



Recommendations

- Nuclear medicine

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PURPOSE

The final outcome of the ORAMED project is to propose, on the basis of the results of measurement and simulation campaign performed, the guidelines in order to minimise radiation risk to medical staff in nuclear medicine.

Directed to:

- physicians
- nurses
- technicians
- radiation protection officers
- authorities in the field

The following recommendations concern only radiation protection aspects.

RECOMMENDATIONS

1. Extremity monitoring is a necessity in nuclear medicine.
2. The base of the index finger of the non dominant hand with the detector (TLD) placed towards the inside of the hand is the recommended position for routine extremity monitoring in nuclear medicine.
3. A rough estimate of the maximum dose to the hand can be obtained by multiplying the reading of the dosimeter worn in the base of the index of the non dominant hand by 6.
4. Shielding of vials and syringes are essential and a precondition but not a guarantee for low exposures.
5. The minimum acceptable shielding required for a syringe is 2 mm of tungsten for ^{99m}Tc and 5 mm of tungsten for ^{18}F . For ^{90}Y 10 mm PMMA completely shield beta radiation, nevertheless 5mm shielding of tungsten provides a better shielding cutting down bremsstrahlung radiation too.

RECOMMENDATIONS

6. The minimum acceptable shielding required for a vial is 3mm and 3cm lead for ^{99m}Tc and ^{18}F respectively. For ^{90}Y an acceptable shielding is obtained with 10 mm PMMA with an external layer of few mm of lead.
7. Training and education on good practice (e.g. procedure planning, repeating procedures using non radioactive sources) are more relevant parameters than the experience of the worker.
8. All tools increasing the distance (e.g. forceps) between the hand/finger and the source are very effective for dose reduction.
9. Working fast is not sufficient, the use of shields or increasing the distance are more effective than pushing on the working speed.

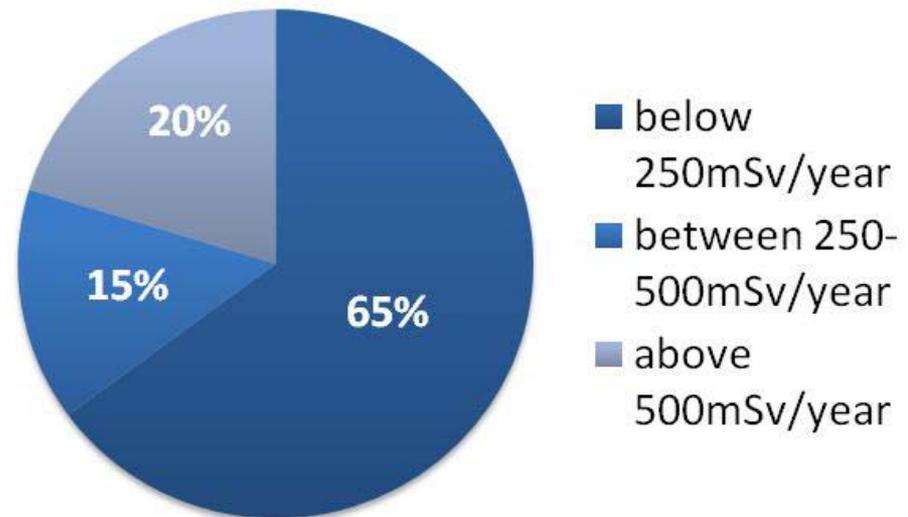
RECOMMENDATION 1

EXTREMITY MONITORING

The annual dose of 60% of the workers monitored for the ORAMED project has been estimated only considering the procedures from which real measured values were available and only for those whom their workload was known.

