

Towards a specific education and training programme in radiological protection for practioners in interventional cardiology

H. Thierens, E. Bogaert , K. Lemmens,
K Bacher

Dept. Med.Phys. and Rad. Prot.
University Ghent Belgium

Introduction

- Interventional cardiology procedures involves :
 - ⇒ high doses to the patient sometimes exceeding the threshold dose for skin deterministic effects of 2 Gy
 - ⇒ high doses to the personnel
- Cardiologists have an active role in the avoidance of radiation injuries from intervent procedures
 - ⇒ Interventional physician should be trained to use information displayed at the operator's position on the level of patient skin dose

Introduction

- Council directive 97/43/EURATOM specifies that member states have to assure theoretical and practical training in radiological protection issues related to the applied radiological techniques
- For cardiology education programmes should cover not only general radiation protection issues but also specific topics related to interventional cardiology

Topics related to X-ray equipment

- Dose reduction by high additional filtration
- Dose reduction by pulsed X-ray beams versus continuous beams
- Importance of image hold
- Effect of low- and high dose fluoroscopy modes on image quality and dose
- Dose increment associated by the antiscatter grid
- Effect of magnification on the dose received by the patient

Topics related to dosimetric quantities

- Definition and importance of dose-area product (DAP) as patient dose monitor
- Correlation between skin entrance dose – DAP in complex geometries
- Methodology of determination of organ doses, uterus and gonadal doses
- Dependence of skin and organ doses on X-ray source quantities (mA, time, distance, kV, filtration)

Topics related to dosimetric quantities

- Definition of effective dose-risk estimation for late effects
- Relationship between DAP and effective dose
- Measurement methods for occupational and patient dosimetry (TLD, ionometry, film, electronic dosimeters)
- Personnel dosimetry with double dosimetry when using personal protection as leaded aprons

Topics related to radiobiology

- Characteristics of deterministic direct and stochastic late effects
- Overview of the different deterministic effects on the skin with threshold dose
- Examples of skin injuries due to overexposures in interventional cardiology –time course
- Risk estimations during pregnancy for patients and staff
- Radiation induced cataract formation in the lens

Topics related to radiobiology

- Overview of the UNSCEAR report data on late radiation effects
- Decrease of risk of late radiation effects with age: difference between paediatric and adult patients
- Risk estimation for radioinduced hereditary (genetic) effects

Radiological protection of the staff

- Dose reduction by the use of personal protection : leaded aprons (thickness), gloves, eyeglasses, thyroid collar
- Influence of distance between staff and patient: repercussions on operational procedures during image acquisition
- Influence of X-ray C-arm positioning on the occupational doses, illustrated by isodose curves in the catheterization room

Radiological protection of the staff

- Effect of position of TVmonitor on the eye lens dose
- Importance of collimation, kV, cine- and fluoroscopy mode on the occupational dose
- Overview of typical values of the occupational dose quantities (effective dose, extremity dose, eye lens dose) for the cardiologist and nurse during most common cardiological interventions (coronary angiography, PTCA, stent-implant)

Radiological protection of the patient

- Effect of the focus-to-skin distance and patient-to-image intensifier distance on skin dose
- Reference DAP values
- Typical values of patient entrance skin dose rate in high and low dose fluoroscopy modes
- Typical values of patient entrance skin dose per image for cine runs
- Typical values of patient effective dose per unit of DAP

Avoidance over patient overexposures

- Discussion of the counselling given to a patient before the intervention on the doses they can receive and the effects involved.
- Importance of patient's informed consent with respect to radiation risks
- Written protocol for the radiopathological follow up of patients including the information of patient's personal physician.

Avoidance over patient overexposures

- Use of the cumulative DAP value as patient skin dose monitor during a procedure
- Determination of skin doses for a number of patients in case of normal procedures for most common types of procedures : to allow for the interventional physician to have operational knowledge of the patient's skin dose.
- Protocol for using different C-arm orientations to avoid overexposures in case of complex and long procedures

Avoidance over patient overexposures

- Cumulative DAP has to be recorded in every patient's records
- Procedure and patient data to be registered in patient's records in case of exceeding DAP thresholds for diagnostic (skin dose 2 Gy) and therapeutic (skin dose 1 Gy) interventions
- Decision of radiopathological follow up of a patient based on the operational knowledge of the patient's skin dose by the cardiologist (complexity and duration) and the DAP value.

Conclusions

- In Radiation protection education programmes in the medical field have to be evidence based and oriented practically: apart from the necessary basic subject material they should discuss also the application in daily practice
- In view of the high radiation burden in interventional cardiology, dedicated programmes have to focus on patient dose reduction to lower the effective dose and on the avoidance of radiation injuries.