

Non Medical Referrer IRMER Training Session

A WARM WELCOME

09:00 – 09:05	Course Introduction
09:05 – 09:40	An Introduction to Ionising Radiation – Kate Rowe, DCH Medical Physics
09:40 – 10:40	Focus on IR(ME)R – Jim Thurston, DCH Medical Physics
10:40 – 11:20	IR(ME)R Referrer Responsibilities – Kate Lewins – DCH Diagnostic Imaging
11:20 – 11:30	Quiz and Feedback forms

HAVE YOU SIGNED THE ATTENDANCE SHEET?

**All presentations may be found on the Non-Medical Referrers info page on
DCH StaffNet**

**Presentations will be emailed out to all non-DCH staff following the session
today**

Non Medical Referrers Training Session

INTRODUCING IONISING RADIATION

Kate Rowe
Clinical Scientist
Medical Physics

Presentation topics

- ▶ The discovery of x-rays
- ▶ The interaction of x-rays with the body
- ▶ Radiation legislation
- ▶ MRI safety awareness





The History of X-Rays

What is an “X-Ray”?

- ▶ Discovered in 1895 (over 120 years ago) by a German physicist called Wilhelm Rontgen.
- ▶ Experimenting on Crookes partial vacuum tubes.
- ▶ Strange “rays” that could also pass through his study books and even thin metal plates.
- ▶ Didn’t know what was being emitted – so used the term “X-radiation” – X is the mathematical designation for something unknown – “X-Rays”!

What A Discovery!

- ▶ First x-ray picture of his wife's hand
- ▶ Changed the face of human medical science!



Advances in technology

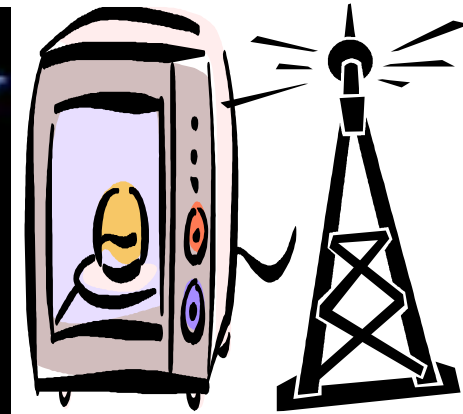
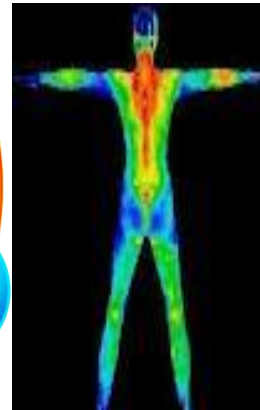
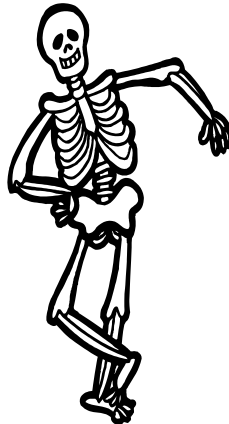


Where is ionising radiation used?

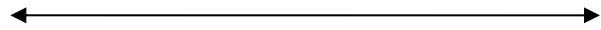
- ▶ General (static) x-ray room – DCHFT and DHUFT – incl dental and mammo
- ▶ Static Fluoroscopy (screening) Rooms – Interventional Radiology and general fluoro room, Cardiac Catheter Labs
- ▶ CT scanners x 3 (2 at DCH and 1 at WCH)
- ▶ Mobile x-ray equipment – x-ray (ward work) and fluoro kit (theatre work)
- ▶ DXA – South Walks House
- ▶ Special Care Dentistry – north wing



Electromagnetic Spectrum



Cosmic Gamma X-rays Ultraviolet Visible light Infrared Microwave Radiowave



Ionising Radiation
(potentially harmful or beneficial to humans)