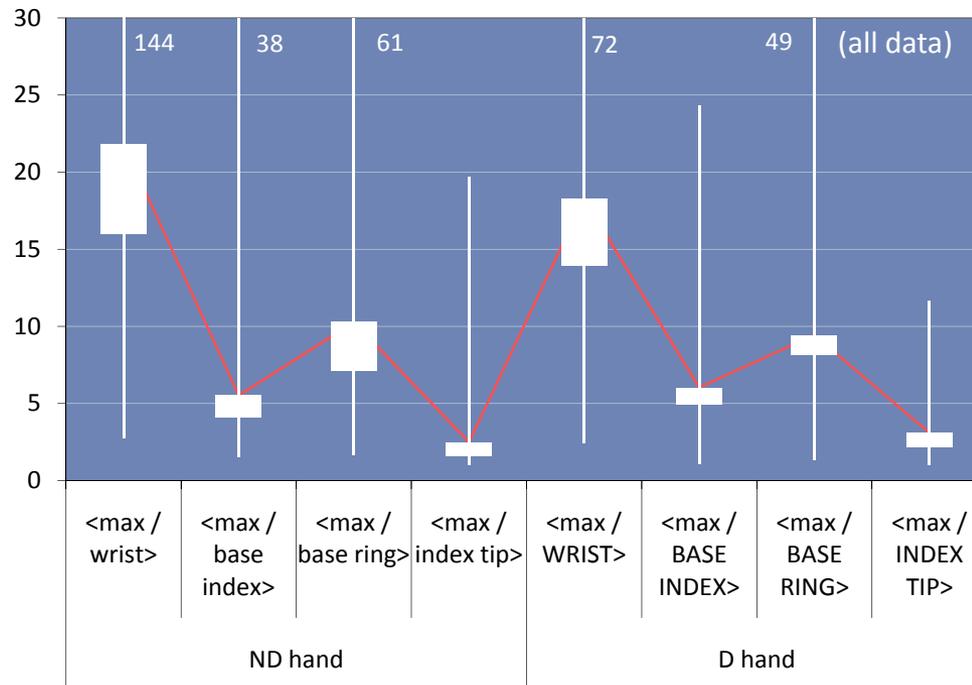


- The annual dose estimation is above 250mSv (half of the annual limit) for 35% of the workers.
- 20% of the workers exceed the annual dose limit of 500mSv.



RECOMMENDATION 2

ROUTINE MONITORING



Best monitoring position: index tip of the non dominant hand **BUT** not feasible for routine monitoring with ring dosimeters

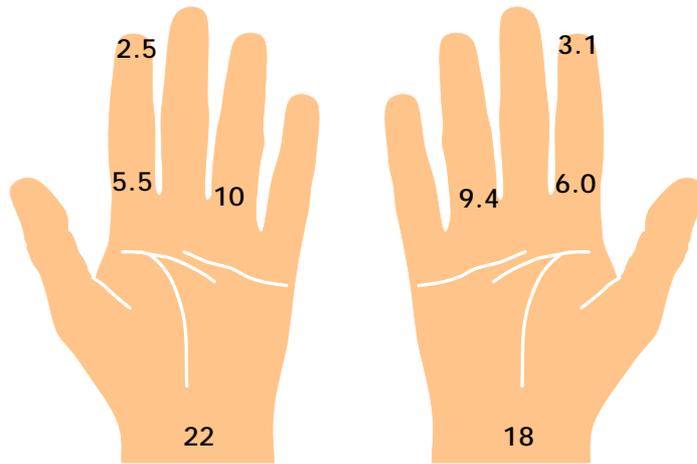


Recommended monitoring position: base index finger of non dominant hand with TLD directed to the inner side

