



The Use of Effective Dose

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Effective Dose

- E enables the summation of all radiation exposures for comparison with constraints, reference levels and limits
- E is used for optimisation of protection / limitation of exposure, in planning and regulatory control
- E is a risk-adjusted dosimetric quantity, applying to reference persons, relating to nominal risk coefficients for uniform external low LET radiation exposure
- E is sex-averaged, uses simplified weighting factors, is applied without uncertainties, assumes LNT dose-response, chronic = acute, internal = external

Limitations on the Use of E for Medical Exposures

Effective dose intended for the control of radiation exposures

- “ OK for comparing doses from different procedures ✓
- “ OK for comparing doses from the same procedure in different hospitals ✓
- “ **NOT for the calculation of risks to individuals ✗**

However can simple adjustments be made to the risk per unit E as a function of age and sex?

Stochastic detriment x 10⁻² per Sv

Publication 60 (1991)

	Cancer	Hereditary	Total
Worker	4.8	0.8	5.6
Public	6.0	1.3	7.3

Publication 103 (2007)

Worker	4.1	0.1	4.2
Public	5.5	0.2	5.7

Risks from medical x-ray examinations

- “ ICRP 103 risk models to calculate age- and sex-specific lifetime risks of cancer for Western population
- “ Organ and effective doses calculated for a range of x-ray examinations
- “ Risks from individual procedures calculated using organ doses and age- and sex-specific risk factors
- “ Risk per unit effective dose calculated for each procedure as a function of age and sex

Wall *et al* (2011) HPA-CRCE-028

Typical UK Patient Doses from Common X-Ray Examinations

Examination	Effective dose (mSv)		Highest organ dose	
	E-60	E-103	Organ	mGy
Radiography				
Foot	0.0002	0.0002	Skin	0.007
Head (skull)	0.05	0.068	Salivary glands	1.3
IVU	2.3	2.1	Stomach	6.9
Fluoroscopy				
Ba follow	1.5	1.3	Kidneys	6.1
Coronary angiography	3.9	3.9	Lungs	15
CT				
Head	1.6	1.4	Brain	45
Chest+Abdo+Pelvis	9.2	10	Thymus	15

Lifetime Risk of Cancer Incidence per Unit Effective Dose (% / Sv)

Exam	Sex	Age at exposure (y)				
		0-9	20-29	40-49	60-69	80-89
Chest	M	8.7	6.2	5.0	3.2	0.9
Chest	F	13	9.6	8.6	5.7	1.3
Head	M	17	8.7	4.7	1.8	0.4
Head	F	16	7.8	4.2	1.5	0.3
Ba follow	M	13	8.0	5.0	2.3	0.5
Ba follow	F	11	6.9	4.7	2.1	0.4
Coronary angiography	M	8.6	6.4	5.5	3.7	1.0
Coronary angiography	F	11	9.5	9.4	6.8	1.7
CT ches+abdo+pelvis	M	9.6	6.2	4.3	2.4	0.6
CT chest+abdo+pelvis	F	15	9.1	6.3	3.6	0.8

Proposed Risk Coefficients (% / Sv) for Cancer Induction from X-Ray Examination

Region	Age group (years)									
	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
Male										
Head	18	13	9.1	6.8	5.2	3.6	2.2	1.2	0.5	0.1
Neck	9.1	6.2	4.1	2.8	2.0	1.3	0.8	0.4	0.2	0.0
Chest	8.3	7.0	5.8	5.1	4.6	4.0	3.0	1.9	0.8	0.0
Abdo & Pelv	12	9.7	7.5	6.0	4.7	3.4	2.2	1.1	0.4	0.0
Whole body	10	8.0	6.2	5.1	4.2	3.3	2.2	1.3	0.6	0.04
Female										
Head	15	11	7.6	5.5	4.6	3.0	1.7	0.9	0.3	0.0
Neck	20	12	7.2	4.2	2.6	1.6	1.0	0.5	0.2	0.0
Chest	14	12	10	8.8	8.3	7.1	5.4	3.3	1.3	0.0
Abdo & Pelv	10	8.3	6.6	5.2	4.4	3.2	2.0	1.1	0.4	0.0
Whole body	14	11	8.5	6.8	5.8	4.4	3.1	1.8	0.7	0.02

ICRP Task Group 79

The use of Effective Dose as a Risk-related Radiation-protection quantity

- “ Explain the calculation and purpose of E for occupational, public and medical exposures
- “ Consider uses of E beyond those intended – particularly to provide an indication of age- and sex- specific risks from medical X-ray examinations
- “ Explain the calculation of best estimates of cancer risks using organ doses and age- and sex- specific risk data, considering uncertainties