

Radiation exposure in medicine: what you need to know

Imaging is an indispensable tool in modern medicine, yet very few patients know just how important it is. From cancer detection and therapy to diagnosing stroke or serious trauma in time, radiologists contribute to saving lives by covering every field of medicine. To raise public awareness, the European Society of Radiology will launch the European Day of Radiology on February 10, marking the anniversary of x-ray discoverer Wilhelm Conrad Röntgen's death. Most European national societies have joined this initiative, including the Italian Society of Radiology (SIRM), which has chosen to address the sensitive topic of radiation exposure.

Milan, February 2011 – Over the last decade, technical advances in computed tomography (CT) have been considerable. CT examinations, which use x-rays and a computer to provide 3-dimensional and slice images of the inside of the body, are now very fast and accurate. For instance, CT can acquire excellent images of the entire body in less than 20 seconds. In patients suffering polytrauma, it enables a quick overview of possibly life-threatening pathologies and increases chances of survival. CT has also improved the detection of many cancers, significantly extending the survival time of patients. Moreover, many abdominal diseases are now easily diagnosed and assessed with CT, preventing unnecessary surgery in many cases. Finally, CT has become the standard imaging modality in diagnosing pulmonary embolism and is also gradually replacing cardiac catheterisation in some heart diseases.

All these benefits have translated into a massive rise in CT examinations worldwide. The population's cumulative exposure to ionising radiation, which is capable of causing cancer in humans, has thus grown, and will continue to grow in the future. Ionising radiation is contained in all imaging methods using x-rays such as CT or radiography.

However, it remains very difficult to assess the cancer risk induced by CT, as the majority of estimates so far are based on scientific studies of atomic bomb survivors in Japan.

The dose administered by a CT examination depends on the region on which it focuses. Chest CT generates on average 7 mSv (millisievert – a derived unit of dose equivalent that attempts to reflect the biological effects of radiation), head CT, 2 mSv, and abdomen/pelvic CT, 10 mSv.

The annual exposure for an average person is about 3.6 mSv, 80 percent of which comes from natural sources of radiation contained in water, food, some materials and the atmosphere. The remaining 20 percent results from exposure to artificial radiation sources, such as industrial sources like smoke detectors, a small fraction from nuclear weapons tests, and medical sources - 60% of which are induced by CT examinations.

Every patient has a different sensitivity to radiation exposure, but some factors are particularly important. Children and young patients are more sensitive than adults, and females also have a slightly higher risk depending of the type of CT scan (e.g. CT of the thorax). Finally, the type of CT scan has a direct influence on the exposure level. For instance, a CT scan of the thorax presents a higher risk than a CT scan of the head because the chest comprises many more radiosensitive organs, such as breast and lung.

In recent years, numerous successful efforts have been made to reduce CT radiation dose. CT manufacturers have developed CT scanners that are more dose-efficient and many radiologists have optimised their CT protocols in order to reduce the radiation dose.

The benefits of CT largely outweigh the risks, but nevertheless every examination has to be justified by a clinical indication. The radiologist has to weigh the potential benefits against the risks and then decide if the ordered examination is appropriate or if another non-ionising modality would be more appropriate to answer the clinical question.

“The justification principle is a real limit to the inappropriate use of all x-ray examinations,” said Professor Francesco Schillirò from the Faculty of Medicine, Seconda Università Di Napoli (SUN) in Naples.

Radiologists follow very strict directives to ensure patient safety. The ALARA (As Low As Reasonably Achievable) principle, which guarantees that the best examination is carried out using the lowest possible dose of radiation, is practised by every radiologist all around the world.

“The principal aim is to set scan parameters based on the patient’s size in order to obtain the best imaging quality and the lowest concomitant exposure,” said Schillirò.

Whenever possible, radiologists perform examinations with non-ionising modalities such as magnetic resonance imaging (MRI), which uses magnetic fields to produce images of the inside of the body, and ultrasound (US). US uses sound pressure and frequencies, and is widely used in prenatal and paediatric imaging, and 3D applications are particularly relevant in neonatal imaging. MRI applications are as efficient and numerous as CT, particularly in the brain, where they have reduced examination time, making it easier to perform on young patients.

Patients throughout the world remain poorly informed on radiation exposure, so contact with the radiologist is key. “Patients often receive inappropriate or incomplete information about the risks of radiation, thus a pivotal role is constantly played by specialists in providing correct information,” said Schillirò.

SIRM is continuously working to improve communication between patients and physicians, and Italian radiologists have been obliged to attend a training course on radiation protection every five years since 1997, as many techniques are developed in this field.

Patients should bear in mind that CT examinations are not to be repeated at a different radiological institution, as the ordering physician might not know about CT studies conducted shortly before the consultation.

Finally, frequent follow-up studies with CT, especially in children and young patients, must be avoided. If CT is the only diagnostic method to answer the question of the follow-up study, a low dose protocol with a reduced scan range should be used. Experts advise the parents of children, teenagers and young patients to contact their radiologist before the study and ask them if a low-dose exam is possible. Depending on the medical question, diagnostic studies without ionising radiation such as MRI or US can frequently be used.

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