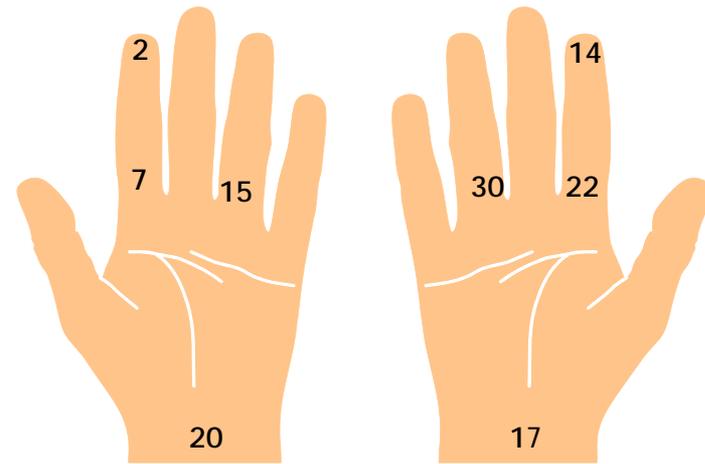
- low ratio
- high correlation with the maximum
- comfortable for manipulating

RECOMMENDATION 3

ESTIMATION OF MAXIMUM DOSE



Diagnosics

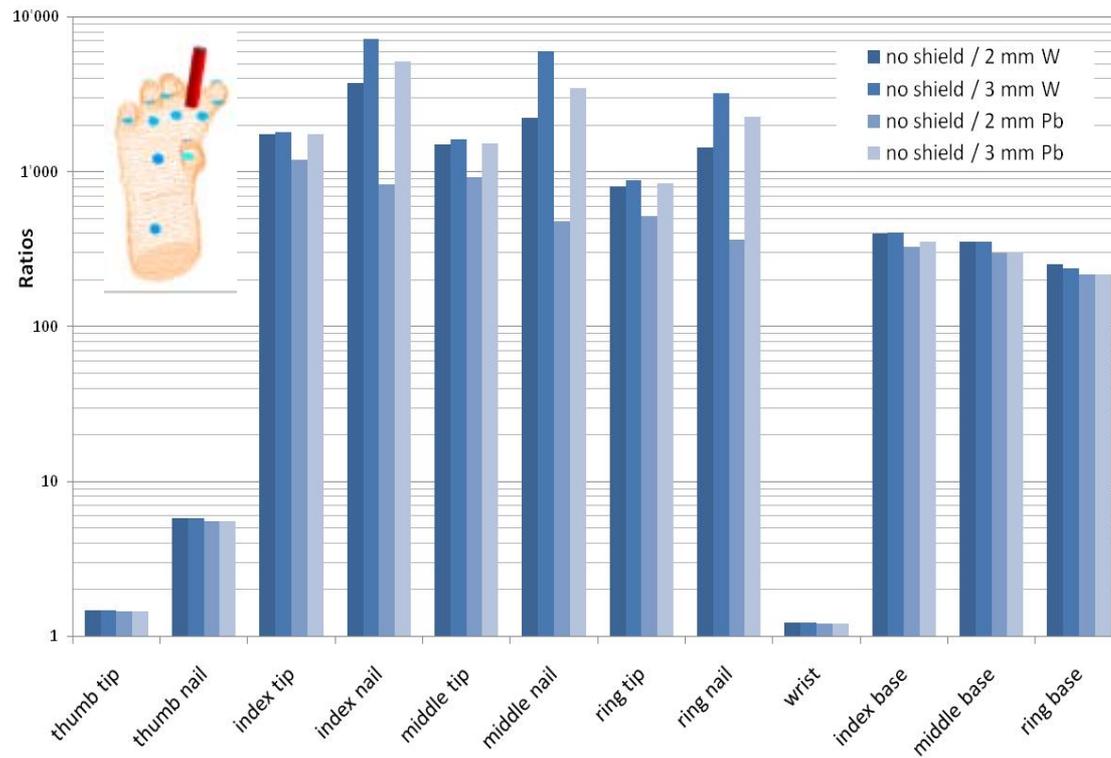


Therapy

The **maximum dose** can be estimated multiplying the dose measured at the base of the index finger of the non dominant hand by a **factor 6**