High Frequency

Low Frequency



THE ENERGY SPECTRUM

Electromagnetic Spectrum

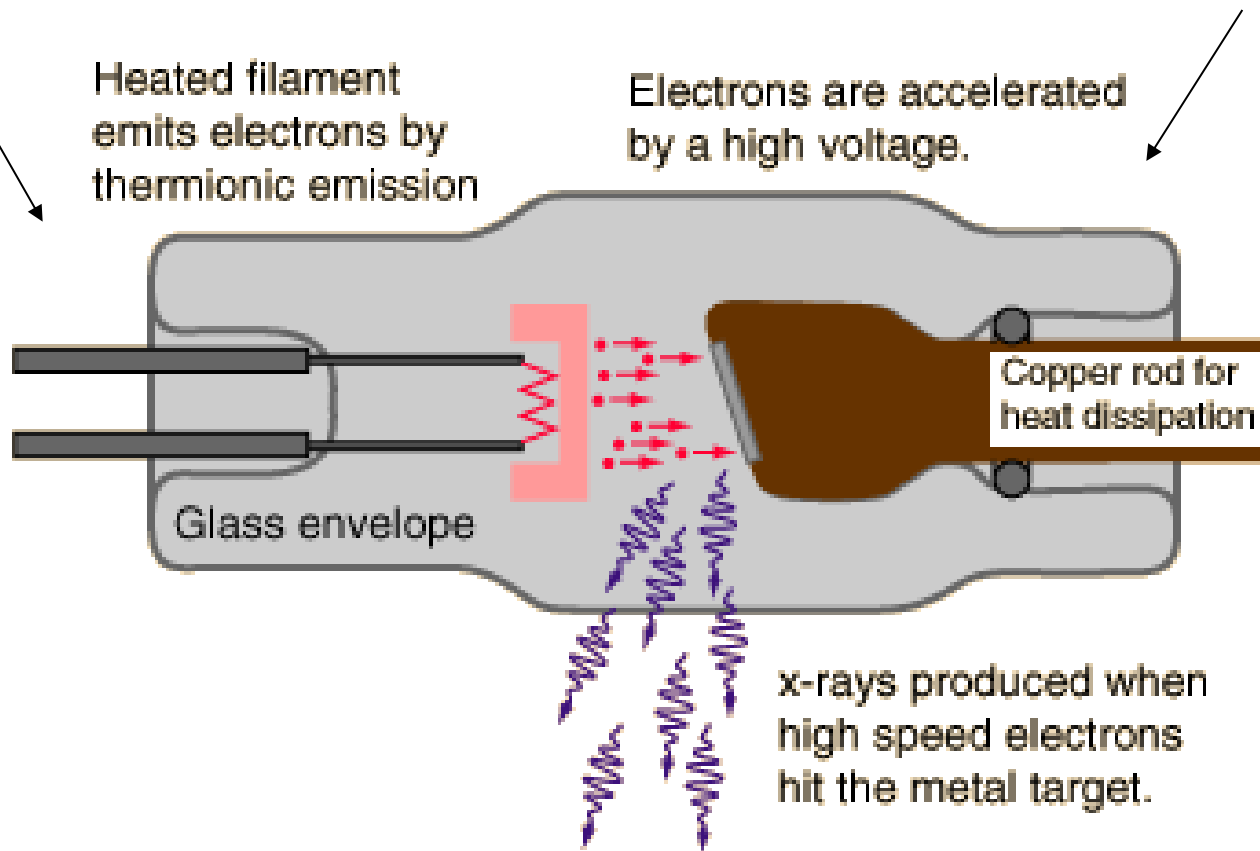
Visible light and x-ray photons behave in a similar fashion BUT x-ray photons have a much higher energy than visible light waves



Diagram of an X-ray Tube

Cathode (-ve)

Anode (+ve)



How is an X-Ray picture formed?

- ▶ Relies on different tissues of the body having different densities
- ▶ Density will affect how much of an x-ray beam is transmitted through a part of the body
- ▶ If a large number of x-rays reach the “film”, the image will be black
- ▶ If a small number of images reach the “film”, it will be white
- ▶ You will end up with a negative image

