutz (BfS), Berlin, Germany
4 Institut de Radioprotection et de Sûreté Nucléaire (IRSN), Fontenay -aux - Roses, France
5 Radiation Protection Institute (ENEA), Bologna, Italy
6 Slovak Medical University (SMU), Bratislava, Slovakia
7 Belgian Nuclear Research Centre (SCK•CEN), Mol, Belgium

General overview of the ORAMED project

Optimization of Radiation Protection of MEDical staff

Collaborative FP7 project: 2008 – 2011 - Coordinator: F. Vanhavere (SCK-CEN)

ORAMED aimed at developing methodologies for better assessing and reducing exposures to medical staff in interventional radiology and nuclear medicine.

- Optimization in interventional Radiology and interventional cardiology:
  - See poster P02.25 hall 4, Carinou et al.
- Optimization in nuclear medicine (this presentation)
  - Context
  - Objectives - Material and methods
  - Main results
  - Recommendations

More information:

www.oramed-fp7.eu

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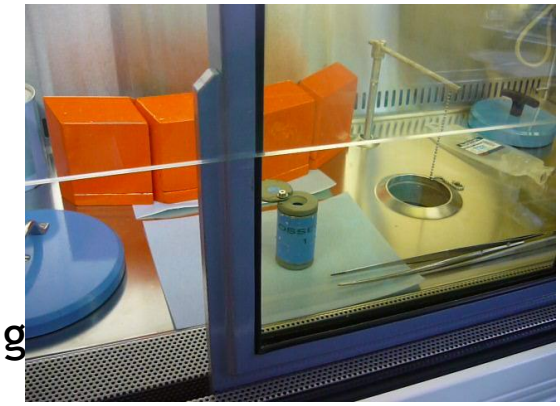
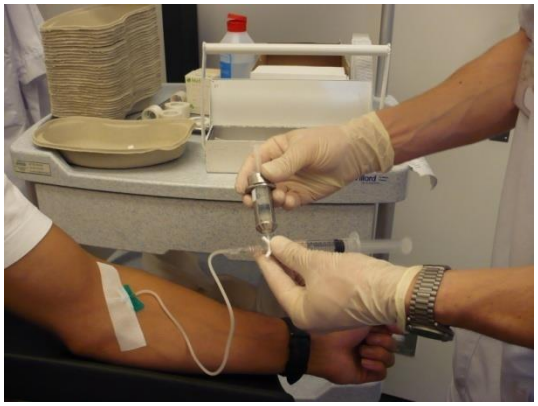
Context: Occupational exposure of workers in Nuclear Medicine

- Low whole body doses
- Hands particularly exposed
- Fields:
  - γ / β / γ-β
  - Use of β and PET increasing
  - presence of shields
  - Typically inhomogeneous





- Extremity dosimetry
  - Extremity dosemeters not always used
  - Dosimeter material and design not always appropriate
  - The position of the dosemeter on the hand matters
- Radiation protection
  - Not always appropriate
  - Extremity dosemeters often underestimate $H_p(0.07)$, the annual dose could surpass the dose limit

Objectives

- To evaluate extremity doses and dose distributions across the hands of medical staff working in NM departments.
- To study the influence of protective devices such as syringe and vial shields and to improve such devices when possible.
- To propose “levels of reference doses” for each standard NM procedure and to use these for risk assessment and optimisation of working methods.
- To propose guidelines to reduce doses to NM workers.

