Ionising Radiation (IR) in Paediatric Imaging

The World Health Organisation (WHO) has published a document “Communication radiation risks in paediatric imaging: information to support health care discussions about benefit and risk”. This document is intended to be a tool for health care providers to communicate about risks associated with paediatric imaging procedures. View the document

The risk of ionising radiation: the model

Ionising radiation is employed in x-rays, mammography, CT scans, fluoroscopic procedures and nuclear medicine examinations.

Ultrasound and Magnetic Resonance Imaging (MRI) do not use ionising radiation.

The risks of IR incurred at diagnostic imaging levels are presumptive and based on the 'linear / no lower threshold' (LNLT) model and extrapolated from data collected after the atomic bomb explosions in Japan. It is important to note that all major responsible authorities believe it prudent to work to that model.

The LNLT model indicates that no dose of IR, however small, is entirely without risk. This model estimates the average lifetime risk of induction of a fatal cancer from exposure to 5 milliSieverts (mSv) to be approximately 1 in 4000 and that to 20 mSv to be 1 in 1000.

In diagnostic imaging, the effects of IR are essentially only stochastic effects i.e. unpredictable and random in nature. Induction of malignancy is the most significant stochastic effect where there is considered to be no threshold point at which this occurs. The risks of stochastic effects are considered to increase with dose but severity of effect is independent of this, with the development of a particular effect an all or nothing concept.

The risk of ionising radiation in children

The risk of IR is considerably greater than average in children and young adults (probably 2-3 x the average risk) and becomes smaller with age over the age of 40 years.

During childhood growth and development, rapid cell division occurs. This means that the developing fetus and children are more sensitive to IR than adults. A further reason for the greater risk in children than older adults is that the risk of cancer induction by IR is deferred (for 5-15 years) - so children have a greater length of time ahead of them for any cancer to declare itself.

A CT scan of the abdomen and pelvis, depending on the protocol, used may expose the patient to about 10 - 20 mSv of IR which, on average, increases the risk of fatal cancer by about 1 in 1000 - 2000. However, this risk may be doubled or tripled in children. Remember, though, that the risk is cumulative if the patient undergoes repeated scans. This risk must be put into the clinical context and compared against other common risks. For example the risk of being killed on Western Australian roads in a ten year period is approximately 1 in 1000.

Justification and optimisation

All imaging procedures need to be justified before being performed - particularly those employing IR.

The process of justification requires that the potential benefit of the procedure outweighs the risk. In the
case of ionising radiation, this risk is related to the induction of cancer in the exposed individual. The size of that risk depends on patient factors (in particular the age since children and young adults are especially susceptible), the extent and part of the body exposed (since some organs are more sensitive to IR than others) and to the nature of the examination and the imaging protocol used to perform it.

The risk of cancer induction by IR is a deferred risk that may occur from 5 to 15 years after exposure. The underlying clinical context in the individual patient is important, since, for example, in a young patient with a curable disease, the risk is important to consider, whereas in a patient who is undergoing imaging for an incurable cancer or in a 80 year old patient, the risk may be irrelevant.

In recent decades there has been a marked increase in population exposure to IR. Most of this is related to medical procedures and especially to CT scans. The radiation dose received during a CT scan depends on the protocol used - that is the radiographic factors and the number of series obtained. For example scans may be obtained before intravenous iodinated contrast injection and in one or more phases post-contrast.

All procedures involving IR should be performed according to the principle of **ALARA (As Low As Reasonably Achievable)**. This refers to the process of optimisation - that is using as low a dose of IR as possible while still achieving a diagnostic quality examination. Optimisation is the responsibility of the imaging technician and imaging specialist.

**Summary**

If the potential benefit of the diagnostic imaging procedure outweighs the risk, then the scan is justified. If the patient needs a scan for treatment or management then they should not be put off having one.

Choose a procedure that does not involve IR (ultrasound or MRI) if available and if it is likely to give at least as much information as one that does use IR.

Consult with a radiologist where there is any doubt or concern.

Appropriate and justified exposure to IR in diagnostic imaging is good; inappropriate examinations are bad.

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