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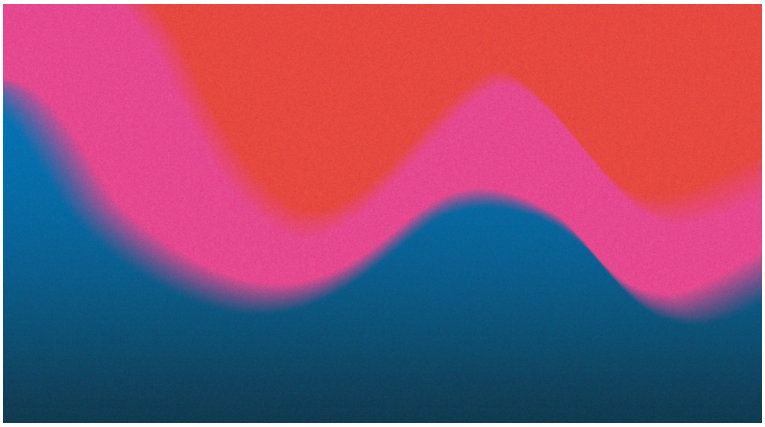

Guideline
DRL in interventional radiology
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http://www.bag.admin.ch/str-wegleitungen

Contact
Phone: +41 58 462 96 14
e-mail: str@bag.admin.ch

Diagnostic reference levels for interventional radiological procedures

Objective

Diagnostic reference levels (DRL) are intended to identify situations in which the radiation exposure to the patient is unusually high. The concept of DRL is internationally recognized and has established as an important tool for optimizing radiological procedures in medicine.

National DRL for the most common types of procedures are based on national surveys of radiation doses, which are directly related to patient doses and thus enable an efficient dose management. The DRL is defined as the 75th percentile of the dose distribution for standard patients. This means that 75% of all dose values for a particular radiological procedure are below the corresponding DRL.

If the DRL are regularly exceeded, the increased dose must be justified or reduced by appropriate optimization measures. If the doses are systematically below the DRL, this level must at least be maintained, or further optimization must be carried out by defining local DRL. In this sense, DRL do not represent limits, but define a reference that users can apply as a guide and that allows them to keep the radiation exposure for the patient as low as reasonably achievable, considering medical necessities (ALARA principle).

Legal basis

According to Article 35 of the Radiation Protection Ordinance (RPO) of 26 April 2017, the license holder must regularly analyse its own practice in the case of interventional radiological procedures.

If the dose averaged over a certain period exceeds the DRL, a detailed analysis and optimization of the examination protocol used must be carried out with the aim of ensuring an optimized and dose-reduced procedure.

Diagnostic reference levels for interventional radiological procedures

The following tables show the DRL for the most common interventional radiological procedures. These procedures are not only performed in diagnostic radiology, but also in other medical fields such as for example angiology, cardiology, gastroenterology, and urology.

The relevant dose quantity for estimating the patient dose for interventional radiological procedures is the dose area product (DAP). According to Article 22 of the X-ray Ordinance of 26 April 2017, the corresponding X-ray systems must have a device for determining and displaying the accumulated DAP.

In addition to the DAP, DRL are also defined for the fluoroscopy time and the number of images. Since these parameters do not necessarily always correlate, optimization should be based primarily on the DAP. This guideline also includes DRL for the cumulative dose at the patient entrance reference point for cardiological procedures, which represents a measure of the expected skin dose for the patient.

For cardiological procedures, the 50th percentiles (median values) of the dose distributions are also specified in addition to the DRL. The median values can serve as a guidance for further optimization of the radiation dose and image quality, even if the DRL have already been exceeded.

References

1. Radiological Protection Act (RPA, SR 814.50) of 22 March 1991

2. Radiological Protection Ordinance (RPO, SR 814.501) of 26 April 2017

3. Ordinance of the FDHA on radiation protection of medical X-ray systems (X-ray Ordinance, SR 814.542.1) of 26 April 2017

4. ICRP Publication 103, The 2007 Recommendations of the International Commission on Radiological Protection, 2007

5. ICRP Publication 135, Diagnostic Reference Levels in Medical Imaging, 2017

6. European Commission, Radiation Protection N° 180, Diagnostic Reference Levels in Thirty-six European Countries, 2014

7. Diagnostic reference levels in interventional cardiology, internal report of a FOPH funded project conducted by the radiation protection unit of the university hospital of Zurich, 2025

8. Swiss population exposure to radiation by interventional radiology in 2008, Samara E.T. et al., Health Phys 103(3), 2012

9. An audit of diagnostic reference levels in interventional cardiology and radiology: are there differences between academic and non-academic centres?, Samara E.T. et al., Radiat Prot Dosimetry 148(1), 2012

10. How to set up and apply reference levels in fluoroscopy at a national level, Aroua A. et al., Eur Radiol 17(6), 2007

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12. Adult reference levels in diagnostic and interventional radiology for temporary use in Switzerland, Aroua A. et al., Radiat Prot Dosimetry 111(3), 2004

Legal status

This guideline is an enforcement aid issued by the FOPH in its capacity as the supervisory authority in the field of radiation protection. It is aimed primarily at license holders and radiation protection experts. It specifies the requirements of radiation protection legislation and reflects the current state of the art in science and technology. If the licence holders and radiation protection experts comply with this guidance, they can be sure that they are implementing the radiation protection legislation in a legally compliant manner.