Chest x-ray



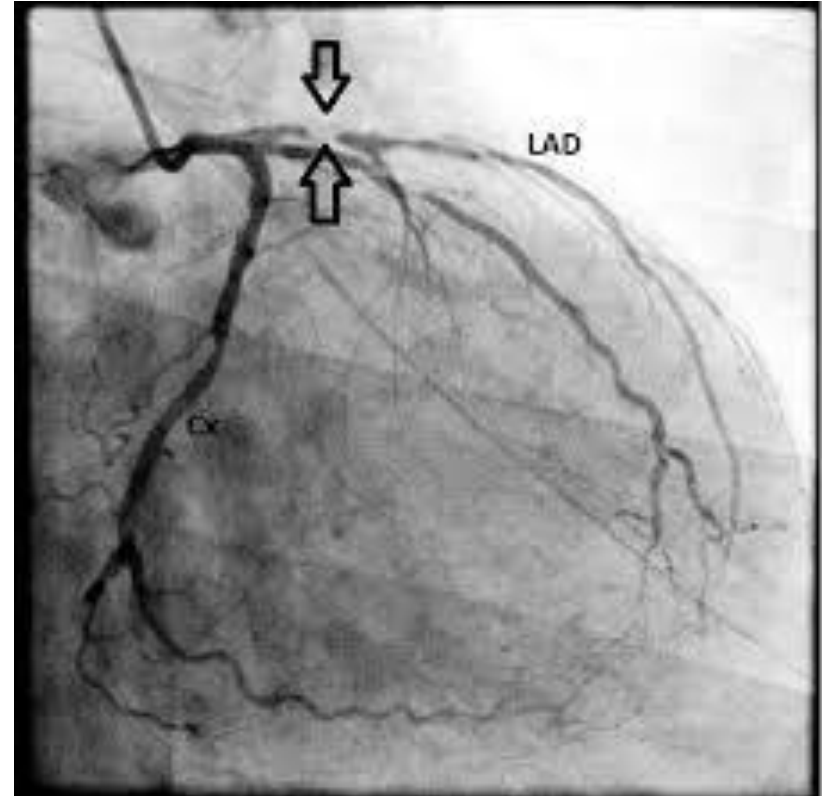
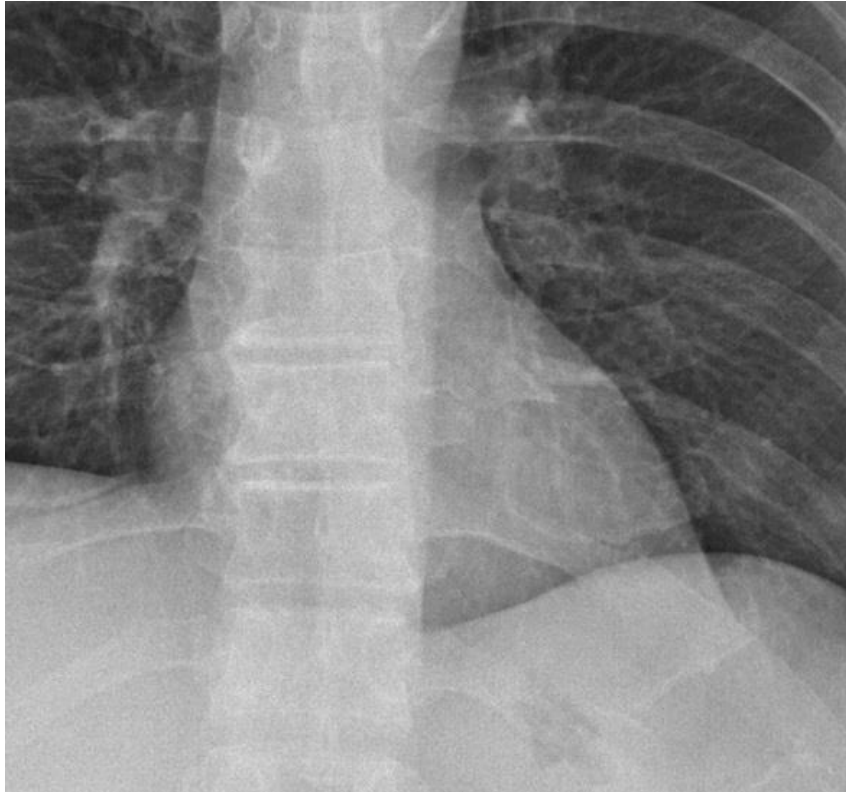
Contrast

- ▶ The density of most body parts fall in between air and bone
- ▶ The resultant image has a lot of grey scales
- ▶ Example of the vascular system (can't see on a plain x-ray)
- ▶ Introduce contrast media which has a greater density than body tissue (iodine or barium GI studies).
- ▶ Has your patient any relevant allergies? If so note it on the imaging referral.