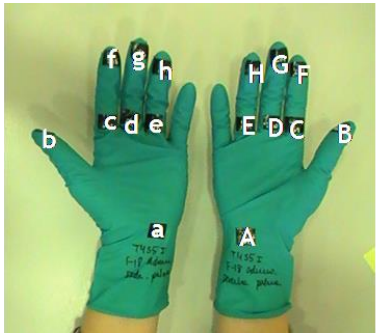
Methodology (1/2)

Hand dose survey

- 735 measurements (x 22 dosemeters) in 7 EU countries, 32 NM departments, for 124 workers
- Common protocol
- Diagnostics: ^{99m}Tc, ^{18}F
- Therapy: ^{90}Y-Zevalin®
- Preparation and administration stages

Measurement protocol

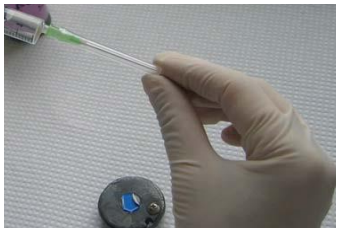
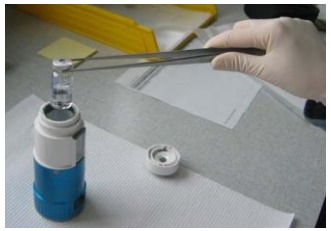
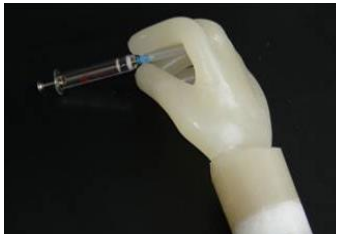
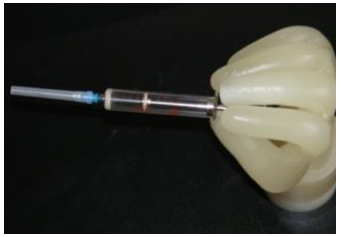
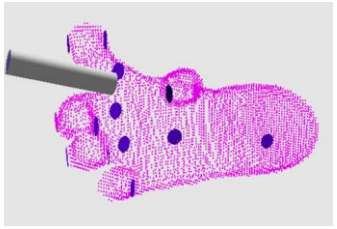
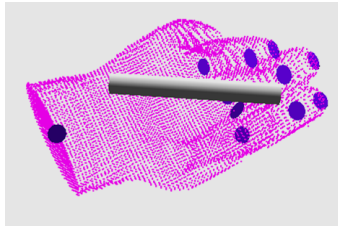
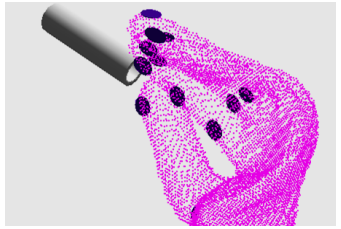
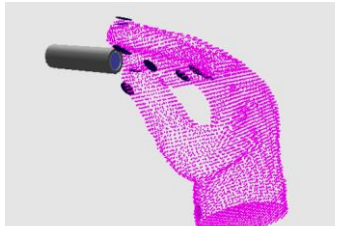
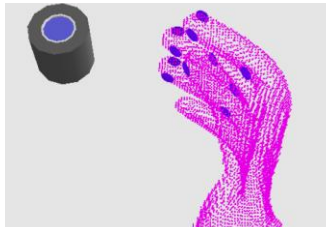
- 22 positions across the hands
- At least 2 different NM departments in each country
- Workers: at least 2 workers from the same NM
- Number of measurements per worker: 5



Methodology (2/2)

