

Dose Levels In Digital Radiology

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Patient Dosimetry

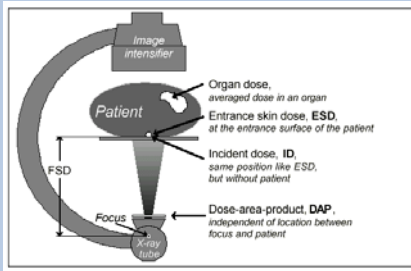
- Introduction
- Dosimetry protocols
- Reference levels

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QUANTITIES FOR PATIENT DOSIMETRY

From: Avoidance of radiation injuries from interventional procedures. ICRP.



ABSORBED DOSE D

- The absorbed dose D, is the energy absorbed per unit of mass. This quantity is defined for all ionizing radiation (not only for electromagnetic radiation, as in the case of the "exposure"), and for any material.
- $D = dE/dm$. The SI unit is called Gray [Gy].
- $1 \text{ Gy} = \text{J/kg}$.
- The former unit was the "rad". $1 \text{ Gy} = 100 \text{ rad}$.

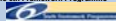
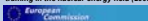
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ENTRANCE SURFACE DOSE

- The entrance surface dose is defined by the BSS as the absorbed dose in the centre of the field at the surface of entry of radiation for a patient undergoing a radiodiagnostic examination, expressed in air and with backscatter

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ENTRANCE SKIN DOSE

- The entrance skin dose (ESD) is the absorbed dose in the skin at a given location on the patient. It includes the backscattered radiation from the patient
- It can be measured directly with a dosimeter on the patient or by multiplying the ID with a backscatter factor (B).
- The magnitude of the ESD also increases as the FSD is reduced.

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- The dose-area-product (DAP) is the product of the incident dose and the area of the x-ray field. It can be determined at any convenient location between the x-ray source and the patient.
- The unit for DAP is Gy x cm².



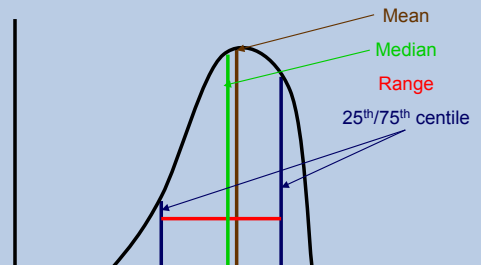
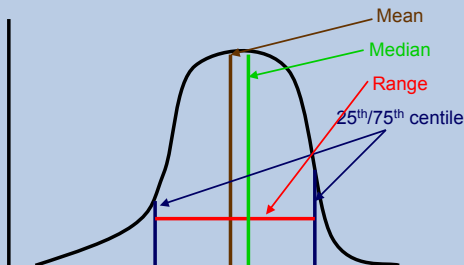
- The commission recommends the use of diagnostic reference levels for patients. These levels, which are a form of investigation level apply to an easily measured quantity, usually the absorbed dose in air or in a tissue equivalent material at the surface of a standard phantom or representative patient



- In principle diagnostic reference levels are applicable for standard procedures in all areas of diagnostic radiology
- Particularly mammography, pediatrics and interventional radiology
- Important where a reduction in dose means a relatively high reduction in risk



- National patient dosimetry protocol
- Entrance surface dose
- Dose-area product
- Based upon 75th percentile



Statistical Indices

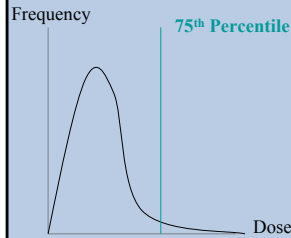


- Mean is the sum of all values divided by the number of data points, it is affected by skewed distributions
- Median is the 50th centile
- Range is the difference between the maximum and minimum values, it is effected by extreme values
- The difference between the 75th and 25th centiles is a marker for variability not effected by extreme values

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Reference Levels Optimisation Tool



- Most dose histograms are skewed distributions with a high dose tail; range 100x
- Optimisation studies should concentrate on high dose 25%

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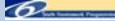


Patient Doses In The UK



- Results of a national survey undertaken by the NRPB in 2000
- Doses almost entirely for film/screens
- All distributions are skewed with a high dose tail
- Reference levels based on 75th centile

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Mean entrance surface dose per room