Table 1
DRL for radiological procedures

Procedure	DAP [Gy·cm^2]	Fluoroscopy time [min]	Number of images
Cerebral angiography	150	15	400
Carotid angiography (4 vessels)	100	10	250
Angiography of the upper extremities	150	15	150
Pulmonary angiography	150	15	150
Selective abdominal angiography	300	20	150
Mesenteric angiography	300	20	150
Renal angiography	300	20	150
Angiography of the aortoiliac vessels	300	20	150
Arteriography of the pelvic girdle	300	20	150
Arteriography of the hip	300	20	150
Angiography of the lower extremities	200	10	150
TIPS[1]	350	40	250
Hepatic embolisation	300	20	200
Embolisation of the upper extremities	150	30	300
Embolisation of the bronchial arteries	150	30	300
Embolisation of the pelvic arteries	300	30	300
Embolisation of the cerebral arteries	350	50	1000
PTA[2] cerebral	350	50	1000
PTA[2] renal	200	20	150
PTA[2] iliac	200	20	250
PTA[2] of the lower extremities	350	14	200
Vertebroplasty	80	15	75

[1] Transjugular intrahepatic portosystemic shunt

[2] Percutaneous transluminal angioplasty

Table 2
DRL for cardiological procedures

Procedure	DAP [Gy·cm²]	Fluoroscopy time [min]	Number of images	Cumulative dose [mGy]
Electrophysiological procedures				
Electrophysiological studies (EPS)	2	5	30	31
Implantation of cardiac resynchronization devices (CRT)	10	19	145	111
Pacemaker (PM) implantation	2	6	69	15
Implantable cardioverter-defibrillator (ICD) implantation	3	5	86	20
Leadless pacemaker (PM) implantation	12	7	281	n/a
Electrode extraction	9	8	n/a	n/a
Electrode extraction followed by an implantation of a new electrode	11	12	n/a	56
Left-side catheter ablation with electro anatomical mapping (EAM) (except atrial fibrillation)	3	12	119	34
Ablation for atrial fibrillation with/without electro anatomical mapping (EAM)	8	18	138	50
Right-side catheter ablation with electro anatomical mapping (EAM)	2	8	20	21
Right-side catheter ablation without electro anatomical mapping (EAM)	2	7	0	17
Cardiac catheterization procedures				
Coronary angiography (CA)	24	6	548	322
Coronary angiography (CA) followed by percutaneous transluminal coronary angioplasty (PTCA)	45	14	1130	880
Endomyocardial biopsy (EMB)	1	3	0	10
Right heart catheterization	12	9	178	116
Structural heart procedures				
Transcatheter aortic valve implantation (TAVI)	38	15	450	328
Patent foramen ovale (PFO) / atrial septal defect (ASD) / left atrial appendage (LAA) closure	15	8	287	163
Transcatheter edge-to-edge repair (TEER)	49	26	n/a	331

Table 3

50th percentiles (median values) of the dose distribution for cardiological procedures

Procedure	DAP [Gy·cm²]	Fluoroscopy time [min]	Number of images	Cumulative dose [mGy]
Electrophysiological procedures				
Electrophysiological studies (EPS)	1	3	0	7
Implantation of cardiac resynchronization devices (CRT)	9	18	80	54
Pacemaker (PM) implantation	2	5	38	13
Implantable cardioverter-defibrillator (ICD) implantation	2	4	9	15
Leadless pacemaker (PM) implantation	8	6	237	n/a
Electrode extraction	8	7	n/a	n/a
Electrode extraction followed by an implantation of a new electrode	5	9	n/a	9
Left-side catheter ablation with electro anatomical mapping (EAM) (except atrial fibrillation)	3	7	6	19
Ablation for atrial fibrillation with/without electro anatomical mapping (EAM)	4	15	0	43
Right-side catheter ablation with electro anatomical mapping (EAM)	2	7	0	21
Right-side catheter ablation without electro anatomical mapping (EAM)	1	6	0	16
Cardiac catheterization procedures				
Coronary angiography (CA)	17	4	418	214
Coronary angiography (CA) followed by percutaneous transluminal coronary angioplasty (PTCA)	34	12	794	617
Endomyocardial biopsy (EMB)	1	2	0	9
Right heart catheterization	7	6	0	63
Structural heart procedures				
Transcatheter aortic valve implantation (TAVI)	30	12	379	261
Patent foramen ovale (PFO) / atrial septal defect (ASD) / left atrial appendage (LAA) closure	13	8	176	127
Transcatheter edge-to-edge repair (TEER)	33	16	n/a	155

Table 4
DRL for gastroenterological procedures

Procedure	DAP [Gy·cm²]	Fluoroscopy time [min]	Number of images
Biliary drainage und dilatation	250	30	50
ERCP[1]	30	10	n/a

Table 5
DRL for urological procedures

Procedure	DAP [Gy·cm²]	Fluoroscopy time [min]	Number of images
Retrograde ureteropyelography	15	3	10
Cystography	10	10	10
Nephrostomy	10	2	9
Retrograde urethrography	5	1	7
ESWL[2]	15	5	n/a

[1] Endoscopic retrograde cholangiopancreatography

[2] Extracorporeal shock wave lithotripsy