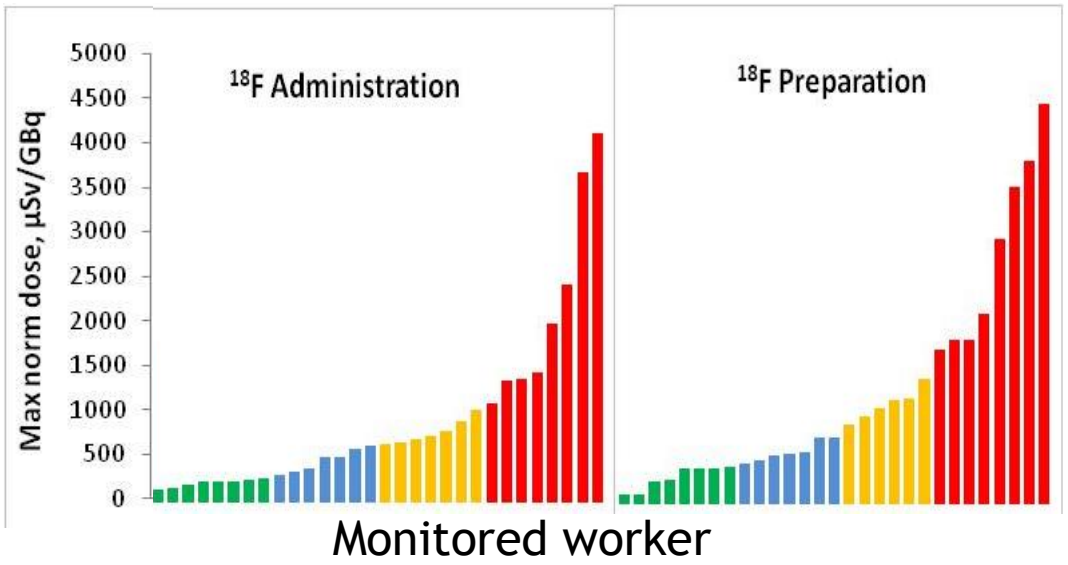
- Analysis of the parameters influencing the doses

MCNPx Monte Carlo simulations (~200) for realistic scenarios (voxel phantoms)

	ADMINISTRATION		PREPARATION		
	I1 The hand pushing the syringe piston	**I2** The hand holding the syringe	**PSM1** The hand holding the syringe by the piston	**PSM2** The hand holding the syringe by the needle	**PTR** The hand handling the vial
Working step					
Hand phantom					
Simulation geometry					

Hand dosimetry in nuclear medicine

- Main results



- Large spread of doses is observed.
- Bad practices are clearly associated with high doses.
- Preparation leads to higher doses than administration.
- Y-90 leads to higher doses than F-18, and F-18 higher doses than Tc-99m.
- The non-dominant hand receives higher doses than the dominant hand.
- Nature and minimum thicknesses of shields have been defined (through Monte Carlo simulations).

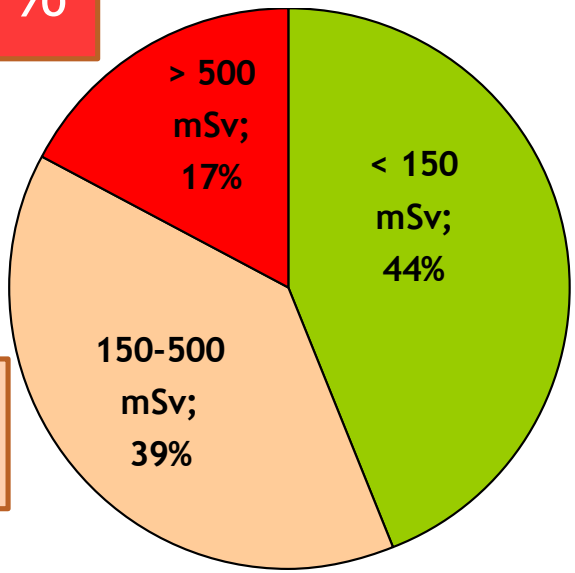
Hand dosimetry in nuclear medicine

- Main results

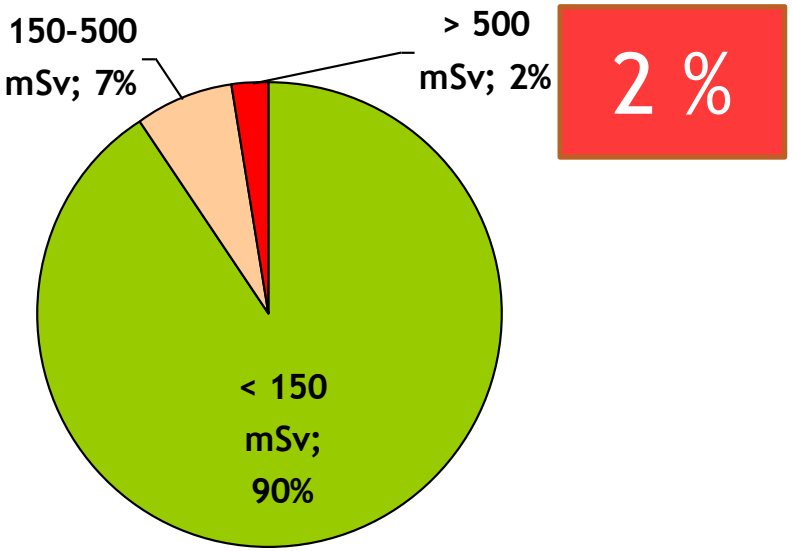
  - **Extrapolated annual maximum skin dose**

