



# Medical Radiation Safety



Changi  
General Hospital  

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SingHealth

As part of healthcare checks and examinations for the diagnosis and treatment of medical conditions, patients may need to undergo medical imaging procedures such as x-rays, computed tomography (CT) scans, and angiographies. This may involve the use of radiation to visualise body parts that cannot be seen on the surface. Read on to find out more about radiation exposure, and efforts to carry out these procedures safely for patients.



## What are x-rays?

X-rays are a form of electromagnetic radiation that is similar to light, but it is invisible to the naked eye. It is also known as ionising radiation due to its higher energy level, and can pass through the body to produce images of body parts that cannot be seen on the surface. This provides valuable information to help the doctor make an accurate diagnosis.

## Which medical imaging examinations involve radiation?

General radiography is the most common examination that involves the use of the x-ray to obtain images for diagnostic purposes. Other medical imaging that uses radiation include angiography, bone mineral densitometry, CT, dental x-ray, fluoroscopy, mammography, and nuclear medicine.

## Are these examinations safe?

The level of medical radiation used in diagnostic imaging examinations is generally considered low, and safe for patients. The specific dose of radiation varies depending on the patient and type of procedure, with radiographers trained to use the lowest dose of radiation possible, to capture the required image for diagnosis.

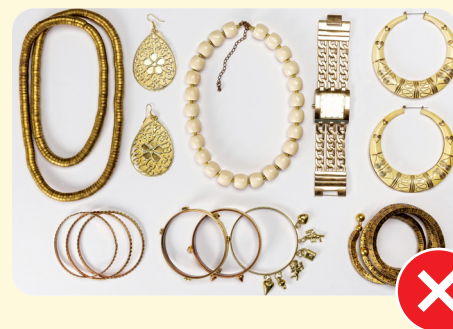
Undergoing multiple examinations will also result in a higher cumulative dose of radiation, but safety guidelines are in place to ensure that each recommended examination is appropriate, and its medical benefits tend to outweigh the radiation risks.

For example, a computed tomography (CT) scan may involve the use of higher radiation compared to a simple x-ray, but it can provide valuable information and images that will help your doctor better diagnose and treat your medical condition.

Please speak with your doctor if you have questions about the benefits and risks of your examination.

## How should I prepare for my examination?

Please wear comfortable clothing and remove all accessories before the examination so that clearer images can be obtained from the scan.



## Health effects of ionising radiation

Ionising radiation is a type of radiation with enough energy to potentially lead to biological tissue damage in high doses or changes in genetic material of the human cell.

Examples of biological tissue damage include skin burn, hair loss, cataract, infertility and circulatory disease. Current radiological examinations generally do not require the use of such high levels of radiation.

Damage to the genetic material of the human cell, however, can happen with any level or dose of ionising radiation. These changes may potentially result in cancer or changes in the reproductive genes in the later part of life. It is believed that the likelihood increases with radiation dosage. In addition, the risk of radiation-induced cancer is greater in children than adults as they are more susceptible to radiation. Doctors may consider alternative imaging or diagnostic tests for this group of patients.

The table below shows the lifetime risk of cancer for adults undergoing various medical imagings with ionising radiation<sup>1,2</sup>.

Examination	Risk Qualification	Risk Level
Extremity X-ray	Negligible	Less than 1 in 1,000,000
Bone Mineral Densitometry	Negligible	Less than 1 in 1,000,000
Chest X-ray	Minimal	1 in 1,000,000 to 1 in 100,000
Spine/ Abdominal X-ray	Very Low	1 in 100,000 to 1 in 10,000
Mammography	Very Low	1 in 100,000 to 1 in 10,000
Head CT Scan	Very Low	1 in 100,000 to 1 in 10,000
Chest CT Scan	Low	1 in 10,000 to 1 in 1000
Abdomen and Pelvis CT Scan	Low	1 in 10,000 to 1 in 1000
Intravenous Urography	Low	1 in 10,000 to 1 in 1000
Barium Meal	Low	1 in 10,000 to 1 in 1000
Barium Enema	Low	1 in 10,000 to 1 in 1000

## Radiation guidelines for prenatal exposure

For safety reasons, women of childbearing age (9 to 60 years old) will be asked to declare their pregnancy status prior to the examination, as radiation poses risk to the unborn child. A pregnancy test may also be required.

Radiation exposure, even at a minuscule level, carries risk and possible detrimental effects to the developing foetus and patient.

Studies have shown that the radiation dose in existing diagnostic examinations does not exceed 50 milligray (mGy), and will not cause congenital disorders or birth defects in developing foetuses if a pregnant patient needs to undergo a diagnostic imaging examination<sup>3,4</sup>. Exceptions to this are situations that require complex angiographic procedures or multiple examinations that will cumulatively result in high radiation exposure.

