CENTRA medical imaging

Radiation in Medical Imaging

Patient Information

From time to time the media report the potential risks of radiation exposure during medical imaging procedures. While it is important you are well informed of the risks associated with any medical procedure, these reports often provide statistics without context and in some cases lead patients to being unnecessarily alarmed. Unfortunately some patients will then delay or opt not to have a procedure, potentially compromising care.

This information has produced to help you to answer some common questions regarding radiation and medical imaging.

What is radiation – am I exposed to background radiation each day even if I do not have an X-ray examination?

Broadly speaking, radiation is the emission or transmission of energy in the form of waves or particles through a medium or a space. We all use and are exposed to different type of radiation every day as in figure 1.

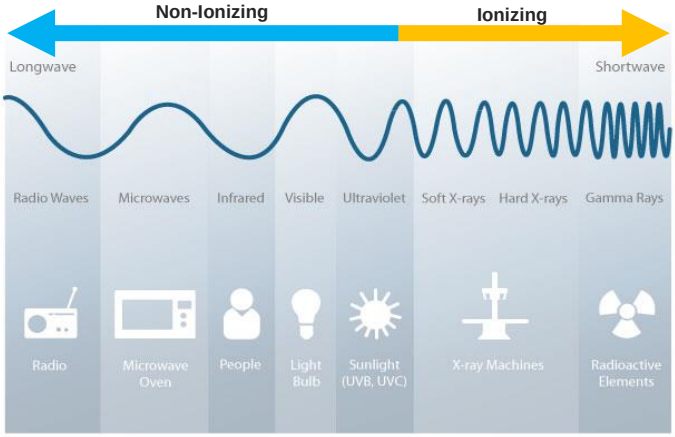

Fig 1. Types of Radiation in Daily Life [1]

Radiation is often categorized as either ionizing radiation or non-ionizing radiation depending on the energy of the radiated particles. Non-ionizing radiation such as microwaves or radio and television waves have less energy and so unable to produce charged particles (ions) in the interacting matter. Its effect is generally limited to generating light or heat.

Radiation such as from X-rays, gamma rays and higher energy range of ultraviolet light have sufficiently high energy to dislodge (ionize) tightly bound electrons and so categorised as 'ionising radiation'. The free radicals produced from ionization can break or create new chemical bonds damaging important biomolecules such as DNA. These processes have great potential to cause biological damage that result in cells death or mutation and increased chance of cancer.

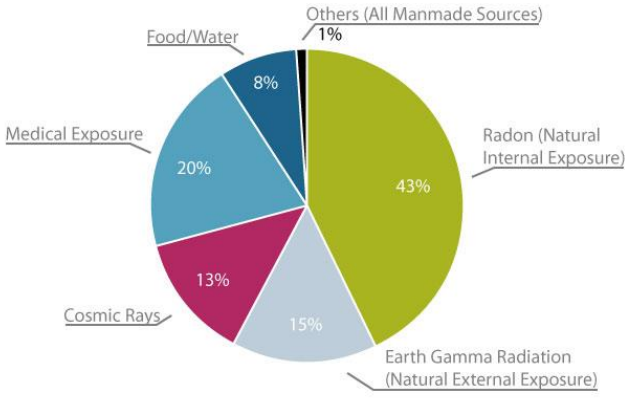

Fig 2. Sources and Distribution of average radiation exposure to the world's population. [2]

Background radiation

We are unavoidably and continuously exposed to background radiation in our daily lives. The sources of ionising radiation in our environment are cosmic rays from the universe, naturally occurring radioactive substances in the food and water we eat and drink, the air we breathe, in the ground, in building materials, and so on. In Australia, the background radiation is estimated to be 1.5 mSv, which is approximately equivalent to 100 single chest X-rays per year.

Radiation in Medical Uses

There are many uses of radiation in medicine. The most well-known is using x-rays for diagnostic radiology, for example, to see whether bones are broken or lung changes. X-ray is easily stopped and absorbed by bone, appearing as white; but is easily transmitted through air, like in the lungs, not being much absorbed giving blackness in the image. This is how the x-ray image is created depending on the varying absorption rate. Sometimes the images are still, like pictures from a camera, and sometimes they show movement, like a video camera.

Examinations of mammography (breasts x-ray), CT scan (cross sectional images), nuclear medicine (radioactive material injection), cardiology (specialised heart imaging), fluoroscopy (viewing real-time and moving structures) and radiation therapy (to kill cancer cells) are all use of different types and amount of radiation in medicine.

Which kinds of tests are associated with Ionising radiation and which ones are not?

The radiation exposure will depend on the type of examination and the purpose of the imaging study. Generally, **plain X-rays, mammography and fluoroscopy** give a lower radiation dose than CT, but complex procedures using fluoroscopy can result in doses similar to extensive CT examinations.

Ultrasound and MRI do not use ionising radiation. Because children are more sensitive to the effects of ionising radiation it is important, where possible, to use tests that do not require ionising radiation providing the answers required by the referring doctor.

What are the RISKS associated with radiation from diagnostic X-ray imaging and nuclear medicine procedures?