RECOMMENDATION 4

SHIELDING



RECOMMENDATION 5

MINIMUM SYRINGE SHIELD



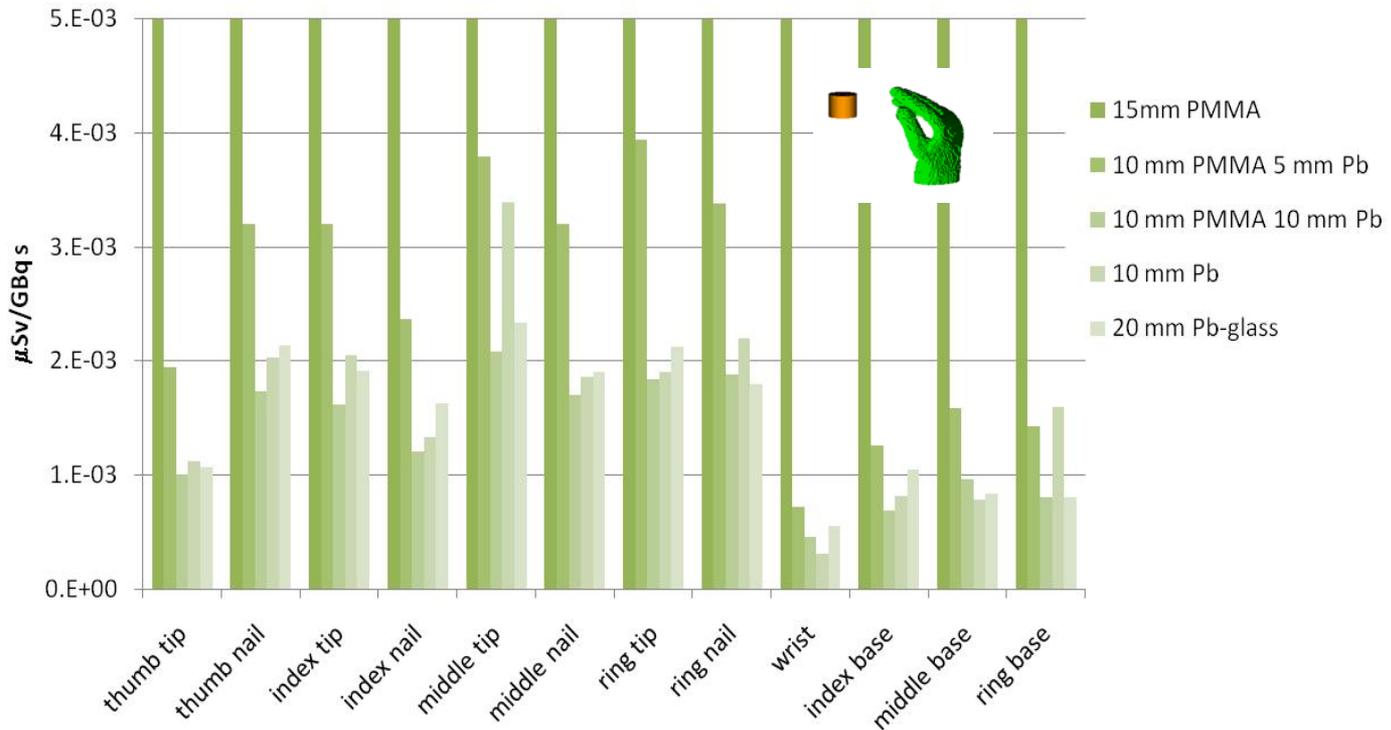
- Tc-99m: 2 mm W provide about more than 2 order of magnitudes of attenuation
- F-18: 5 mm W provide a factor up to 10 and 8 mm W a factor up to 40 in dose reduction
- There is little differences between Pb and W, even if W is better performing (because of specific density 11.35 versus 19.3 g/cm³)
- Y-90: 5 mm PMMA shield beta radiation sufficiently (97%) and 10 mm completely. If available, a 5 mm W shielding is better since it also reduces the exposure by bremsstrahlung providing more than 3 order of magnitudes of attenuation

