



# **ORAMED: Extremity and Eye lens dosimetry in interventional procedures (Work Package 1)**

## **Practical guidelines to reduce extremity and eye lens doses in interventional cardiology and radiology procedures**

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# GUIDELINES FOR REDUCING EXTREMITY AND EYE LENS DOSE IN INTERVENTIONAL PROCEDURES

These guidelines were established in the framework the ORAMED project (2008-2011), a Collaborative Project supported by the European Commission within its 7th Framework Program.

## General problematic



During interventional radiology and cardiology procedures the medical staff can receive relatively high doses. The operator and assisting personnel is required to remain close to the patient and thus they are in the scattered field. Despite the fact that the body area can be individually shielded by protective lead aprons, the hands, legs and the eye lenses often remain practically unshielded.

## Description of the work

A coordinated measurement program was performed in different hospitals in Europe. Moreover, simulations of the most representative workplaces/procedures in interventional cardiology and radiology (IC/IR) were performed to determine the main parameters that influence the extremity and eye lens doses.

A measurement protocol was established, according to which several parameters related to the angiographic system, the type and complexity of the procedure, the position of the physician and the protective equipment, some field parameters (kV values, filtration, projections, etc.) and finally the KAP values were recorded. For the measurements in the various positions TLDs were used, sealed in small plastic bags and taped on the parts of the body to be monitored.

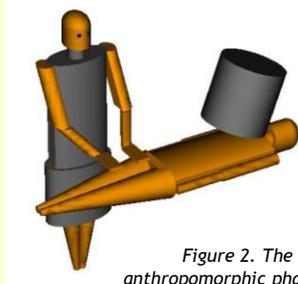


Figure 2. The anthropomorphic phantoms used for the simulations

Numerical simulations were performed using the MCNP-X software. The input file contains 2 anthropomorphic phantoms, representing the patient and the operator. Some modifications were performed on the operator's phantom: eyes and hands were added, as well as a lead apron and a thyroid collar. Moreover, the arms of the phantom are bent in a representative position. An X-ray source and an image intensifier are also included.

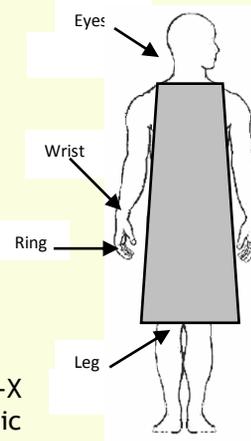


Figure 1. Location of the measuring points

## MEASUREMENT CAMPAIGN

The list of procedures includes 3 cardiac and 5 general interventional diagnostic and therapeutic examinations. The list is composed of cardiac angiographies (CA) and angioplasties (PTCA), radiofrequency ablations (RFA), pacemaker implantations (PM), angiographies (DSA) and angioplasties (PTA) of the lower limbs (LL), the carotids (C) and the reins (R), embolisations and endoscopic retrograde cholangiopancreatographies (ERCP).

The aim was to evaluate extremity and eye lens doses of medical staff.

Data comes from:

- 42 hospitals/rooms across Europe
- 6 different European countries
- 1329 procedures

## SIMULATION CAMPAIGN

The parameters examined are: tube voltage, filtration, beam projection, field size, irradiated part of the patient, position of the operator and protective equipment (table and ceiling shield and lead glasses).

The aim was to evaluate the influence of different parameters on eye, hand, wrist and leg doses.

## Conclusions

The various parameters which can influence the doses were studied and analysed through the measurements and simulations and the following conclusions were drawn:

- The ceiling suspended shield can reduce the eye dose (2-7 times)
- When ceiling suspended shield is not available protective glasses with side shield can be used (90% dose reduction)
- The proper use of table shield can reduce the doses to the legs from 2 to 5 times.
- The tube should be placed below the operating table. There is a significant reduction at the eye (2-27 times) and hand doses (2-50 times). However, there is an increase at the leg doses which can be compensated by the use of properly positioned table shield.
- If the biplane configuration is used the proper use of lateral shield is very important because otherwise the eyes and hands are practically unshielded.
- The femoral access should be preferred, if it is possible, from the medical point of view, than the radial one. The doses, if the shields are properly used, are lower in the femoral access, 2 to 7 times.
- Going outside the operating room during the image acquisition is a practice which can reduce the doses significantly (4 to 7 times), especially the hand ones.



