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**Are children more sensitive to radiation than adults?**

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There is a commonly held belief that children may be two to three times more sensitive to radiation than adults.

According to the latest findings of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), the general perception that children are more vulnerable to radiation exposure than adults is only partly true. While there are clear instances of an increased risk of radiation induction of some cancers for children, compared to adults, children actually have a lower risk or equivalent risk for other types. There are similar examples with regard to deterministic effects.

The UNSCEAR report is expected to be made available online in October 2013. Please refer to www.unscear.org. This article provides a summary of the main messages from the upcoming report, 'Effects of Radiation Exposure on Children'.

UNSCEAR advises that in any discussion of the effects of childhood radiation exposure, generalisations are best avoided and attention should be directed to the specifics of the exposure, age at exposure, absorbed dose to certain tissues, age at the time of assessment, and the particular effects in question.

The term 'radiation sensitivity' with regard to cancer induction refers to the rate of radiogenic tumour induction and does not refer to the degree of malignancy.

Generally, for about

- 25% of tumour types children are clearly more radiosensitive. These include leukaemia, as well as thyroid, skin, breast and brain cancer.
- 15% of tumour types (such as bladder cancer) children appear to have about the same radiosensitivity for tumour induction as adults.
- 10% of tumour types (e.g. lung cancer) children appear less sensitive to external radiation exposure than adults.
- 20% of tumour types (including oesophagus cancer) the data are too weak to draw a conclusion regarding differences in risk with age at exposure.
- 30% of tumour types (including Hodgkin's lymphoma, prostate, rectum and uterus cancer) there is only a weak or no relationship between radiation exposure and risk at any age of exposure.

Currently used estimates do not adequately capture the known variations and additional work is needed.

What is the situation for direct effects (deterministic) that occur after high acute or high fractionated doses? The differences in deterministic effects between exposure in childhood and adulthood are complex and can be explained by the interaction of different tissues and pathways. These effects may be seen after justified radiation therapy or following accidental exposure. The

radiation sensitivity of children as compared with adults for deterministic effects in a specific organ is often different from that for tumour induction. There are some instances where childhood exposure poses more risk than adult exposure (e.g. for cognitive defects, cataracts and thyroid nodules). There are other instances where the risk appears to be about the same (e.g. neuroendocrine and kidney) and there are a few instances where a child's tissue is more resistant (e.g. lung function, immune system, marrow and ovarian failure).

There have been many human studies of possible heritable effects following radiation exposure. These studies have led to the conclusion that no heritable effects in humans due to radiation exposure have been conclusively identified (specifically studies on the children of atomic bomb survivors). Over the past decade, there have been additional studies that have focused on survivors of childhood and adolescent cancer, and gonadal doses from radiotherapy are often very high. There is essentially no evidence of an increase in chromosomal instability, minisatellite mutation, transgenerational genomic instability, congenital anomalies or cancer risk for children of individuals exposed to radiation. There is also no evidence to suggest changes in the sex ratio of offspring.

The reasons for the differences in the radiosensitivity between children and adults are easy to explain for some effects (e.g. the developmental and physiological status of the brain) while in many other instances the reason for the different effects between children and adults is unknown.

- children have smaller body diameters and there is less shielding from overlying tissues
- for a given external exposure the dose to children's internal organs will be higher than for an adult

The report aims to answer the following questions:

- What are the most important sources of ionising radiation exposure to children and the levels of exposure, both now and potentially in the future?
- What are the dosimetric differences between children and adults?
- How does ionising radiation affect children differently from adults?
- How sensitive are children to radiation exposure in comparison with adults?
- What are the factors that make children more sensitive to radiation exposure?
- Are children more sensitive to all radiation sources and effects or just to some?
- What gaps exist in our knowledge of radiation effects following childhood exposure that may guide future research?