Australian Government
Australian Radiation Protection and Nuclear Safety Agency

Having a scan?

A guide for Medical Imaging

Medical imaging enables earlier and less invasive diagnosis for numerous medical conditions. Different types of medical imaging examinations are available to help medical practitioners identify what's happening inside the body and a number of them involve radiation.

There is a small potential risk from radiation with some medical imaging. However, the benefits of accurately identifying, locating and treating medical issues will typically far outweigh the relatively small risks involved. For example, some diseases when identified early can be easily treated and result in full recovery, while a late diagnosis may lead to prolonged treatment, less favourable outcomes and even death. Medical imaging can also rule out serious illness - providing reassurance for patients. Scans may also be a viable and welcome alternative to 'explorative surgery'.

A guide for Medical Imaging

While it's useful to be aware of the risks associated with any medical procedure, the internet or media may provide misleading information and in some cases lead patients to being unnecessarily alarmed. Unfortunately some patients may then delay or decide not to have a procedure, potentially compromising care. On the flip side, inappropriate examinations displace necessary ones, delaying diagnoses and subsequent treatments for both you and other patients. Discussing any concerns with your doctor can allow a better understanding of why a scan has been prescribed and minimise delays or refusals due to unfounded concerns.

Common types of medical imaging and their uses

X-rays
X-rays are forms of radiant energy like light or radio waves. Unlike light, X-rays can penetrate the body, providing internal images that enable doctors to identify medical issues. X-rays are well known for identifying bone fractures and chest X-rays are also commonly performed.

CT scans
CT scans are X-ray procedures where multiple images are taken rapidly around a patient to produce pictures of soft tissue, bone and blood vessels at different depths. CT scans can show in detail parts of the body that are obscured by other tissues on a standard X-ray image. As a result, they can allow earlier diagnosis and more successful treatment of some injuries and illnesses. Often patients are given oral or intravenous contrast agents that increase the detail and clarity of the images taken.

Mammography
Mammography uses X-rays to image the breasts and is principally used as a screening tool to detect early signs of breast cancer. Breast tissue is very radiosensitive, so the dose to the breast is kept as low as possible to justify its use as a routine breast cancer screening test.

Nuclear Medicine
Nuclear medicine uses small amounts of radioactive material (typically injected or swallowed) that emits radiation similar to X-rays to build a functional picture of what is happening inside a body. Included in nuclear medicine are PET scans and bone scans.

Fluoroscopy
Fluoroscopy shows a continuous X-ray image on a monitor (like an X-ray movie) and uses this imagery to diagnose and treat patients by displaying the movement of a body part, or dye through the body.

Bone Density Testing
Bone density testing is sometimes called DEXA (Dual-Energy X-ray Absorptiometry) or BMD (Bone Mineral Density) and employs very low X-ray doses to measure bone density.

Magnetic Resonance Imaging
Magnetic Resonance Imaging or MRI uses magnetic fields and radiofrequency waves and these are not known to produce any harmful effects if used appropriately. While MRI images are similar to CT images, they are constructed by very different processes and while either can often be used to provide adequate diagnostic information, each is better than the other for the diagnosis of certain conditions. There are far fewer MRIs than CT units, so accessibility and cost may be practicalities that influence you and your doctor's decisions.

Ultrasound
Medical ultrasound (also known as diagnostic sonography or ultrasonography) uses high frequency sound waves, not radiation, to see internal body structures such as tendons, muscles, joints, vessels and internal organs. It's commonly used for examining pregnant women.

Benefits and Risks

How much radiation do patients get from medical imaging?
The type of examination involved determines each dose. So too do other factors such as the specific type of equipment used, the patient's age, gender, body size and anatomy. Highly trained medical staff consider all these factors. They only scan the part(s) of the body required, and keep the dose as low as possible while still achieving effective results.

How safe are X-rays?
The radiation doses from medical diagnostic tests are generally very small and rarely produce harmful effects. There is a very small increase in the risk of developing cancer later in life. As a comparison, the radiation dose from a typical chest X-ray is approximately equivalent to the natural radiation received in an aircraft flight from Sydney to Cairns or five days of background radiation from normal living.

