Improving protocols and procedures for strengthened radiation protection in interventional procedures

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German Commission on Radiological Protection (SSK)
German Roentgen Society (DRG)
Frequency and collective dose of medical examinations in Germany 2009

Frequency

- Angiography/Interventions: 37%
- Mammography one side: 31%
- Gastro-Urology: 8%
- Skeleton: 6%
- Dental: 2%
- CT: 2%
- Others: 11%

Collective effective dose

- Angiography/Interventions: 20%
- Skeleton: 9%
- Gastro-Urology: 6%
- Dental: 4%
- Others: 1%
- Thorax: 2%
- CT: 60%
Fluoroscopic interventions in radiology and cardiology are the two most frequent procedures involving a significant radiation exposure of patients as well as an occupational exposure of the staff.

**Frequency**
1. Cardiology
2. Radiology
3. Others
   - Vascular surgery
   - Gastroenterology
   - Urology
   - Other applications in operating rooms

**Emergency-interventions:**
The patient does not ask for the dose, but what about the staff?

**Critical pulmonary embolism**
Technical minimum requirements for all interventional fluoroscopy systems:

- Pulsed fluoroscopy
- Last image hold/run system
- Automatic exposure control (AEC)
- Selectable dose and/or image quality for fluoroscopy and angiography mode
- Removable grid
- Additional copper filter (children)
- Dose-area product meter (DAP/KAP) and fluoroscopy time
- C-arm system with under table x-ray tube (for monoplane system or first biplane tube)
- Basic protective shielding
- Contrast agent injector
State of the art technique and protocols for interventional fluoroscopy systems:

• Display of all exposure parameters including thresholds for skin entrance dose
• Automatic contrast agent injector with programmable flow protocols
• DICOM store of exposure parameters (fluoroscopy and every single series)
• Flat panel detector
• Simulation of table movement, collimation and wedges without radiation
• Roadmapping, DSA overlay, store of fluoro loops
• Second monitor for reference images
• Third monitor for images of other modalities (CT, MRI, US, CBCT, ....)
• Seamless protective under table shielding
• Additional over table shielding to reduce stray radiation from the patient
• Rotational angiography and/or cone beam CT (CBCT) for 3D visualisation
• Store of last image hold (LIH) instead of DSA series
Optimizing of run length in angio- and DSA-mode
Optimizing the frame rate and pulse in DSA mode and pulsed fluoroscopy

New SOP: dose reduction of 81%
Virtual insert of wedges
Virtual table motion
Roadmap

Tip of guide wire

Roadmap
3D-angio / cone beam CT

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Current and future developments:
2D/3D registration of CT/CBCT and DSA for planning, navigation and control of interventional procedures
Robot-systems: eccentric rotation with increased field of view (FOV) from 27 to 48 cm
Navigation (steering of catheters) with high magnetic fields in cardiology (no staff exposure)
Navigation (tracking of catheters) with low magnetic fields (reduced staff and patient exposure)
• New dynamic flat panel detectors (higher quantum efficiency)

• New dose tracking systems for skin entrance dose, erythema threshold and overlapping or new skin entrance fields
Radiation protection of staff
(additional to general system requirements)

- Personal protective devices
- Good dosimetry
ICRP: 20 mSv/a for the eye lens !!!

4x 0.5 mm lead equivalent

Thyroid collar

ICRP: 20 mSv/a for the eye lens !!!
Standard dosemeters (film based)

Personal dose – dosimeter under the lead apron

Second dosemeters – optional over the lead apron
Electronic dosemeters

THERMO FISHER SCIENTIFIC EPD Mk2
Electronic dosemeters with small flexible probe
Individual dosimetry when starting new procedures or changing procedures
Therapy with radioisotopes (e.g. Y-90 SIRT)
Close cooperation with nuclear medicine

Patient with liver metastasis after colon cancer
FDG-PET before and 3 month after SIRT
OCCUPATIONAL BETA RADIATION EXPOSURE DURING RADIOSYNOVIOERTHESIS

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Different positions of TLD dosemeters
Radiation protection of patient and staff

- Justification (guidelines, referral criteria)
- Patient: informed consent and cooperation
- .... training, training, training, training ....
Training vs. fluoroscopy time

Fluoroscopy time [minutes]

<75 Coro, <50 PTCA
4.3

>300 Coro, >200 PTCA
2.5

<75 Coro, <50 PTCA
7.7

>300 Coro, >200 PTCA
3.9

Procedures per year

Gleichmann 1993
Complications of arterial recanalization

DGIR Report 2011
Every green or red bar indicates one institution
Fortschr Röntgenstr 2012; 184: 570–576
Interventional Procedures - Avoiding Radiation Injuries

- Information abstracted from
  - ICRP Publication 85

- Available at www.icrp.org

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Avoiding Radiation Injuries

Informed consent and records

- Patients are entitled to know the risks of radiation injury if likely to be high.
- A written record should be kept if skin doses are estimated to be >3 Gy (1 Gy for repeated procedures).
- Not all skin reactions are due to radiation; e.g. contrast medium allergy.

Information abstracted from ICRP Publication 85
www.icrp.org
Follow-up

- Radiation skin injury may present late and the association not considered if no documentation
- All patients with estimated skin doses of 3 Gy should be followed up 10-14 days after exposure
- A system to identify repeat procedures should be set up
Free Material

The training material on this site is available for free downloading (subject to conditions specified in 'Intended use' and 'Disclaimer' below), and are on the topics of Radiation Protection in:

- Diagnostic and Interventional Radiology
- Radiotherapy
- Nuclear Medicine
- Prevention of Accidental Exposure in Radiotherapy
- Cardiology
- PET/CT
The EC has announced the MARTIR CDROM in its WEB site allowing to download the full content: http://europa.eu.int/comm/energy/nuclear/radioprotection/index_en.htm