

UNIVERSITY OF WASHINGTON
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 UW Medicine

UW Medicine Radiology

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CT Exam Radiation Dose

In many X-ray examinations, the energy imparted to the body (also called ‘radiation dose’) is very small and the risk of developing a cancer in the future from such an examination is minimal (about 1 in 2,000 for a typical CT of the abdomen and pelvis). Higher accumulated dose from several exams over time might induce a cancer that would be observed up to 20 or more years after exposure. It is difficult to detect such a small increase in the cancer rate because the natural incidence of cancer is high (25% over a lifetime) and the latent period for most cancers is long¹ (median latency of 25 years).² This latent period makes it impossible to say which of the various possible carcinogenic agents an individual may come into contact with was the cause.

A patient’s physician must decide whether the benefit of a diagnostic radiology procedure justifies the very small risk to the patient from the radiation exposure. A diagnostic radiology exam should be performed only if it is likely that it will yield useful clinical information. If the patient accepts their physician's advice along with the associated risk, either evidence of disease will be found with the patient entering into treatment, or the patient will learn that they are free of the suspected disease. Either result is preferable to not knowing at all.

UW Medicine’s Radiology Department practices the ‘as low as reasonably achievable’ or ALARA doctrine. The ALARA doctrine represents a commitment to minimize radiation exposure to patients, the public, the staff and the environment. This means that examinations requiring ionizing radiation provide the best possible images with the least radiation exposure. Our Radiology Department has continuous quality assurance programs that monitor the radiation dose administered to patients, with special attention to CT.

As a national site of excellence in radiology, UW Medicine has on-staff dedicated radiology Ph.D. physicists who work in partnership with our technologists and radiologists to ensure the best possible CT study with the lowest possible radiation. Our unique strategies and leading-edge CT technology have led to dose reductions of up to 60% – unequaled in most medical settings.

In summary, risk must be balanced with benefit. The risk is a slight increase in the development of cancer, a small risk when compared with other risks in daily life. Medical radiation is not a mysterious source of disease, but is better understood than almost any other carcinogen.

A comparison of the risks of some CT medical exams is on page 2.

CT Scan Procedure	Effective Dose (mSv)	LAR Increased Cancer Incidence (%) - Male	LAR Increased Cancer Incidence (%) - Female	Compared to One Plain-Film Chest X-Ray	BERT (Years)
Head	1.8	0.011	0.015	18	0.58
Neck	5.1	0.032	0.041	51	1.60
Chest	3.6	0.022	0.029	36	1.20
Abdomen	3.9	0.024	0.032	39	1.30
Pelvis	4.7	0.029	0.038	47	1.50
R/O Urinary Track Stone	6.7	0.042	0.054	67	2.20
Lumbar Spine	16.0	0.090	0.130	160	5.20
Thoracic Spine	14.0	0.087	0.114	140	4.50
3-Phase Liver	11.1	0.069	0.090	111	3.60
Cystogram	14.7	0.091	0.120	147	4.70
R/O Pulmonary Embolus	4.7	0.029	0.038	47	1.50
Stroke	9.0 to 24.0	0.054 to 0.149	0.072 to 0.195	88 to 240	2.80 to 7.70

The average radiation dose received from one plain-film chest X-ray is 0.1mSv.
Annual background dose is 3.1 mSv.

Some definitions to understand the table:

Effective Dose (ED)

This reflects the nonuniform radiation absorption of partial body exposures relative to a whole body radiation dose and allows comparisons of risk among different CT exam protocols¹. The unit of measure is a millisievert (mSv). The effective dose is calculated from information about dose to individual organs and the relative radiation risk assigned to each organ.

Lifetime Attributable Risk (LAR) of Increased Cancer Incidence

LAR is the portion of the incidence of a cancer in the exposed population that is due to the radiation exposure. It is the incidence of a cancer *in the exposed* that would be eliminated if exposure were eliminated. For example, in the table above for a 45-year-old female undergoing a pelvis CT exam, the additional lifetime attributable risk of cancer incidence from this procedure is 0.038%³. These risks are in addition to the female baseline lifetime risk (in the absence of exposure) of cancer incidence of 37.49%⁴. Therefore, the new lifetime risk of cancer incidence is 37.53%. In the table above, LAR for a 45-year-old male and female are shown. This risk would increase with decreasing age and vice versa.

Background Equivalent Radiation Time (BERT)

BERT⁵ is a unit of measurement of ionizing radiation dosage. One BERT is the equivalent of one day worth of average exposure to background radiation. The BERT corresponding to a dose of radiation is the number of days of average background dose it is equivalent to. It is calculated from the effective dose by dividing by the average annual background radiation dose (3.1 mSv).

¹ Bushberg et. al, The Essential Physics of Medical Imaging, 2nd Edition, 2002.

² Hall EJ, Radiobiology for the Radiologist, 3rd Edition, 1988.

³ Committee to Assess Health Risks to Low-Levels of Ionizing Radiation, National Research Council (2006) Health risks from low-levels of ionizing radiation. BEIR VII National Academies Press, Washington D.C.

⁴ BEIR VII Cancer Incidence Rates.

⁵ Nickoloff et al. Radiographics 2008; 28: 1439 – 1450.