European ALARA Network 20th workshop

2-4 October 2023

ALARA for interventional radiology & nuclear medicine

Feedback from a busy interventional radiology department
Focus on good practices

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Overview of IRCC UZ Leuven

IRCC: 3 departments including interventional cardiology, radiology and hepatology
109 professionally occupied personnel (56% men – 44% female)

- 25 cardiologists (IC) + 6 fellows
- 4 interventional radiologists (IR) + 2 fellows
- 4 interventional hepatologists
- Around 10 consultants (typically 1 day/week in UZ Leuven to perform FGI)
- supported by the nursing staff
- 9 cathlabs
- More than 20 types of interventional procedures

e.g. coronarography, ablation, pacemaker, PCI, TAVI, electrophysiology, EVAR, angiography, angioplasty, embolization, stenting, ERCP, catheter insertions (cancer treatments) …

Use of FGI procedures is increasing around the world:
Minimally invasive procedures used as an alternative to conventional surgery

- Reduced patient morbidity and mortality
- Avoidance of long post-operative recovery

Overview of IRCC UZ Leuven

Busy department (university hospital):

- 40- 45 procedures per day (normal working day): **>11,000 procedures/year**
- Around 250 emergency procedures per year (during the weekend)
- Full-time interventional physicians perform several hundreds procedures/year
- Research and referral hospital: new, complex and lengthy procedures
- Teaching hospital: fellows are among the highest exposed physicians because of their high workload and interest in the complex procedures

JACC JOURNALS

Journal of the American College of Cardiology | Current Issue | Just Accepted | Archives

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Anticoagulation for Percutaneous Ventricular Assist Device-Supported Cardiogenic Shock: *JACC* Review Topic of the Week OPEN ACCESS

JACC Review Topic Of The Week

Christophe Vandenbriele, Deepa J. Arachchillage, Pascal Frederiks, Gennaro Giustino, Diana A. Gorog, Mario Gramegna, Stefan Janssens, Bart Meyns, Amin Polzin, Mara Scandroglio, Benedikt Schrage, Gregg W. Stone, Guido Tavazzi, Thomas Vanassche, Pascal Vranckx, Dirk Westermann, Susanna Price, and Alaide Chieffo SEE FEWER AUTHORS

J Am Coll Cardiol. 2022 May, 79 (19) 1949–1962

Leuven cardiac specialists first to replace mitral valve without surgery

7 June 2021

For the first time in Belgium, a team of cardiologists and cardiac surgeons have replaced a mitral heart valve by a prosthetic valve in a minimally invasive way. Until recently this was only possible with cardiac surgery and the use of a

Exposure of staff members:

IR and IC: Occupational whole-body doses are among the highest in the clinic
Eye doses can exceed the legal limits if no proper radiation protection measures are put in place

Nurses: The whole-body doses are < 3 mSv/year (internal dose constraint)

Primary beam:

Patient dose: 1-200 mSv/**procedure**

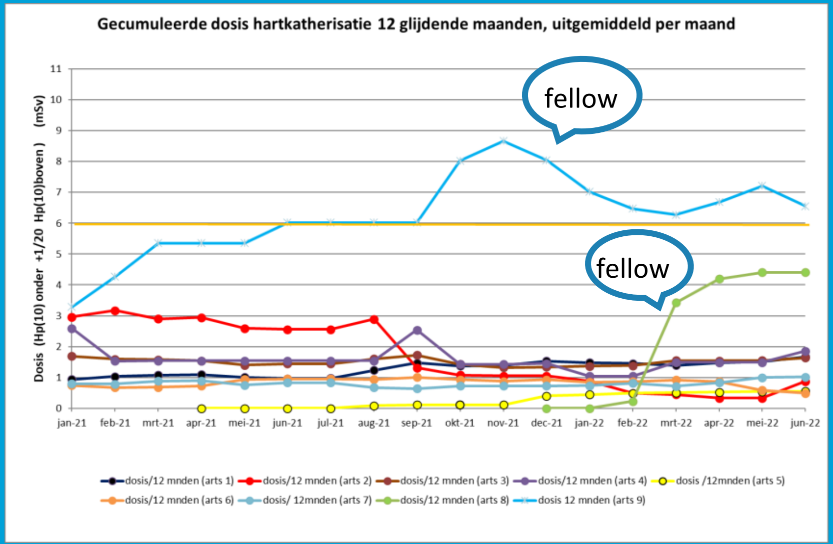
Scattered radiation:

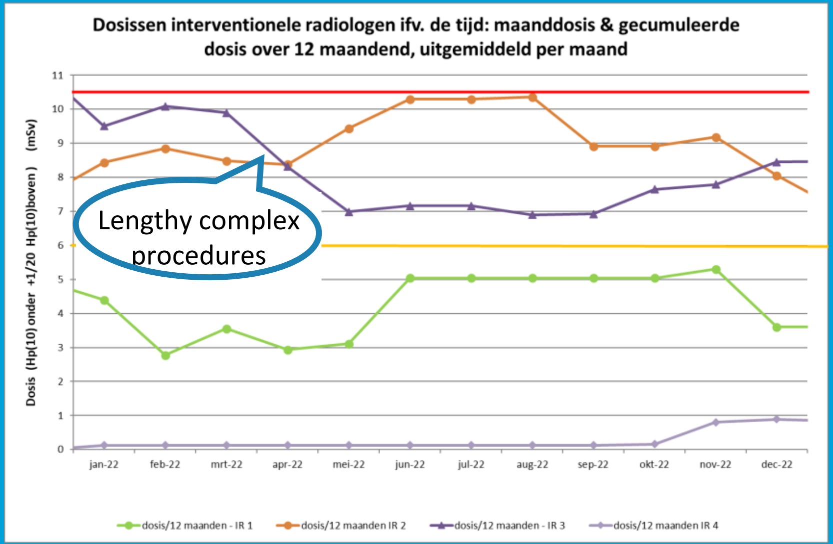
physician: 0,1-11 mSv/year 2022 (avg. 1,75)

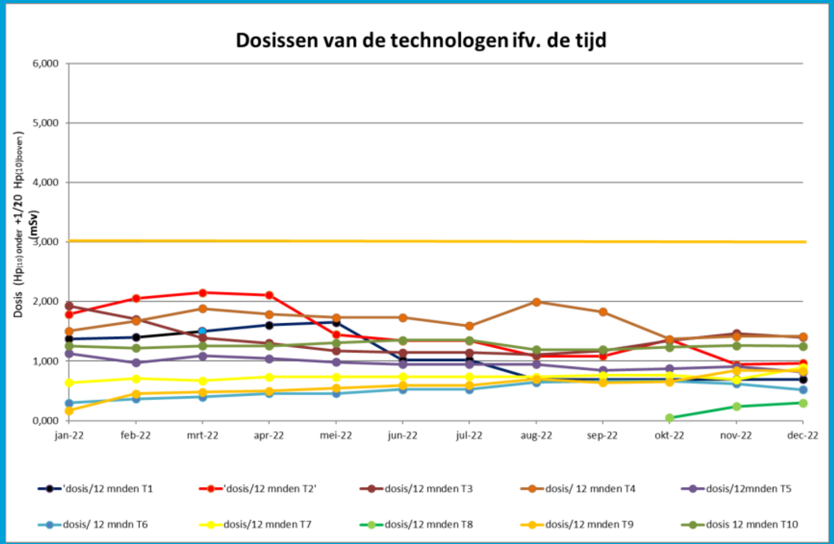
nurse: 0-2 mSv/year 2022

These procedures require a high level of optimization

Permanent follow-up of the highest staff doses







Exposure of personnel is monitored with dual dosimetry on a monthly base

- For physicians internal dose constraint of 6 mSv/year, for nurses internal dose constraint of 3 mSv/year

  ⇒ Dose constraints can be exceeded, but only by fellows IC or IR due to very high workload and long fluoroscopy times (combination of lengthy complex procedures + learning curve)

- Results are communicated to the department
- 4 monthly a radiation safety meeting with: head of the department, head nurse (also RPO), occupational physician, RPE, MPE, head of HSE

Exposure of staff members

The radiation exposure of the IR/IC is of significance principally for these reasons:

Location: has to work inside and near the X-ray tube and cannot be too far away from the patient

Time: the radiation 'ON' time in a busy cathlab is typically a few hours per day (~120-240 min)

Shielding - attenuation by lead apron can be to the order of 85-95% depending upon the Pbeq of the apron

Further factors to consider are:

Radiation intensity: in fluoroscopy mode, intensity is lower by a factor of few tens compared to cine or CBCT mode
Education on when to use which settings is important!

