



University of Colorado Radiology Dose-Risk Smartcard

Estimates of cancer risk from the low-dose radiation exposures in this card come from ICRP-103 and BEIR-VII (see references). These studies assume a linear, no-threshold (LNT) relationship between radiation dose and cancer risk to extrapolate the high-dose, high linear energy transfer (LET) exposures (eg, to atomic bomb survivors, where subsequent radiation-induced cancers have been documented) to the low-dose, low-LET exposures from diagnostic radiology exams, where no direct cancer-causing effect has been documented in humans. There is good evidence from studies of atomic bomb survivors that organ doses at and above 100 milliSieverts (mSv) result in a small, but statistically significant increase in cancer risk. The risks stated on this card assume a LNT model to extrapolate the dose-risk relationship down to the low dose levels used in diagnostic exams. These risk estimates are conservative in terms of protecting patients and may overestimate rather than underestimate radiation risk from medical exams. The CU Department of Radiology is dedicated to the goal of ensuring that patients undergoing diagnostic exams receive the minimum radiation dose possible to yield a medical benefit.

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Definition of Terms in Dose-Risk Tables

Effective dose is an estimated whole-body radiation dose in units of milliSieverts (mSv) that can be used to estimate the potential risk of inducing cancer for each type of imaging study utilizing ionizing radiation. Effective dose is based on gender-averaged and age-averaged estimates for adults, ICRP-103, 2007. To place this risk into perspective when communicating with patients, the level of environmental background radiation, as well as the risk of dying from several natural events is listed below. The risk levels have been color coded for natural events and imaging studies.

Average Annual Effective Dose from Natural Background Radiation	
United States	3.1 mSv
State of Colorado	4.0 mSv
Color Code for Risk Levels	
Approximate additional risk of fatal cancer for an adult	Risk Level
less than 1 in 1,000,000	Negligible
1 in 1,000,000 to 1 in 100,000	Minimal
1 in 100,000 to 1 in 10,000	Very Low
1 in 10,000 to 1 in 1,000	Low
1 in 1000 to 1 in 500	Moderate
Estimated Lifetime Risks of Death	
Lightning Strike	1 in 100,000
Bicycle Accident	1 in 10,000
Drowning	1 in 1,000
Motor Vehicle Accident	1 in 100
Cancer (Natural Causes)	1 in 5

Conventional Radiography

Adult X-Ray Exam	Average Effective Dose (mSv)	Lifetime Risk of Cancer Death
Dual X-Ray Absorptiometry	0.001	1 in 24 million
Extremity	0.005	1 in 5 million
Chest (PA only)	0.02	1 in 1.2 million
Chest (PA & Lateral)	0.05	1 in 480,000
Cervical Spine	0.2	1 in 120,000
Bilateral Mammography	0.48	Age 50: 1 in 125,000*
Abdomen/Hip/Pelvis	0.7	1 in 35,000
Thoracic or Lumbar Spine	1.25	1 in 20,000
Small-Bowel Series	3	1 in 8,000
ERCP	4	1 in 6,000
Upper GI Series (with fluoro)	6	1 in 4,000
Barium Enema	8	1 in 3,000

*Based on age-dependent estimates for females, from BEIR-VII, 2006.

Adult CT Scans

Head	2	1 in 12,000
Calcium Scoring	3	1 in 8,000
Neck	3	1 in 8,000
Pelvis	6	1 in 4,000
Spine	6	1 in 4,000
Chest	7	1 in 3,500
Abdomen	8	1 in 3,000
Virtual Colonoscopy	10	1 in 2,400
Coronary Angiography	12	1 in 2,000
Chest for PE	15	1 in 1,600
3-Phase Liver Study	15	1 in 1,600

Nuclear Medicine		
Adult Nuclear Medicine Exam	Average Effective Dose (mSv)	Lifetime Risk of Cancer Death
Lung ventilation (^{99m}Tc -DTPA)	0.2	1 in 120,000
GI emptying (^{99m}Tc -labeled solids)	0.4	1 in 60,000
Lung ventilation (^{133}Xe)	0.5	1 in 50,000
Renal (^{99m}Tc -DTPA)	1.8	1 in 14,000
Thyroid scan (Sodium iodine-123)	1.9	1 in 13,000
Liver-spleen (^{99m}Tc -sulfur colloid)	2.1	1 in 12,000
Lung perfusion (^{99m}Tc -MAA)	2	1 in 12,000
Renal (^{99m}Tc -glucoheptonate)	2	1 in 12,000
Renal (^{99m}Tc -MAG3)	2.6	1 in 9,400
Biliary tract (^{99m}Tc -disofenin)	3.1	1 in 7,900
Renal (^{99m}Tc -DMSA)	3.3	1 in 7,400
Thyroid scan (^{99m}Tc -pertechnetate)	4.8	1 in 5,000
Brain (^{99m}Tc -ECD-neurolite)	5.7	1 in 4,000
Bone (^{99m}Tc -MDP)	6.3	1 in 4,000
Parathyroid scan (^{99m}Tc -sestamibi)	6.7	1 in 3,600
White blood cells (^{111}In)	6.7	1 in 3,600
Brain (^{99m}Tc -HMPAO-exametazine)	6.9	1 in 3,500
PET mammography (^{18}F -FDG)	7	1 in 3,500
GI bleeding (^{99m}Tc -labeled RBCs)	7.8	1 in 3,100
Cardiac ventriculography (^{99m}Tc -labeled RBC)	7.8	1 in 3,100
White blood cells (^{99m}Tc)	8.1	1 in 3,000

Nuclear Medicine Cont'd		
Adult Nuclear Medicine Exam	Average Effective Dose (mSv)	Lifetime Risk of Cancer Death
Breast gamma imag (99mTc-sestam.)	9.4	1 in 2,600
1-day cardiac rest-stress (99mTc-sestamibi)	9.4	1 in 2,600
Cardiac rest-stress (99mTc-tetrofosman)	11.4	1 in 2,100
Pentretotide (111In)	12	1 in 2,000
2-day cardiac rest-stress (99mTc-sestamibi)	12.8	1 in 1,900
Brain (18F-FDG)	14.1	1 in 1,700
Tumor (18F-FDG)	14.1	1 in 1,700
Cardiac (18F - FDG)	14.1	1 in 1,700
Gallium 67 citrate	15	1 in 1,600
Cardiac stress-rest (thallium 201 Cl)	40.7	1 in 600

Adult Interventional Procedures		
Head & Neck Angiography	5	1 in 5,000
Thoracic Angiography of Pulmonary Artery or Aorta	5	1 in 5,000
Coronary Angiography (dx)	7	1 in 3,500
Abdominal Angiography or Aortography	12	1 in 2,000
Coronary Percutaneous Transluminal Angioplasty, Stent Placement, or RF Ablation	15	1 in 1,600
Pelvic Vein Embolization	60	1 in 400
Transjugular Intrahepatic Portosystemic Shunt Placement	70	1 in 350

Fundamental Ways to Reduce Dose

1. Perform only essential tests.
2. Use alternative imaging such as ultrasound or MRI.
3. Refer to facilities utilizing state of the art minimum dose techniques.

Resources

www.radiologyinfo.org

www.xrayrisk.com

www.nlm.nih.gov/medlineplus/radiationexposure.html

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