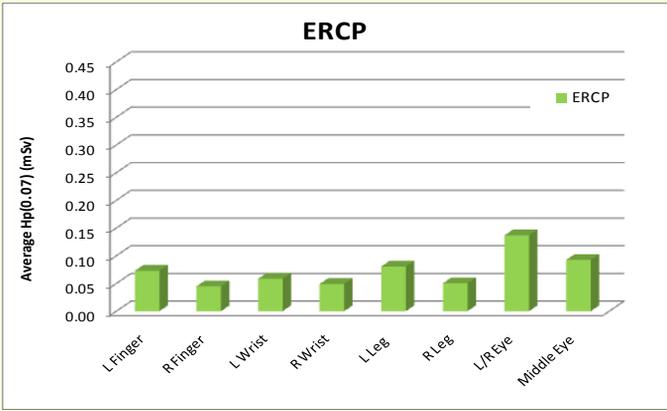
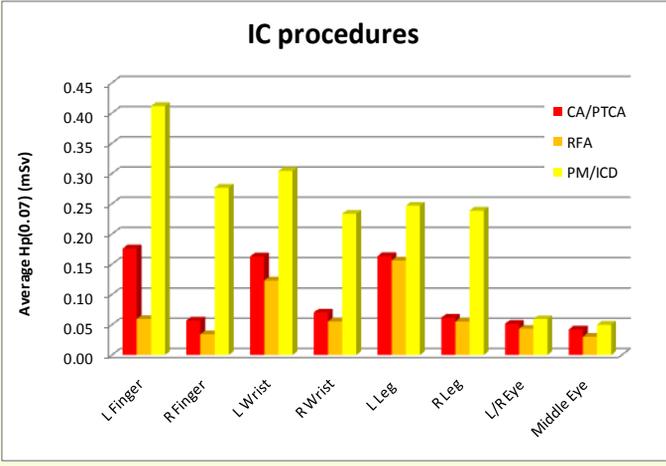
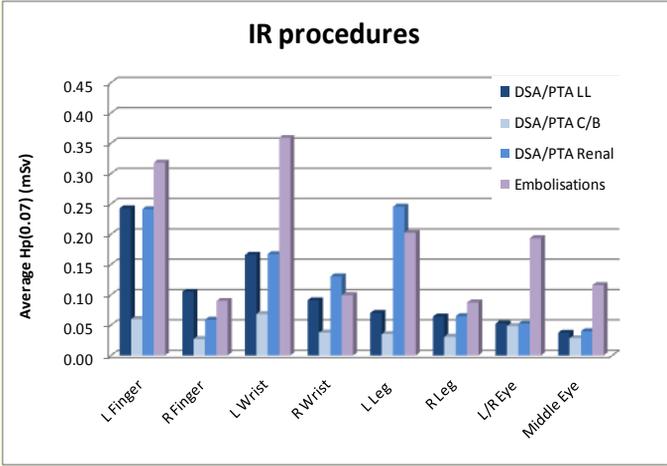
## Recommendations

- Only dedicated interventional equipment and room (properly shielded) should be used.
- Personal protective equipment should be used (at least collar and lead aprons). Lead glasses with side shield should be preferred.
- The room protective equipment should be used and positioned properly.
- Care should be taken for the table shield when assisting personnel stands close to the primary beam or when the operators need to move around the table for medical reasons.
- The ceiling suspended shield should be placed as close to the patient as possible. The combination of transparent ceiling shield and lead drapes that touch the patient is very efficient.
- If biplane systems are used the proper use of lateral shield is very important for the protection of eyes .
- The tube should be placed below the operating table. The higher doses at the legs in this setup can be reduced by a properly positioned table shield.
- The femoral access should be preferred whenever it is possible from medical point of view.
- Going outside the operating room during the image acquisition is a practice which can reduce the doses significantly.
- Avoiding the direct exposure of hands to primary radiation.
- Monitoring of doses to fingers or wrists and eyes should be performed on routine basis .