RECOMMENDATION 6

MINIMUM VIAL SHIELD

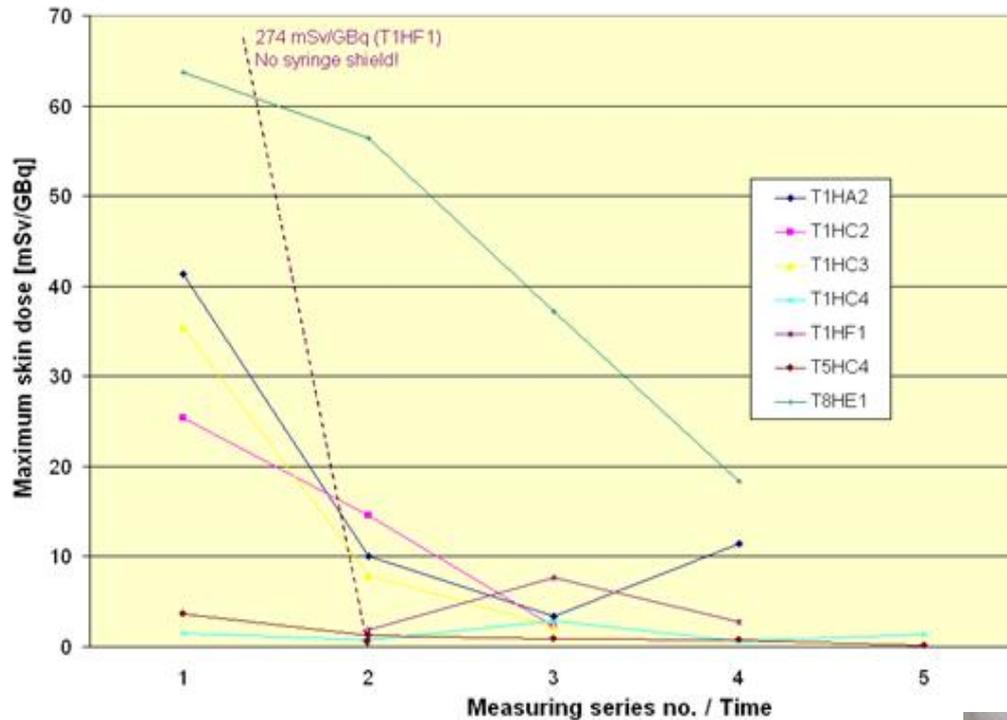
➤ 1 cm Pb provides a reduction factor of 6 in case of ^{18}F manipulation, 3 cm of Pb provides 2 order of magnitudes. The same attenuation for $^{99\text{m}}\text{Tc}$ is obtained with 2 mm Pb.

➤ The largest dose reduction when manipulating an ^{90}Y vial can be obtained adding some mm of W (or Pb) to the



RECOMMENDATION 7

TRAINING AND EDUCATION



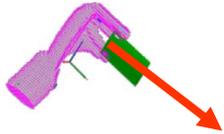
For therapy procedures when feedback is given on doses and appropriate radiation protection measures, doses can be reduced significantly.

Procedure planning: preparation of tools, estimation of doses to be received ([dose estimation tool](#)), first trial with inactive sources.