What about radiation from CT scans and Nuclear Medicine?

Compared to standard X-rays, CT scans use higher X-ray radiation levels, from relatively low dose examinations (head, neck) to higher doses for a typical coronary angiography. For nuclear medicine examinations the relative radiation levels are also generally higher than for standard X-rays – from lower (lung ventilation/perfusion) to higher (PET/CT).

What about MRI and Ultrasound?

While Ultrasound and MRI do not use X-rays or similar radiation, they are not always available, or suitable for a number of medical conditions.

Pregnancy and Children

Pregnancy

Before you have an X-ray or any other form of medical imaging it is important to advise your doctor if you are pregnant, or if it's possible you're pregnant. Unborn babies are more sensitive to radiation than an adult, so it is important to take precautionary steps, which may involve an alternative examination, such as ultrasound or MRI. In the small number of cases where clear benefit may only be obtained using X-rays, medical imaging staff will take great care to ensure any dosage is kept as low as possible.

Children

As one might expect, children are more sensitive to ionising radiation than adults and every proposal for diagnostic examination through medical imaging needs to be very carefully considered to assess the need. When it is determined that such an examination is required, medical imaging staff will take great care to keep the radiation dose as low as possible.

Considerations

- As with any medical procedure, there is a risk associated with medical imaging examinations. Asking your doctor whether a scan is appropriate for your particular circumstances is quite reasonable.
- In considering any risk, you'll also need to consider the risk(s) associated with NOT having the medical imaging examination, which are likely to be greater.
- Medical imaging staff are highly trained, and understand the need to keep radiation doses as low as possible and commensurate with the patient's specific circumstances - such as pregnancy, age, size, shape, gender etc.
- If you have recently undertaken an X-ray, CT scan or other medical imaging examination it is important to advise your doctor before undertaking further examinations. Similarly, any chronic conditions and/or history of multiple scans should be reported to your doctor. Your doctor's understanding of your medical history will allow better informed decisions.
- If you are pregnant or believe there is a possibility you may be pregnant it is important to advise your doctor and medical imaging staff so that they can adjust radiation dosages accordingly. They may advise you to set aside/ postpone your examination, or opt for a different type of examination.
- When considering the risks from radiation in medical imaging, keep in mind that everyone is exposed to low levels of radiation in normal day to day life. Make sure you assess any potential risk based on good information and consult your doctor if you have any concerns or questions.

Remember

- The benefits of scans will almost always outweigh potential risks.
- Don't get any study you don't need.
- Keep a history of your studies (reports and images) to avoid unnecessary repeat exams.

The information presented here is of a general nature only and is not intended as a substitute for professional medical advice. Additional information on specific procedures is often available from medical imaging facilities.

Discover more...

Information on imaging children and young people http://www.healthdirect.gov.au/ctscansforkids

InsideRadiology, an Australian information website for patients and referrers by the Royal Australian and New Zealand College of Radiologists www.insideradiology.com.au

Radiology information for patients developed by the Radiological Society of North America and the American College of Radiology www.radiologyinfo.org

International Atomic Energy Agency information on the safer use of radiation in medicine for the benefit of patients https://rpop.iaea.org/RPOP/RPoP/Content/InformationFor/Patients/information-patients/index.htm

ARPANSA's Radiation Protection for the Patient Module, which aims to support referrers in clinical practice www.arpansa.gov.au/RPOP/Module

The Australian Radiation Protection and Nuclear Safety Agency www.arpansa.gov.au

The Alliance for Radiation Safety in Pediatric Imaging www.imagegently

Information for patients from the Royal Australian College of General Practitioners http://yourgp.racgp.org.au/welcome

Indicative radiation dose to adult patients from common medical imaging procedures

Paediatric doses are generally lower, however the risks may be higher. Doses vary, depending on gender, age and weight as well as equipment and imaging settings used.