Barium study



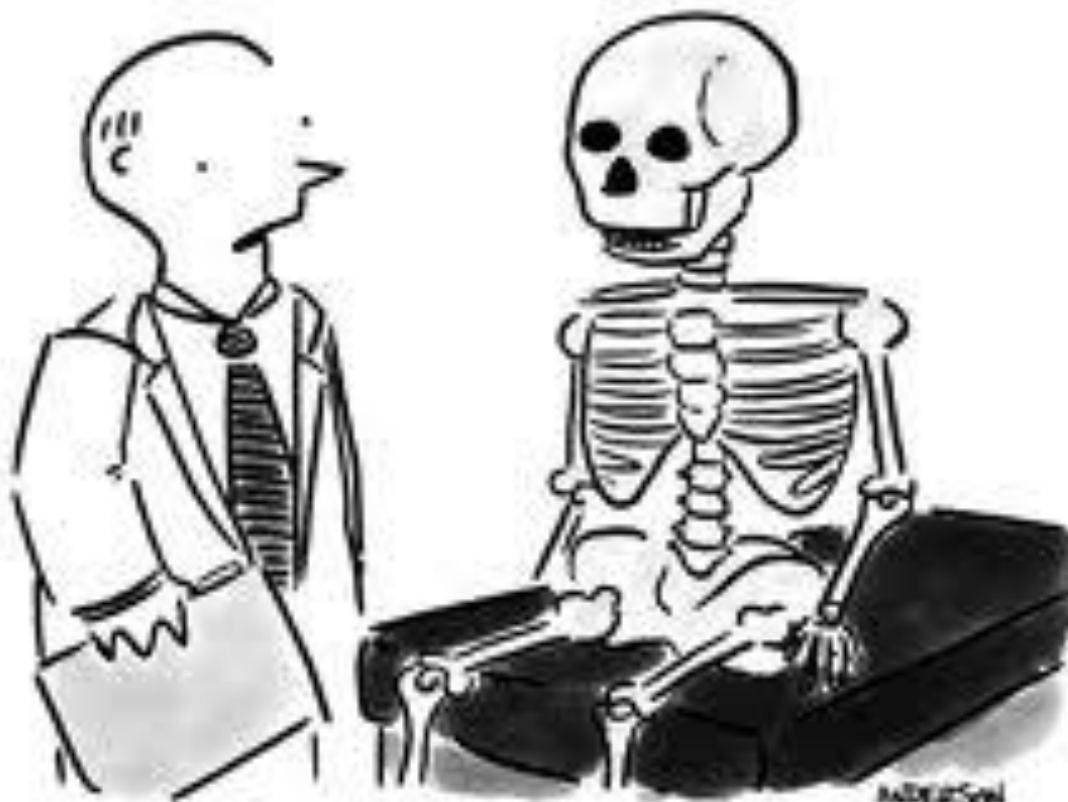
Vascular study



Still with me?

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"Still, let's do an x-ray just to be sure."