Radiograph	Mean ESD (mGy)
Abdomen AP	4.7
Chest PA	0.15
Chest LAT	0.85
Chest AP	0.14
Lumbar spine AP	5.0
Lumbar spine LAT	11.7
Lumbar spine LSJ	24.3
Skull AP/PA	2.3
Skull LAT	1.2
Thoracic spine AP	2.9
Thoracic spine LAT	8.0
Pelvis AP	3.6

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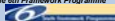
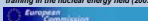


Summary of dose-area product data for radiographic examinations



Radiograph	Mean DAP (Gy cm ²)
Abdomen AP	2.5
Chest PA	0.1
Lumbar spine AP	1.4
Lumbar spine LAT	2.3
Lumbar spine LSJ	2.4
Pelvis AP	2.2

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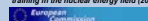


Entrance surface dose (ESD) per radiograph for paediatric patients



Examination	Age	Mean ESD (µGy)
Abdomen AP	0	110
	1	340
	5	590
	10	860
	15	2-010
Chest AP/PA	0	60
	1	80
	5	110
	10	70
	15	110
Pelvis AP	0	170
	1	350
	5	510
	10	650
	15	1-300
Skull AP	1	600
	5	1-250
Skull LAT	1	340
	5	580

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Reference doses proposed in the UK for radiographic examinations 1990



Radiograph/examination	Entrance surface dose (mGy)
Skull AP/PA	4
Skull LAT	2
Chest PA	0.2
Chest LAT	0.7
Thoracic spine AP	5
Thoracic spine LAT	16
Lumbar spine AP	5
Lumbar spine LAT	20
Lumbar spine LSJ	35
Abdomen AP	7
Pelvis AP	5

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Recommended national reference doses for individual radiographs on adult patients



Radiograph	ESD per radiograph (mGy)	DAP per radiograph (Gy cm ²)
Skull AP/PA	3	
Skull LAT	1.5	
Chest PA	0.2	0.12
Chest LAT	1.0	
Thoracic spine AP	3.5	
Thoracic spine LAT	10	
Lumbar spine AP	6	1.6
Lumbar spine LAT	14	3
Lumbar spine LSJ	26	3
Abdomen AP	6	3
Pelvis AP	4	3

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Entrance Surface Dose (mGy) CR San Carlos Hospital Madrid



Year 2004	Mean	Median
Abdomen AP	2.22	1.50
Pelvis AP	1.79	1.34
T Spine AP	2.37	1.88
T Spine Lat	2.52	1.77
L Spine AP	3.37	2.45
L Spine Lat	10.70	8.52
Chest PA	0.18	0.10
Chest Lat	0.86	0.57

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Paediatric Doses (uGy) CR SCUH Madrid Chest (no Bucky)



Age (years)	Median	Mean
< 1	41	51
1-5	34	57
6-10	54	91
11-15	109	122

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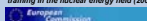


Paediatric Doses (uGy) CR SCUH Madrid Abdomen



Age (years)	Median	Mean
< 1	91	115
1-5	225	291
6-10	600	756
11-15	1508	1960

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Paediatric Doses (uGy) CR SCUH Madrid Pelvis



Age (years)	Median	Mean
< 1	48	65
1-5	314	455
6-10	702	943
11-15	1595	2261

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Mean Dose-Area Product Direct Digital Trier



Examination	Reference DAP Gy cm^2	Mean DAP Gy cm^2
Skull AP	11	5.66
Skull PA	11	3.91
Skull Lat	10	3.52
Chest AP	2	1.46
Chest PA	2	0.84
Chest Lat	10	4.39
T Spine AP	22	9.18
T Spine Lat	32	25.98

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Mean Dose-Area Product Direct Digital Trier



Examination	Reference DAP Gy cm^2	Mean DAP Gy cm^2
L Spine AP	32	18.09
L Spine PA	32	12.20
L Spine Lat	80	39.42
Pelvis AP	50	16.09
Abdomen AP	55	9.31

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Paediatric Doses (μGy) CR SCUH Madrid Chest (Bucky)



Age (years)	Median	Mean
< 1		
1-5	87	114
6-10	105	129
11-15	170	219

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Dose Comparison Chest Ramiki et al 2005



- Film/screen 0.2mGy
- Computed radiography 0.2mGy
- Selenium plate digital radiography 0.25mGy

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Diagnostic Reference Levels Summary



- Useful radiation protection tool for the optimization of protection
- Approach depends upon objective
- Use multiple methods in interventional radiology

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