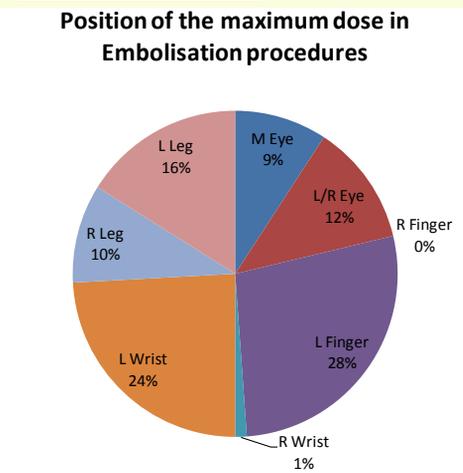
# APENDIX - Main results of WP1

## AVERAGE DOSES FOR THE DIFFERENT PROCEDURES

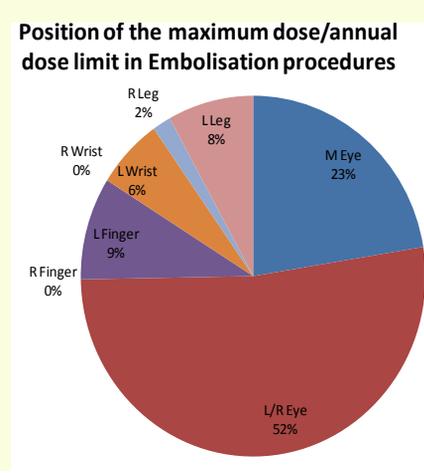


- Among the cardiac procedures studied, the doses to the operators are higher during PM and ICD implantations, even though the KAP values are relatively low. During these procedures the operators work very close to the irradiating field and most of the time without any protective shield.
- For the IR procedures special attention should be given to the embolisations, especially to the doses to the eye lenses. Operators are also significantly exposed during therapeutic procedures such as angioplasties of the lower limbs and the renal arteries.
- For ERCP procedures the doses are generally low. Special care should be taken regarding the use of a ceiling suspended shield, especially for the protection of the eyes, when over couch systems are used.

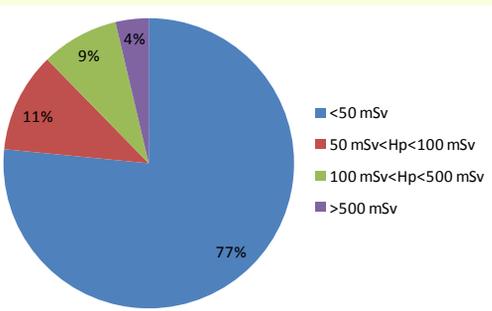
## MAXIMUM DOSES



- The maximum doses were recorded most frequently on the left finger and on the left wrist most of the times.
- However, taking into account the respective annual limits for all positions (150 mSv for the eyes and 500 mSv for the extremities) the eye lens exposure seems to become more important.



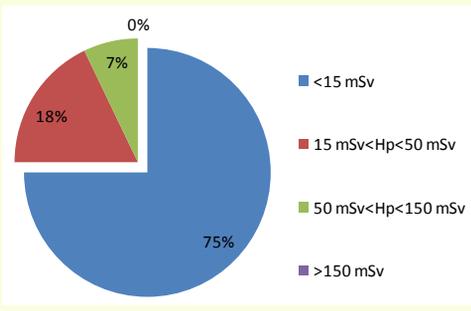
## EXTRAPOLATION TO ANNUAL DOSES



In many cases the 3/10th of the extremity and eye lens limits were exceeded.

For the hands there were cases exceeding the limit.

Monitoring of the hands and eye should be performed in routine basis in all procedures except ERCPS.



Frequency distribution of how many times the annual dose for hands exceed a certain dose level

Frequency distribution of how many times the annual dose for eyes exceed a certain dose level