In Australia, background radiation is approximately 1.5 mSv per annum

Procedure		(Approx) Typical Adult Dose (mSv)	Background Equivalent Radiation Time (BERT)	Equivalent Chest X-rays	* ‹1mSv ** 1-5mSv *** 5.1-10mSv **** ›10mSv	Additional Lifetime Risk Level of Fatal Cancer
CENTRAL NERVOUS SYSTEM	X-ray - Cervical Spine	0.2	7 weeks	10	*	MINIMAL
	X-ray - Thoracic Spine	1.0	8 months	50	**	VERY LOW
	X-ray - Lumbar Spine	1.5	12 months	75	**	VERY LOW
	CT - Head	2	18 months	100	**	VERY LOW
	CT - Head with & without contrast	4	3 years	200	**	LOW
	CT - Neck	3	2 years	150	**	LOW
	CT - Spine	6	4 years	300	***	LOW
BONE	X-ray - Extremity	0.001	6 hours	0.05	*	NEGLIGIBLE
	X-ray - Shoulder	0.01	2.4 days	0.5	*	NEGLIGIBLE
DENTAL	X-ray - Bitewing	0.01	2.4 days	0.5	*	NEGLIGIBLE
	Dental Cone Beam CT (CBCT)	0.1	3 weeks	5	*	MINIMAL
CHEST	X-ray - Chest	0.02	5 days	1	*	NEGLIGIBLE
	CT - Chest	7	5 years	350	***	LOW
HEART	Cardiac CT for Calcium Scoring	3	2 years	150	**	LOW
	Coronary Angiography	16	11 years	800	****	LOW
ABDOMINAL REGION	X-ray - Pelvis	0.6	5 months	30	*	VERY LOW
	CT - Abdomen	8	5 years	400	***	LOW
	CT - Pelvis	6	4 years	300	***	LOW
	Fluoroscopy - Upper GI	6	4 years	300	***	LOW
	Fluoroscopy - Small Bowel follow-through	5	3 years	250	**	LOW
	Fluoroscopy - Barium Enema	8	5 years	400	***	LOW
	Fluoroscopy - IV Pyelogram	3	2 years	150	**	LOW
WOMEN'S IMAGING	Bone Density (DEXA)	0.001	6 hours	0.05	*	NEGLIGIBLE
	Mammography	0.3	3 months	15	*	VERY LOW
	3D Tomosynthesis	1	8 months	50	**	VERY LOW
	Hysterosalpingogram	2	18 months	100	**	VERY LOW
NUCLEAR MEDICINE EXAM	Lung Ventilation/ Perfusion	3	2 years	150	**	LOW
	Thyroid	3	2 years	150	**	LOW
	Bone Scan	5	3 years	250	**	LOW
	Cardiac Rest/Stress	12	8 years	600	****	LOW
	PET/CT	14	9 years	700	****	LOW
Magnetic Resonance* Imaging (MRI)	All	0	0	0	0	Nil
	*While Ultrasound and MRI do not use X-rays or similar radiation, they are not always available, or suitable for a number of medical conditions.					
Ultrasound*	All	0	0	0	0	Nil

*RISK LEVEL	Negligible	Minimal	Very Low	Low	Moderate
Estimated additional risk of fatal cancer for an adult from examination	Less than 1 in 1, 000, 000	1 in 1, 000, 000 to 1 in 100, 000	1 in 100, 000 to 1 in 10, 000	1 in 10, 000 to 1 in 1, 000	1 in 1,000 to 1 in 500

Note: These risk levels represent very small additions to the 1 in 5 chance we all have of dying from cancer.

ESTIMATED LIFETIME RISKS OF DEATH

Lightning strike	1 in 100, 000
Bicycle accident	1 in 10, 000
Drowning	1 in 1, 000
Motor vechile accident	1 in 100
Cancer (Natural causes)	1 in 5

ARPANSA Fact Sheet – Medical Imaging: Information for Patients
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www.insideradiology.com.au
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