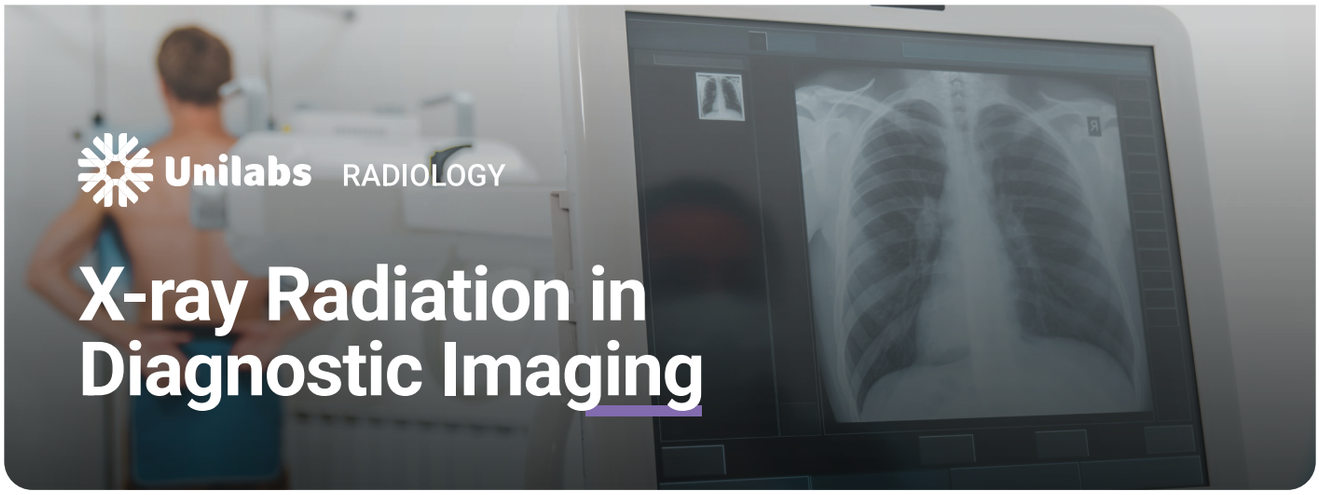


Unilabs RADIOLOGY

X-ray Radiation in Diagnostic Imaging

What is X-ray radiation?

X-ray radiation is electromagnetic radiation with energy high enough to ionize atoms during interactions. It is referred to as ionizing radiation.

What happens during an X-ray?

X-ray radiation partially penetrates the body. Depending on the type of tissue, part of the emitted radiation is absorbed. The transmitted radiation is captured by the detector and converted into a grayscale image. This image allows different types of tissue to be distinguished.

How does CT differ from conventional X-ray?

In CT, X-ray images are taken from all directions around the body. This is typically done by continuously rotating the X-ray tube around the patient. From the resulting absorption profiles, cross-sectional images of the body can be calculated, which are then used to reconstruct three-dimensional models.

Are X-ray examinations the only source of radiation we are exposed to?

We are all exposed to natural ionizing radiation. This includes terrestrial radiation from natural materials in the Earth's crust and cosmic radiation. Together, these sources result in an average exposure of about 4.4 mSv per year. Medical applications contribute an average annual dose of about 1.2 mSv per person.

How high is the radiation dose for different examinations?

Type of examination	Examination	Effective dose (mSv)	Equivalent natural radiation
Dental	Dental X-ray	0.005	0.5 days
	Panoramic dental X-ray	0.02	2 days
	Dental CT (CBCT)	0.5	1.5 months
Mammography		0.2	3 weeks
Conventional X-ray	Extremities	0.001	1 day
	Chest [PA]	0.02	2 days
	Chest [PA + LAT]	0.1	1 week
	Skull [PA + LAT]	0.07	1 week
	Thoracic spine	0.7	2 months
	Lumbar spine	1.3	3.5 months
	Hip	0.3	1 month
	Pelvis	0.7	2 months
	Abdomen	1	3 months
CT	Head	2.3	6.5 months
	Chest	9	2 years
	Abdomen	12	3 years

What do the units Sv or mSv mean?

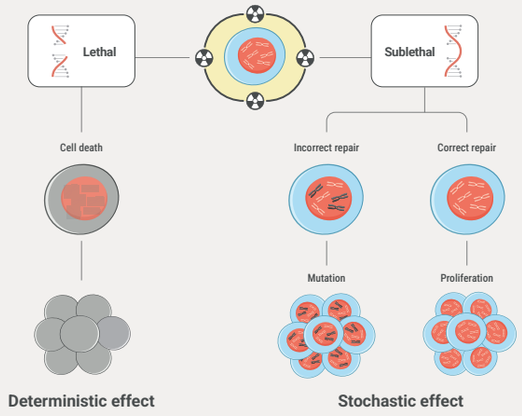
The most important quantity is the effective dose, which takes into account the different hazard properties of radiation types. It is measured in sieverts (Sv). In radiological diagnostics, doses are usually expressed in millisieverts (mSv), i.e. one thousandth of a sievert.

Ludlow JB et al. Patient risk related to common dental radiographic examinations, J Am Dent Assoc 139:1237–1243; 2008, Radiation Protection 118, European Commission 2000.

What effect does radiation have in the body?

Part of the radiation used for imaging is absorbed in the body. Energy is transferred to tissues, which can lead to biological effects. This is referred to as dose. These effects may result in damage to essential cellular components.

This can lead to cell death or mutations. In diagnostics, mutations are particularly relevant, as they may lead to cancer later in life. The higher the cumulative lifetime dose, the greater the risk of developing cancer.



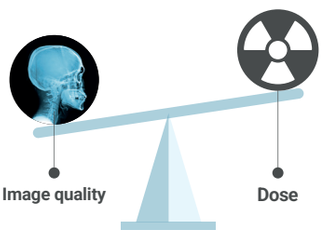
What is the risk of developing cancer from an X-ray examination?

The risk of developing a fatal cancer due to radiation exposure is estimated at about 0.005% per millisievert. This means that out of 200,000 patients undergoing a chest CT (0.1 mSv), one fatal cancer case is expected. For an abdominal CT (12 mSv), the probability is about 1 in 2,000 patients. The risk remains very low and can be compared to the natural lifetime risk of about 1 in 4.

How is the patient protected from excessive radiation exposure?

Radiation dose is kept as low as possible through various approaches. The most important factor is that only medically necessary imaging is performed. During an examination, machine settings are optimized to achieve the lowest possible dose.

However, image quality must remain sufficient for reliable diagnosis. Additionally, the radiation field should be limited to the region of interest.



Is additional external radiation protection necessary (e.g. lead aprons)?

With modern equipment, the radiation field can be precisely limited so that only the area of interest is exposed. Outside this primary field, radiation intensity drops rapidly. Therefore, additional shielding such as lead aprons is generally not necessary.

Dose reduction is primarily achieved through field limitation, optimized settings, and appropriate protocols. In some cases, protecting sensitive organs may be useful, but this should not compromise image quality.