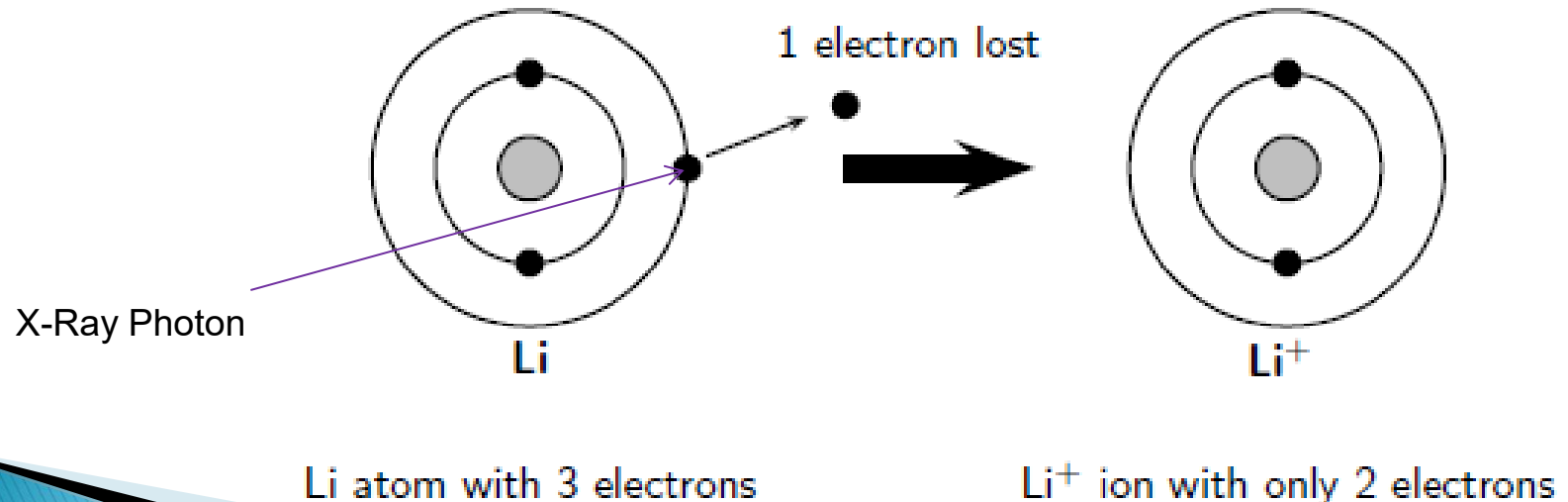
The interaction of x-rays with the tissues of the body

To be treated with caution!



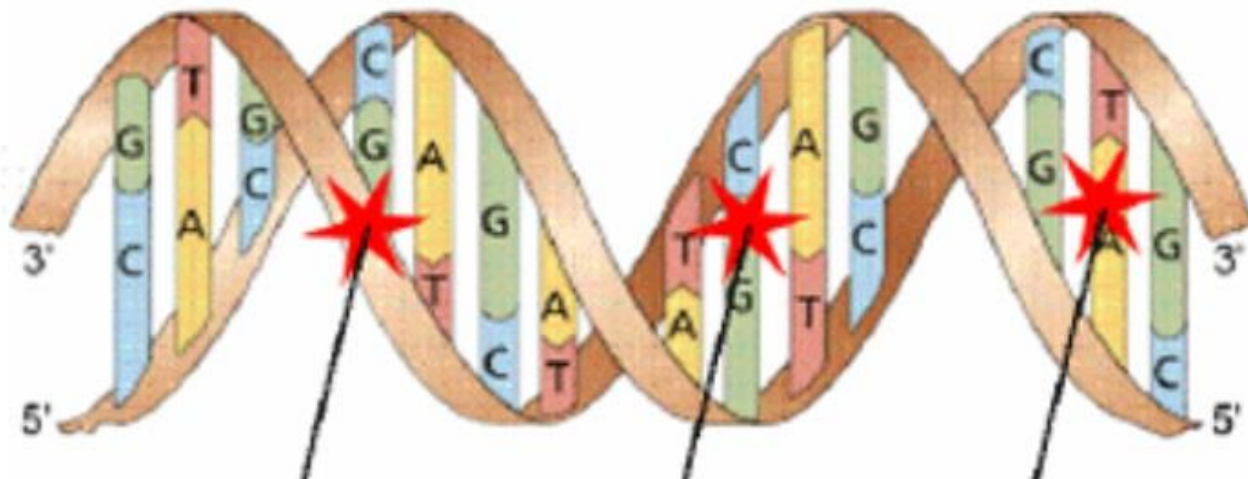
X-ray Interaction With Body Tissue

- ▶ A portion of the x-ray beam does not have enough energy to penetrate right through the body and is absorbed by the body tissues.
- ▶ The energy of the beam will be absorbed by the body tissues in an effect called “Ionisation”. Affects the cells of the body on an atomic level.



The effect of ionising radiation on DNA

- ▶ DNA is particularly susceptible to the damaging effects of radiation – single and double strand breaks and damage to base pairs.



- ▶ DSB is a classic sign of radiation damage.
- ▶ When DNA is damaged, this can prevent or interfere with cell division so leading to cancers, leukaemia's and other blood changes.