Exposure parameters: automatically controlled by equipment - are higher for patients with high body mass
QA/QC of equipment, of the imaging protocols and the ease-of-use of dose reducing techniques is important!

Access point: Radial access gives a higher radiation exposure than using the femoral access point. But, in recent times radial approach is getting popular due to the accessibility of the artery in most patients, the easy control of bleeding and patient comfort after the procedure.
Extra shielding for the operator standing the closest is important!

Shielding tools for optimizing staff exposure

Table 1 Lead equivalency of available personal protective devices

Protective tool	Lead equivalent (mm)
Aprons	0.25–0.50
Ceiling-suspended screen	0.5–1.0
Curtains	0.5–1.0
Rolling shields	0.5–1.0
Goggles	0.25–0.75
Protective gloves	0.03–0.10
RadPad Disposable shields	0.125

Bartal, G., Vano, E. & Paulo, G. Get Protected! Recommendations for Staff in IR. *Cardiovasc Intervent Radiol* **44**, 871–876 (2021). https://doi.org/10.1007/s00270-021-02828-y

Key points to remember for staff dose management

Key points in a radiation protection program

- Know your equipment and make sure that in start-up it is in a dose sparing mode: orientation C-arm with X-ray tube underneath the table, use of low dose protocol, detector placement
- Use lead apron with at least 0.25 mm Pbeq on the back and with overlap 0,5 up to 0,7 mm Pbeq on the front;
- Use protective shields: mounted shields/flaps, ceiling suspended screens with flaps and drapes as applicable;
- Promote the use of lead collars and lead glasses;
- Keep knowledge of staff up-to-date: including practical knowledge on how to use the different shielding tools, settings of the equipment and warning signals, new dose reducing techniques,…
- Personal whole-body radiation monitoring badges and where necessary additional dosimeters;
- Make sure that fluoroscopy equipment is properly functioning and periodically tested and maintained;
- Address questions to appropriate radiation protection specialists
- Optimization needs a multidisciplinary approach

All actions to reduce patient dose will also reduce staff dose!

Key points to remember for staff dose management

Good working practices for the staff members

- X-ray tube as far away as possible and the image intensifier or flat panel detector as close as possible to the patient
- Correct positioning: stand whenever possible on the side of the detector and opposite to the X-ray tube
- Foot on the pedal only when necessary
- Reduce the number of runs, using navigation system
- Do not use acquisition mode for fluoroscopy (if applicable)
- Maximum use of pulsed fluoroscopy and minimum use of magnification
- Use the lowest frame rate consistent with image quality
- Maximum use of collimation
- Avoid exposure to radiosensitive organs such as the chest if possible
- Minimize fluoroscopy time (FT). Keep a record of FT for each patient (repeated procedures)
- Please note that oblique projections and lateral views result in a higher patient dose and associated staff dose
- Keep hands out of the primary beam unless unavoidable for clinical reasons commensurate with good practice

Focus on eye lens dosimetry

Reference: Bergans, N., Vandermaesen, A., Vanheule, J., Bogaerts, M. (2023). A PRACTICAL METHOD FOR ROUTINE EYE LENS DOSIMETRY OF STAFF IN INTERVENTIONAL RADIOLOGY. Accepted for publication in *Radiation Protection Dosimetry*.

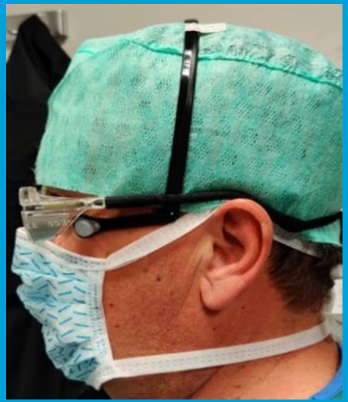
EYE LENS DOSIMETRY:

- Dedicated eye lens dosimeters are not used routinely in UZ Leuven, they are used periodically for study purposes.
  - → Investigate occupational eye lens doses for interventional catheterisation personnel in real life
  - → Obtain answers on which system to use in practice:
    - Choice of Hp(3) dosimeter based on dose results and on ease of use and comfort
    - Possibility to use routine WBD Hp(10) measurement to estimate the eye lens dose

