

RADIOLOGY: X-ray Basics

What are X-rays?

X-rays are part of the electromagnetic spectrum, just like radio and light waves. At the end of the 19th century, it was discovered that if x-rays were shone through the human body against a photographic plate the denser tissues containing calcium such as bone or teeth absorbed the x-rays, whereas the skin and muscles allowed x-rays to penetrate through. Professor Röntgen was awarded the Nobel Prize in Physics for this discovery! X-rays, which penetrate the tissues, are detected on the photographic plate causing it to become darker. Hence, bone appears white on x-rays, whereas soft tissue and air appears dark. The actual image that x-rays produce is called a **radiograph**.

Chest radiographs are usually taken in the radiology department of a hospital and involve a patient standing up with their arms 'hugging' a radiographic plate. With this technique the x-rays penetrate from back to front leading to a 'posterior-anterior' (PA) projection. The alternative is an 'anterior-posterior' (AP) projection, where the X-rays penetrate from the front to back of a patient. This occurs when a patient is too unwell to be transferred to the radiology department, and so a portable x-ray is taken of the patient lying in bed. PA radiographs are usually more accurate than AP radiographs.

When we look at a radiograph we want to ensure it is 'technically adequate'. This means that it needs to satisfy certain criteria before we can safely use it to aid diagnosis.

Assessing the technical adequacy of a chest radiograph (CXR)

- **Penetration** – this is an assessment of how many of the x-rays have penetrated through the bones and soft tissues of the body. Penetration can be assessed by looking at the thoracic vertebrae behind the heart - they should be just visible at this point. If the radiograph appears generally too 'white' and the thoracic vertebrae are not visible behind the heart then the image is under-penetrated. Conversely, if the image is generally too 'black' it may be over-penetrated. An easy way to remember this is that bread starts off white, and if you toast it for too long it becomes black.
- **Rotation** – the x-ray needs to be taken of the chest straight-on. If the body is turned slightly one way or the other it will cause a distorted image. To assess this, look at the medial heads of the clavicle - they should be equidistant to the spinous process visible on the vertebra at the same level.
- **Inspiration** – to be able to assess the lung fields adequately, the patient must take a deep breath just before the x-ray is taken. This requires coordination and can therefore be difficult for children, some elderly patients and very unwell patients. Ideally 9 posterior ribs should be visible on the CXR.
- **Exposure** – to be able to assess the CXR adequately, both lung apices and both costophrenic angles must be visible, otherwise an abnormality might be missed.

You are very unlikely to be given an inadequate CXR to analyse in an OSCE. It is therefore usually enough to state; **'this chest radiograph is technically adequate. It is correctly penetrated, not overly rotated, there is good inspiration and it is fully exposed'**.