

FACT SHEET

Safety Aspects of CT scans

Radiation exposure in CT examinations

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What are X-rays and what do they do?

X-rays are a form of energy, like light or radio waves. Unlike light, x-rays can penetrate the body, which allows a radiologist to produce images of internal structures. These can be viewed on a computer monitor or photographic film.

Measuring radiation dose

The scientific unit of measurement for radiation dose, commonly referred to as effective dose, is the millisievert (mSv). For ease of comparison, a chest x-ray delivers a dose of 0.05 – 0.06 mSv.

Different organs and tissues have varying sensitivity to radiation exposure and therefore, the actual doses to different parts of the body from an x-ray procedure vary. The term effective dose is used when referring to the dose averaged over the entire body. The effective dose accounts for the relative sensitivities of the different tissues exposed. More importantly it allows for quantification of risk and comparison to more familiar sources of exposure that range from natural background radiation to radiographic medical exposures.

Naturally occurring 'background' radiation exposure

We are exposed to radiation from natural sources all the time. The average person in the UK receives an effective dose of about 2.5 mSv per year from naturally occurring radioactive materials and cosmic radiation from outer space. These natural 'background' doses vary throughout the country. For instance, people living in Cornwall receive more than 10 mSv per year, largely because of radioactive radon contained within granite. These levels are high enough for the natural topsoil and rock to meet the criteria for low-level nuclear waste.

There are some parts of the world, e.g. areas in Iran and India where the background radiation levels are extremely high, greater than 200 mSv, which is several times more than workers in nuclear power stations are exposed to, yet the life expectancy in these areas is very high with no apparent adverse effects and no increased cancer risk.

We are also exposed to a significant dose from cosmic rays during an aeroplane flight e.g. a return flight to New York is equivalent to about 0.08 mSv and a frequent flyer aloft for around 100 hours a year would receive an additional annual dose of approximately 0.4 mSv.

To explain it in simple terms, we can compare the radiation exposure from one chest x-ray (about 0.06 mSv) as equivalent to the amount of radiation exposure one experiences from the natural surroundings in 3 days.

Radiation exposure from CT scans

Since its inception in 1973, the role of CT in diagnostic radiology has expanded. It is estimated that in the UK, CT scanning accounts for 4% of all radiological examinations (13% in the US) and delivers more than 40% of the radiation dose.

Radiation dose from CT procedures varies from patient to patient. A particular radiation dose will depend on the size of the body part examined, the type of procedure, and the type of CT equipment and its operation. Radiologists are aware of the radiation risks of CT and work actively to keep patient radiation exposures from CT scanners as low as possible, while achieving the required imaging quality and medical benefit.

Due to its advanced design, the Aquilion ONE 640 slice CT scanner used at the European Scanning Centre typically exposes patients to considerably lower doses of radiation than conventional multi-detector CT scanners used in other centres and the NHS.



The European Scanning Centre is regulated by the Ionising and Medical Exposures Regulations (IRMER) and its independent external Radiation Protection Advisor has calculated the typical effective radiation doses for all the CT scans performed at the centre. The following is a comparison of those doses with natural background radiation, equivalent number of chest x-rays and typical radiation dose for the same CT examination performed on a conventional multi-detector CT scanner.

Aquilion ONE 640 slice CT scanner	Effective radiation dose (mSv)	Comparable to natural background radiation for:	Number of chest x-rays for equivalent effective dose *	Effective radiation dose for same scan with 16-64 slice MDCT scanners (mSv)
Heart scan (EBCT scanner)	0.6	3 months	10	3.3-4.6
Coronary angiography	1-2.4	5 months	16	5-21
Lung scan	1	5 months	16	5
Brain	0.8	5 months	13	1.5-5
Abdomen and pelvis	2-3.5	10 months	32	7-20
Chest, abdomen and pelvis	3	1.2 years	48	10
Virtual colonoscopy	1.7	8 months	28	8.8

* based on the assumption of an average 'effective dose' from chest x-ray (PA film) of 0.06 mSv

Comparing radiation exposure from CT scans with some common radiological procedures can be useful.

Investigation	Dose (mSv)
Conventional invasive angiogram	8-14
Myocardial perfusion scan	15-20
Mammogram	0.3-0.6
Lumbar spine x-rays	2
Barium enema	7

X-ray safety

As with other medical procedures, x-rays are safe when used with care. Radiologists and radiographers have been trained to use the minimum amount of radiation necessary to obtain the needed results. The amount of radiation used in most examinations is very small.

X-rays from CT scanners are produced only when a switch is momentarily switched on. As with visible light, no radiation remains after the switch is turned off.