- **Study set-up:**
  - 17 recruited participants (10 physicians and 7 nurses) , full time work regime
  - 3 months duration with monthly read-out
  - additional dosimeter badge above apron worn at chest height (cfr routine dosimetry)
  - statistical analysis with Graphpad Prism 9
  - Positioning of dosimeters:

(Apelmann et al, 2019)

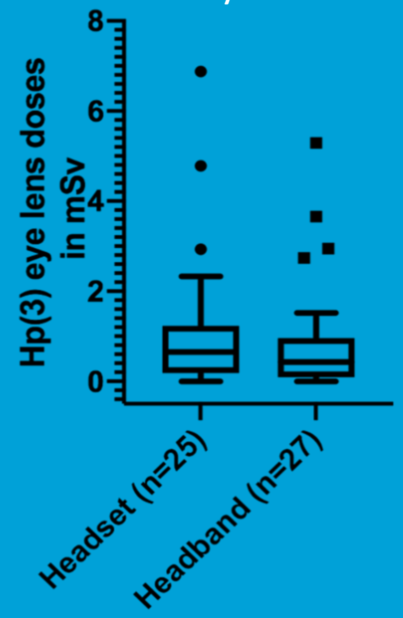
(DOSIRIS product file)

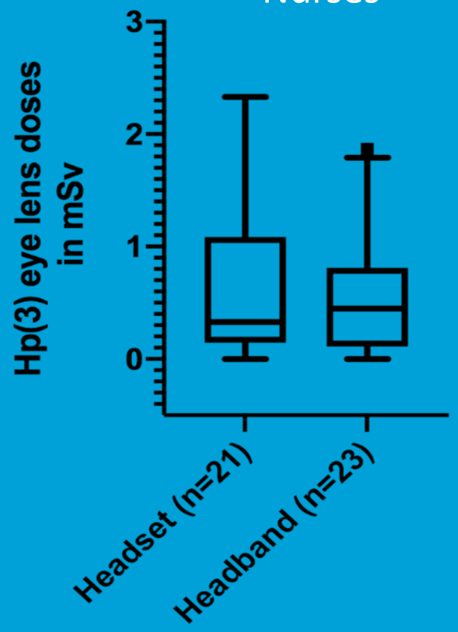


- reported eye lens doses are unshielded doses, not corrected for shielding.
- Survey (Qualtrics XM):
  - grade comfort of both eye lens dosimeters using VAS score
  - assess frequency of using ceiling suspended lead screens and/or lead glasses