    Estimated for each monitored worker from the position receiving the maximum average dose

Diagnostics ^{99m}Tc, ^{18}F
1000 patients/year



Therapy ^{90}Y Zevalin®
5 patients/year



Hand dosimetry in nuclear medicine

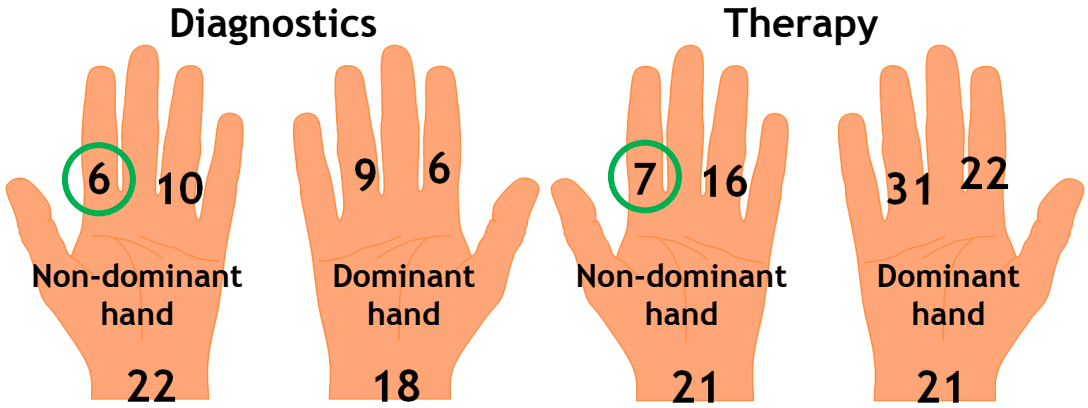
Main results

- The tip of the index is generally the most exposed position.
- Good correlation are found between the maximum dose and doses at positions used for routine ring dosemeters.

➔ Hand monitoring recommendation

- Routine ring dosemeter shall be located at the base of the index finger of the non-dominant hand with the sensitive part of the dosemeter oriented towards the inside of the hand.
- For estimation of the maximum hand dose: multiply by 6

Ratios between the maximum dose and dose at possible locations for routine monitoring



RECOMMENDATIONS

1.- Extremities should be monitored systematically in NM.

2.- The dosemeter should be worn at the base of the index finger of the non-dominant hand (sensible towards inside of the hand).

3.- The maximum skin dose can be estimated multiplying this value by 6.

4.- Shielding of vials and syringes are essential and a pre-condition but not a guarantee for low exposures.

5.- Recommended minimum shielding:
syringe: 2 mm W for ^{99m}Tc; 5 mm W for ^{18}F, 10 mm PMMA for ^{90}Y
vial: 3 mm Pb for ^{99m}Tc; 3 cm W for ^{18}F, 10 mm PMMA + mm Pb for ^{90}Y

6.- Training and education on good practice are more relevant parameters than the experience of the workers.

7.- Any tool increasing the distance between hand and source is very effective for dose reduction.

8.- Working fast is not sufficient, the use of shields or increasing the distance are more effective.

Thank you for your attention

Example of good practices:




Example of bad practices:




Available at www.oramed-fp7.eu:

- Recommendation leaflets
- Training materials
- Freeware: dose calculation tool