These risks are difficult to accurately measure, but it has been shown that the risk of developing cancer is slightly increased if you have been exposed to additional ionising radiation above background levels. Your radiation dose is accumulative and will depend on a variety of factors including:

- Body part being scanned;
- Age
- Body Weight
- Exposure Time and Strength

The increased risk is small, and usually less than the risk from not identifying or treating a disease or condition properly. It is important to make sure that every test has a definite benefit to balance the small radiation risk of the test. If you are referred for a CT scan or other test involving ionising radiation, it is **important that you discuss the relative risks and benefits with your referring doctor** so that you understand how you will benefit from having the study.

All operators of an X-ray machine (including CT) have been trained to use only enough X-rays to provide quality pictures for

the specialist. The dose of ionising radiation is therefore kept to a minimum.

What are the BENEFITS of diagnostic radiology using ionising radiation?

The purpose of diagnostic radiology is to provide the radiologist or nuclear medicine specialist (specialist doctors) with images of sufficiently high quality, so that they can report the results of the test to your doctor to assist in understanding and explaining your medical problem or symptom, and confirm either the presence or absence of disease or injury.

It is important that any request for an imaging test is provided by your doctor, in consultation with you. It is your own doctor who will be able to make an assessment of whether the benefits of the X-ray procedure outweigh any possible risks.

The radiologist or nuclear medicine specialist supervising the procedure will also assess if it is the most appropriate test, taking into account the information your doctor has written on the request form together with your medical history. If there are concerns, then the radiologist/nuclear medicine specialist might want to speak to your doctor before the test is carried out.

Radiation Dose Contextual Comparison

The below are the dose comparison examples in the context of background radiation (Ave. 1.5mSv per year in Australia) and effect of smoking. The risk of causing cancer from 1mSv of radiation exposure is same as to the risk of getting cancer from smoking approximately 100 cigarettes.

Source Of Exposure	Typical Effective Dose	No. Cigarettes Equivalent effect as 1mSv	Equivalent times of Aust. Annual Background Radiation
World Ave Background	2.4 mSv per yr	240	
Australian Background	1.5 mSv per yr	150	
Occupational Dose Limit	2mSv per yr	200	
General Public Dose Limit	1 mSv per yr	**100**	
Chest X-ray	0.04 mSv	**4**	**~10 days**
7 hrs aeroplane flight	0.05 mSv	5	~12 days
People living in Control Zones near Chernobyl	10 mSv per year	1000	6.6 yrs
Dental	0.005-0.01mSv	0.5-1	1~2.5 days
Brain CT	3mSv	300	3 yrs
Abdominal CT	10mSv	1000	6.6 yrs
Chest Ct	8mSv	800	5.3 yrs
Mammography	4mSv	400	2.6 yrs
Spine X-ray	1.5mSv	150	1 yr
Extremities	0.001mSv	0.1	6 hrs

Fig 3. Contextual Comparison of Radiation Dose [3]

How do I decide whether the risks are outweighed by the benefits of exposure to X-radiation when I have a radiology test or procedure?

Your decision should be made in close consultation with your referring doctor. Ask your doctor about the procedure and how it will help to provide information about your symptoms or the presence of disease or injury. Ask your doctor about the risks of the procedure and what the risks would be of not having the procedure; that is, if your doctor needs the information in order to identify and plan the most appropriate treatment.

Although there is a small risk of harm from ionising radiation, there could be a greater risk of not having the information; for example, failure to detect potentially serious disease that could be easily treated at an early stage, but is harder to treat or is incurable if detected later. It might also be as beneficial to you to confirm the absence of disease or injury as it is to confirm its presence.

Our Patient Safety

As international research continues into the potential risk of radiation exposure associated with some medical imaging procedures, Eastwood X-ray strives for the appropriate use where clinically indicated benefit outweigh risks. We proactively ensure, whenever possible, minimise radiation doses by ensuring;

- Appropriateness of the request for your medical condition. If necessary, your referring doctor will be contacted to discuss any concerns.
- Patient Communication. As much of relevant clinical information will be obtained by our friendly staffs to help the x-ray image interpretation of radiologists and to provide the most appropriate patient care during the procedure. Chance of pregnancy will be asked for every child-bearing age female patients and alternative or delay of the x-ray exam will be arranged if there is uncertainty.
- Placing Shielding. Sensitive organs will be covered whenever possible.
- Compliance with the Radiation Act for equipment, processes and procedure.

If you have any concerns regarding your medical imaging, it is best to speak to your referring doctor prior to the x-ray imaging.

Further information

www.arpansa.gov.au
www.insideradiology.com.au
www.ranzcr.edu.au

References
[1], [2] 'Understanding Medial Radiation', Siemens, 2012
http://www.medicalradiation.com/facts-about-radiation/
[3] 'Ionising Radiation and Health', ARPANSA, 2013
http://www.arpansa.gov.au/radiationprotection/factsheets/is_rad.cfm#

This information is credited to Inside Radiology, Royal Australian and New Zealand College of Radiology (RANZCR). ***insideradiology.com.au*** *and* ***SouthernX Radiology*** *Patient Information* Feb 2015