Evaluation of the eye lens dosimeters and doses

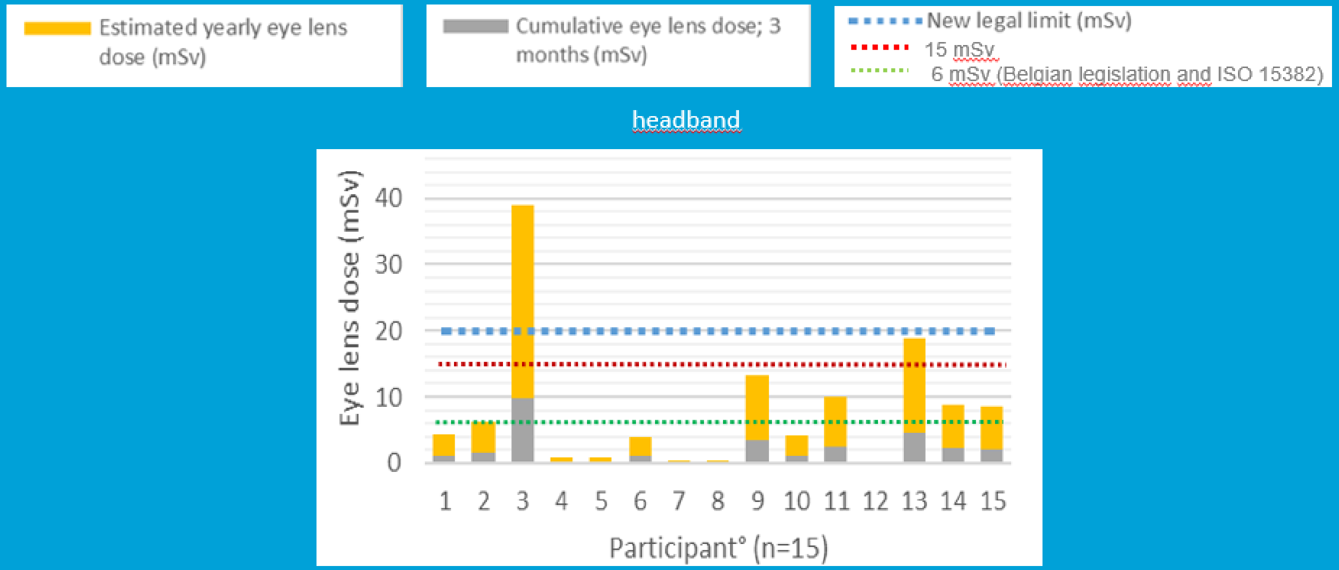
Eye lens dose results and analysis





→ doses measured with headset are higher than with headband but difference is not significant (Wilcoxon and paired T-test)

Extrapolation to yearly eye lens doses



→ Based on extrapolation of the results, the eye dose limit of 20 mSv/y can be exceeded for some physicians (the results do not take the shielding effect of eye glasses into account)

- application of DRF = 2 for leaded glasses:

  1 person > 20 mSv   4 persons > 6 mSv

Survey on use of shielding tools for the eye lens and comfort of the eye lens dosimeters

Survey results

- response rate was 88%, distributed 50/50 between physicians and nurses
- both eye dosimetry systems are found to have an average comfort, headbands are preferred to headsets
- eye lens dosimeters are preferably not to be used on an every day base
- use of protective equipment:

	Always (100%)	Most of the time (99-70%)	Sometimes (69 - 30%)	Rarely (30-1%)	Never (0%)	N
Wearing lead glasses	36%	15%	21%	7%	21%	14
Using lead ceiling screen	47%	38%	0%	0%	15%	14

Especially in situations where surgical techniques make it difficult to use a ceiling-suspended lead screen or mobile radiation shielding at all times, workers should ensure that they also wear lead glasses!

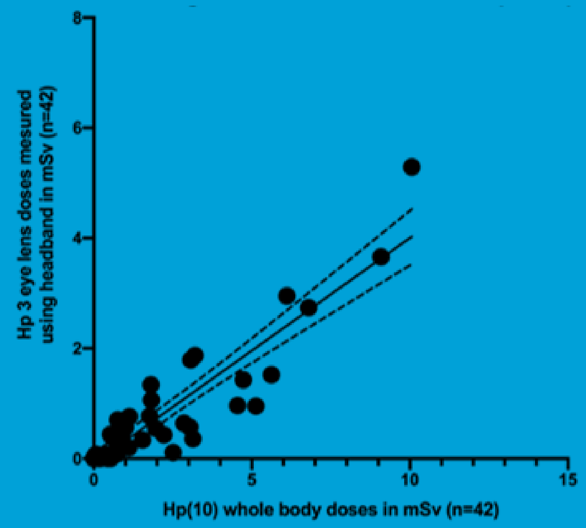
Results on correlation Hp(10)/Hp(3)

- Correlation Hp(10)/Hp(3):
  - correlation is relatively strong, the obtained conversion factors can be used

- Conditions of using this method:
  - correlation should be monitored over a longer period of time or from time to time, the ratio should stay relatively constant and Hp(10) values should be consistently larger than the Hp(3) values

- **To keep eye lens dose monitoring practical in the real working environment, we suggest:**
  - **Monitoring of personnel with eye lens doses > 15 mSv with dedicated eye lens dosimeters**
  - **For personnel with eye lens doses > 6 mSv but <15 mSv, the Hp(10) / Hp(3) ratio can be used to estimate eye lens doses if this ratio stays relatively constant below 1.**

headband



- Spearman correlation factor = 0.84
- slope = 0.40 (CI 0.34-0.46)

Good Work Practices to lower eye lens doses :
The use of personal protection equipment should be promoted and should always be applied
Ceiling suspended screens are mandatory to use whenever practically possible

Multidisciplinary approach to optimize patient and staff doses and manage the image quality: the medical team, MPE and RPE need to be involved and work together

Thank you!

Photo’s: @uzleuven

Thanks to all staff members of IRCC and my colleagues of the Radiation Protection and Dosimetry service