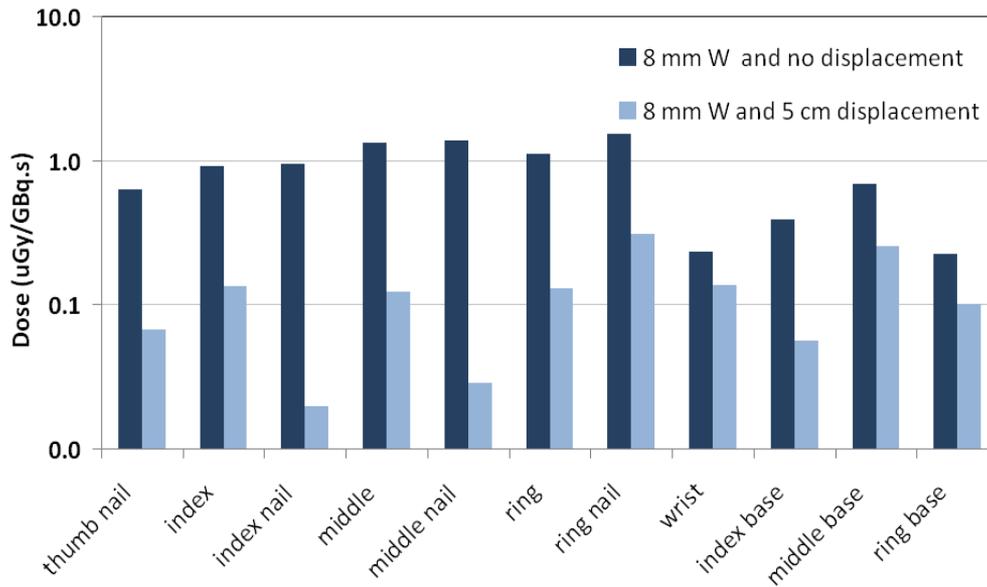


RECOMMENDATION 8

RADIATION PROTECTION TOOLS



F18 - Displacement of the vial



the effectiveness of using **forceps** is also demonstrated when working with shielded sources.

RECOMMENDATION 9

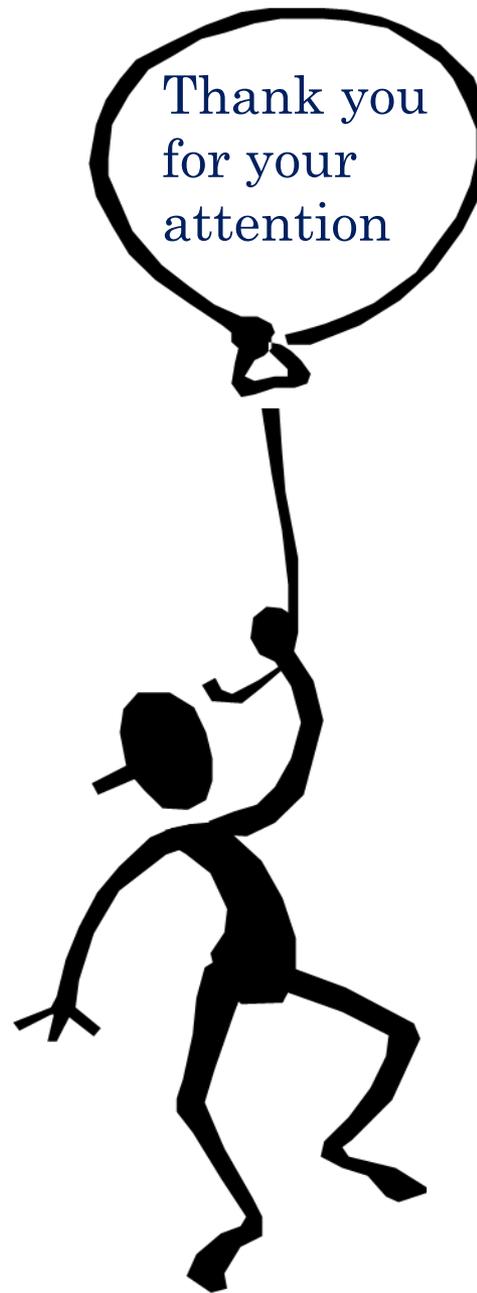
TIME

The accumulated dose is directly proportional to the time.

It is very difficult to correctly estimate the influence of time on the dose during a complete procedure, especially for the preparation of radiopharmaceuticals.

Different steps, very different dose rates in each step, usually for trained workers → the use of shields or increasing the distance are more effective than pushing on the working speed.

Thank you
for your
attention



Special thanks to all the workers
and hospitals that have
collaborated