

HAZARDS OF IONISING RADIATION

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The majority of ionising radiation comes from natural sources on Earth and cosmic rays, and this makes up the background radiation. However, medical exposure accounts for around 15% of the total received by humans. The effects of ionising radiation can be broadly divided into two groups. The first group comprises predictable, dose-dependent tissue effects and includes, for example, the development of cataracts in the lens of the eye. These effects are important for those chronically exposed to radiation, including those using image intensifiers regularly. The second group comprises the all-or-nothing effects such as the development of cancer (termed stochastic). These effects are not dose dependent, but increase in likelihood with increased radiation dose. The risk of radiation-induced cancer for plain films of the chest or extremities is very small, of the order of 1:1000. However, that risk rises considerably for high-dose examinations such as CT of the abdomen or pelvis, where the estimated lifetime excess risk of cancer increases to the order of 1:1000. Use of CT has increased dramatically in the last 20 years, with a 12-fold increase in the UK, and it has been estimated that up to 30% of these examinations may be unnecessary. Obviously, the risk of such examinations has to be balanced against the benefit to the patient in terms of increased diagnostic yield, and must also be viewed in the context that the lifetime risk of cancer for people generally is about 1:3. Nevertheless, the increased risk is important since it is iatrogenic and applied to a large population. Therefore, techniques that do not use ionising radiation, such as ultrasound and MRI, should be carefully considered as alternatives, particularly in children and young people. In the UK, the Ionising Radiation (Medical Exposure) Regulations (IR(ME)R) introduced in 2000, and amended in 2006, impose on the radiologist the duty to the patient to make sure that all studies involving radiation (plain radiographs, CT and nuclear medicine) are performed appropriately and to the highest standards. Inappropriate use of radiation is a criminal offence, so investigations involving radiation need careful consideration in order to prevent wasteful use of radiology.

Summary box 8.2 Criteria for useful investigations There are special considerations for portable and fluoroscopy units. The longer an operator keeps the fluoroscopy unit running, the higher the dose of radiation to all in the vicinity. Portable x-ray machines and fluoroscopic imaging equipment use much more radiation to achieve the same result. Technicians and patients in the next bed, are at risk when portable equipment is used. The result is also of lower quality, so portable x-ray machines should not be used unless absolutely necessary. When using the image intensifier, lead aprons, thyroid shields, lead glasses and radiation badges should always be worn. Pregnancy in the female patient or staff must be excluded. Wilhelm Conrad Roentgen, 1845–1923, Professor of Physics, Würzburg (1888–1900), and then at Munich, Germany. He was awarded the Nobel Prize in Physics in 1901 for his work on x-rays.

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guidance tool, called iRefer, which is widely available on line and shows radiation doses for common procedures (Table 8.1). -

A useful investigation is one in which the result – positive or negative – will inform clinical management and/or add confidence to the clinician’s diagnosis. A significant number of radiological investigations do not fulfil these aims and may add unnecessarily to irradiation of patients. To avoid the wasteful use of radiology, the important questions to be asked are as follows.

1. Has it been done already ? Repeating investigations that have already been done: such as at another hospital, in an outpatient department or in an emergency department. Every attempt should be made to obtain previous images and reports. Transfer of digital data through electronic links will assist in this respect. Although guidelines may not directly address this question, there are other initiatives that do
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 3. Is it needed now ? Investigating too early: for example, before the disease could have progressed or resolved, or before the results could influence treatment. The need for investigation and treatment should be reviewed at a more appropriate time
 4. Is this the best investigation ? Doing the wrong investigation: imaging techniques undergo rapid change. It is often helpful to discuss an investigation with a specialist in clinical radiology or nuclear medicine before it is requested
 5. Has the problem been properly explained ? Failing to provide appropriate clinical information and questions that the imaging investigation should answer: deficiencies here may lead to the use of the wrong technique, or the report being poorly focused on the clinical problem. In some clinical situations formal guidelines have been established Radiologists have a legal responsibility to keep imaging as safe as possible The referrer has a duty to balance risk against benefit The referrer must provide adequate clinical details to allow justification of the examination Avoid using portable (mobile) x-ray machines whenever practical Take all precautions when using an image intensifier The gonads, eyes and thyroid are especially vulnerable to radiation and should be protected
- TABLE 8.1 Band classification of the typical doses of ionising radiation from common imaging procedures. Examples
- | Procedure | Typical dose (mSv) | Typical additional effective dose (mSv) | Relative risk of cancer induction |
|-------------------------------|--------------------|---|-----------------------------------|
| US | 0 | 0 | None |
| MRI | <1 | <1 | <1 |
| CXR | 0.001 | <1 | <1 |
| XR limb, pelvis, lumbar spine | 1-5 | 1-5 | 1-5 |
| mammography | 1-2 | 0.001-0.01 | 1-5 |
| IVU; NM (e.g. bone) | 1-5 | 1-5 | 1-5 |
| CT head and neck | 5-10 | 5-10 | 5-10 |
| CT KUB; NM (e.g. cardiac) | 10-20 | 10-20 | 10-20 |

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