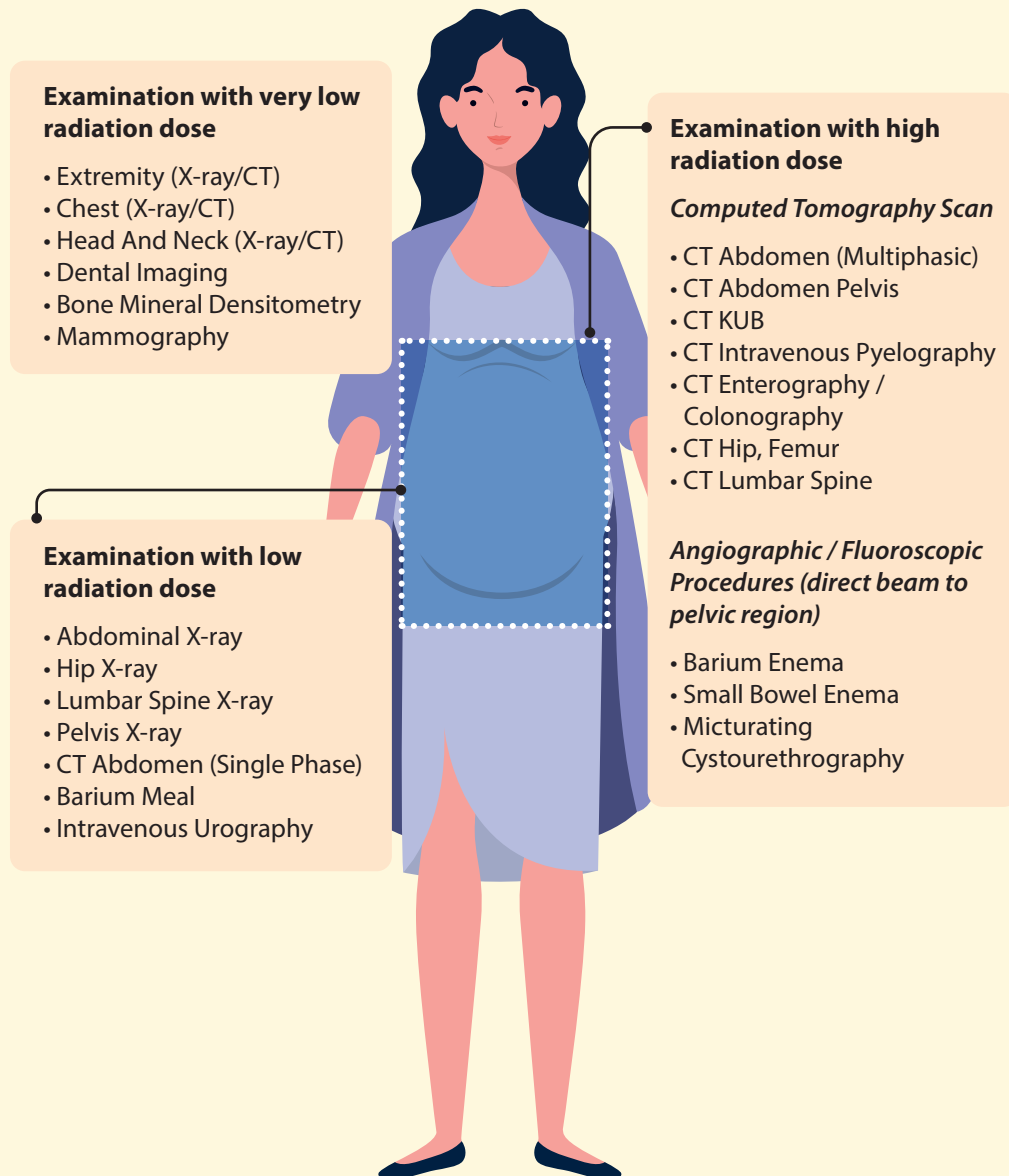
In terms of long-term impact, studies on children whose mothers were exposed to radiation levels as low as 10mGy in the pelvic region, have indicated an increased risk of childhood leukemia<sup>4</sup>.

The table below shows the dose range of radiation and the corresponding potential risks of childhood cancer in developing foetuses for medical imaging examinations of the body regions.

Please speak to your doctor if your examination involves the abdomen and pelvis region, as there is higher risk and special attention is required.

Radiation Dose	Very Low	Low	High
Body Region	Outside Abdomen / Pelvis	Inside Abdomen / Pelvis	
Dose Range (mGy)	0.001 - 1	1 - 10	10 - 50
Risk of Childhood Cancer	Very Low (1 in 100,000 to 1 in 10,000)	Low (1 in 10,000 to 1 in 1000)	Moderate (1 in 1000 to 1 in 200)

## Type of examination by body region and corresponding radiation dose to foetus



1. National Research Council. Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII Phase 2. National Academies Press; Washington, DC, USA: 2006
2. Anderson M., Eckerman K., Mattison S. Lifetime attributable risk as an alternative to effective dose to describe the risk of cancer for patients in diagnostic and therapeutic nuclear medicine. *Phys. Med. Biol.* 2017;62:9177-9188
3. mGy - Unit of energy imparted by ionising radiation to matter/tissue
4. American College of Radiology. (2023). ACR-SPR Practice Parameter for Imaging Pregnant or Potentially Pregnant Patients with Ionising Radiation 2018. Revised 2023 (Resolution 31). <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/Pregnant-Pts.pdf>



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