X-ray Interaction With Body Tissue

- ▶ Some body tissues are more sensitive to the effects of ionising radiation.
- ▶ Dependant on the “Cell Reproducibility Rate” – areas where cells are rapidly dividing
- ▶ Cells with a higher CRR include the blood forming cells, the skin, foetal tissue, bone marrow, gonads and breast tissue
- ▶ Paediatrics are more vulnerable as they have more areas of cell division – growing!

Effects of ionising radiation

DETERMINISTIC EFFECTS

There is a threshold below which, effects will not occur

- ▶ Effects increase with dose
 - Erythema (skin reddening)
 - Epilation (hair loss)
 - Nausea/ vomiting



Can be likened to sunburn



Effects of ionising radiation

STOCHASTIC EFFECTS

- ▶ Governed by chance
- ▶ Radiation induced cancers:
 - Leukaemia
 - Solid Cancers
 - Genetic effects
- ▶ There are no 'safe limits', all doses carry some risk
- ▶ The greater the dose received, the greater the ***probability*** of the effect occurring.

Can be likened to
smoking

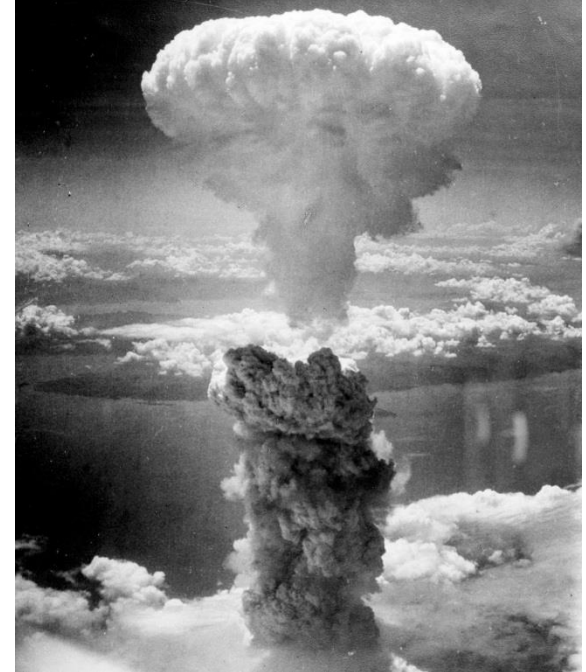


Ionising Radiation Research

How do we know what effects different levels of radiation have on the human body? Where has the data come from?

Think about large scale radiation events over the past 70 years.

- ▶ Hiroshima (1945) – atomic bomb
- ▶ Nagasaki (1945) – atomic bomb
- ▶ Windscale (1957) – radioactive iodine
- ▶ Chernobyl (1986)
- ▶ Fukushima (2011)



X-ray doses in perspective

Unit of measure for radiation - SIEVERT – “Sv”

NATURAL BACKGROUND RADIATION DOSE

Background radiation for people living in Dorset averages
2.6 mSv (0.0026Sv) a year


GOING ON YOUR HOLS

Transatlantic Flight (London to
New York) - 0.10 mSv



Radiation doses from imaging

Transatlantic Flight (London to New York) - 0.10 mSv

Examination	 Dose*
Extremity X-ray	0.01 mSv
Chest X-ray	0.10 mSv
Spinal X-ray	1.50 mSv
Barium swallow	6.0 mSv
CT Head	2.0 mSv
CT Abdomen/Pelvis	10 mSv

* Effective (whole body) dose


Balance of Risk vs Benefit

Examination	Risk of inducing a cancer
Extremity X-ray	< 1 in 1,000,000
Chest X-ray	1 in 1,000,000
Spinal X-ray	1 in 10,000 to 1 in 100,000
Barium swallow	1 in 1,000 to 1 in 10,000
CT Head	1 in 10,000 to 1 in 100,000
CT Abdomen/Pelvis	1 in 500 to 1 in 1,000

Small risk compared to natural cancer risk of 1 in 2

**HOW DO WE
COMMUNICATE THIS
RISK TO OUR
PATIENTS?**

Background dose equivalent

Activity	Effective Dose	Background Dose Equivalent
Eating a banana 	0.1 μ Sv	20 mins
Intra-oral dental x-ray	1 μ Sv	1 day
Chest x-ray	20 μ Sv	5 days
Flight to Hong Kong	50 μ Sv	1 week
Mammogram	400 μ Sv	2 months
Lumbar spine x-ray	600 μ Sv	6 months
CT Head	1400 μ Sv	8 months
Barium swallow	1500 μ Sv	8 months
CT Chest/abdo/pelvis	10000 μ Sv	4.5 years

What do you think is the best way to communicate risk and benefit?