A radiologist looks at every request for a CT scan and ensures that it is the appropriate examination to answer the question asked. If the answer could be better provided by an alternative imaging test which uses no radiation e.g. ultrasound, then this will be recommended. Any additional CT imaging a patient has had in the last few years will also be taken into consideration.

There are special regulations for radiation exposure in females of child bearing age and specific questions will be asked as to whether you could be pregnant. Some examinations will only be undertaken during the first 10 days of your menstrual cycle.

No patients in the paediatric age group are scanned at the European Scanning Centre.

X-rays over your lifetime

The decision to have an x-ray examination is a medical one, based on the likelihood of benefit from the examination and the potential risk of radiation. For low dose examinations, like a chest x-ray, this is an easy decision. For higher dose examinations such as CT, the radiologist will consider your past history of exposure to x-rays. It is a good idea to keep a record of your x-ray history yourself. Your risk factors for developing a specific condition will also be considered.

The probability for absorbed x-rays to induce cancer is thought to be extremely small for radiation doses of the magnitude that are associated with CT procedures. Such estimates of the cancer risk from x-ray exposures have a broad range of statistical uncertainty and there is considerable scientific controversy regarding the effects from very low doses and dose rates.

In the field of radiation protection, there are two schools of thought. No one knows which is correct. One school assumes that the risk for adverse health effects from cancer is directly proportional to the amount of radiation dose absorbed, although there is no definite evidence for this. Using this assumption, it has been estimated that a CT examination with an effective dose of 10 mSv may be associated with an increase in the possibility of fatal cancer of approximately 1 chance in 2000. This increase in the possibility of a fatal cancer from radiation can be compared to the natural incidence of fatal cancer in the general population, about 1 chance in 5. In other words, for any one person the risk of radiation induced cancer is vastly smaller than the natural risk of cancer (1).

To put things further into perspective, it has been recently estimated that the delivery of 10 mSv to the breast of a woman of 30 years old increases the risk of breast cancer by about 0.2% **over** the spontaneous rate for the general population (2).

To look at it another way, approximately 23% of all individuals die from cancer (540,000 deaths a year in the US); one can calculate that of every 100,000 patients scanned, 40 might have a life threatening cancer induced by radiation in their lifetimes. On the other hand, of the same 100,000 people, 23000 are likely to die from cancer.

However, it should be noted that there is uncertainty regarding the risk estimates for low levels of radiation exposure as commonly experienced in diagnostic radiology procedures. There is no definite evidence that the risk of cancer increases linearly with the dose of radiation exposure, and certainly for low doses. Indeed the other school of thought suggests that a small dose of radiation is actually good for us, by weeding out potential cancer forming cells. People living in parts of the world (e.g. Iran) with extremely high levels of background radiation (>200 mSv) do not appear to have an increased rate of cancers and indeed if anything have an increased life expectancy (3).

Will I be exposed to more radiation if my scan shows an incidental finding?

Incidental (unexpected) findings are found on up to 25 % of all CT scans and most of these require no further clarification e.g. hiatus hernia. The most commonly encountered abnormalities which need further imaging to confirm their exact nature are simple liver and kidney cysts. This can easily and quickly

be done by an ultrasound scan, which does not require further radiation and which will confirm the abnormalities are of no further clinical significance.

Lung nodules are also commonly encountered on chest or cardiac scans (approximately 10%). These are most often benign granulomas as a result of a previous chest infection. If such nodules are identified, then guidance is given on further management and the need for a subsequent scan to exclude the possibility that they might be cancerous. The frequency of a recommended repeat scan will depend on the size, number and appearance of the nodules, as well as your smoking history. Sometimes, referral to a specialist chest physician is recommended. All of our advice is based on scientific research and we follow the guidelines of internationally recognised authorities in this field. Most commonly a small incidental non-calcified nodule will need to be followed up for a total period of 2 years, with a repeat low dose chest scan recommended at 1 year and 2 years. While we appreciate that this can be very inconvenient, we cannot ignore these nodules once they have been discovered as we have had a few patients in whom these nodules have turned out to be an early cancer, and their early detection has allowed for more effective surgery.

References and further information:

- (1) www.fda.gov/cdrh/ct
- (2) Allen C. Radiation risks overestimated. *Radiology* 2006;240:613-614
- (3) <http://www.sciencemag.org/cgi/content/full/309/5736/883>

If you have any concerns or wish for additional information regarding radiation exposure and CT, please do not hesitate to contact us at the European Scanning Centre and we will attempt to provide you with satisfactory answers according to the current literature.