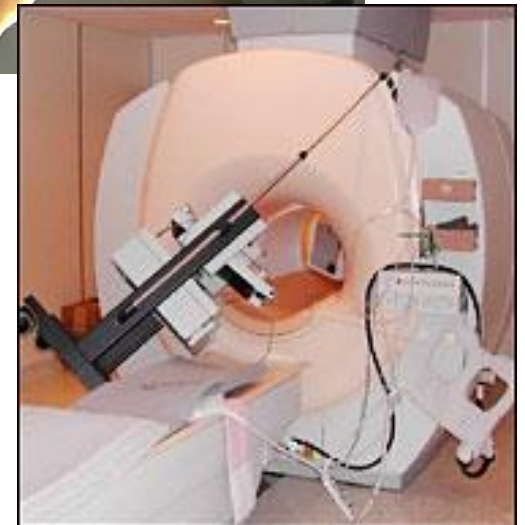
The legislation governing the use of medical ionising radiation

Radiation and the law

There are two main regulations governing the use of medical x-rays – both form part of the Health and Safety at Work Act

- ▶ **Ionising Radiations Regulations 2017** – aimed at the protection of the **public** and health of **staff** who work with x-rays
- ▶ **Ionising Radiations (Medical Exposure) Regulations 2024** – **safety of patients** – justification of requests, optimising services and limiting doses. Includes the area of research.

MRI Safety Awareness



MRI Imaging

- ▶ Non-ionising radiation (no x-rays!)
- ▶ Superconducting magnet 1.5T / 3T (30 – 60,000 x Earth's field)

IT IS ALWAYS ON!

- ▶ Direct (Biological) Effects:
Interaction of magnetic field with tissue
- ▶ Indirect (Physical) Effects:
Mechanical attractive forces – missile effect

Physical Effects of Static Magnetic Fields

Ferromagnetic items entering an MRI environment may result in:

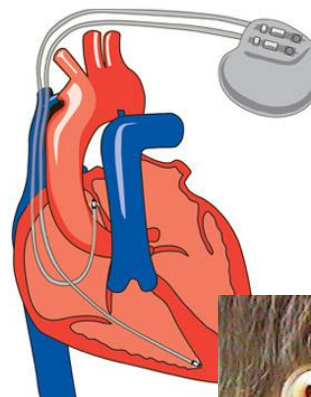
- ▶ Rotational movement (torque)
- ▶ Translational movement (attraction)

Both can be FATAL!

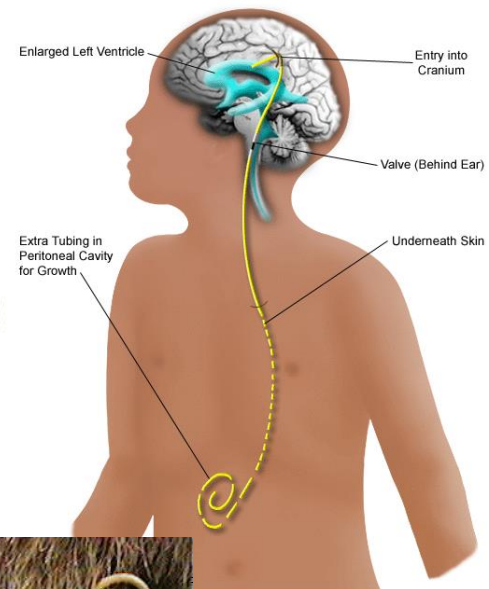
- ▶ Anyone in direct path of attracted object may be struck
- ▶ Dislodging implanted devices could be dangerous

Implanted Medical Devices

Passive or Active
(more about this later)



Ventriculoperitoneal Shunt Placement



Any Questions?



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