X rays
What patients need to know

1 What are X rays?

X rays (like those used in CT) are a form of radiation, as is visible light, but they have high penetrating ability and may pass through the human body. By using appropriate devices and techniques, X rays can be detected and produce images of the inner structures of the body to check for disease or other problems.

2 Can medical diagnostic X rays cause harm?

Generally not. The radiation dose involved in most X ray examinations, whether done by conventional technique on film or by digital system, is quite small. But the concern arises with repeated examinations. Relatively high dose examinations such as CT and interventional procedures have more chance to increase the risk for radiation related cancer (please see tables in Qn. 5 for dose values).

3 What is the most common radiation dose quantity?

Radiation dose or just dose is often described using the quantity **effective dose,** expressed in millisievert (mSv). The effective dose represents the whole body dose that would give the same cancer risk as caused by the doses that were imparted to different organs in a specific part of the body. Effective dose offers a way to compare approximately the relative risk between different radiation procedures. There are a number of other ways that professionals use to describe radiation dose and those are not covered here.

4 Is radiation that we receive from natural sources different and how?

Every person is exposed to radiation from surroundings, such as cosmic radiation, radiation from earth, food, and even our own body. This radiation (gamma rays) is similar to X rays used in medical examinations. Depending upon where one lives, an individual is exposed to 1 to 3 mSv every year, with global average of 2.4 mSv. There are some places where inhabitants are exposed to as much as 10 mSv/year. One can compare these with radiation doses involved in X ray examinations as given below.

5 Do all examinations impart high radiation dose?

No. Different kinds of examinations impart different amounts of radiation. The most common X ray examination is the chest X ray (frontal view). It imparts an average dose of about 0.02 mSv. In the context of the radiation we are exposed to from natural sources, this is a relatively low dose. In the following tables there is a list of patient doses from common radiological examinations as well as equivalent number of chest X rays for the same effective dose.

Examination	Mean effective dose (mSv)	Equivalent chest X rays
Skull X ray	0.1	5
Thoracic spine/lumbar spine X ray	1.0 - 1.5	50 - 75
Mammography	0.4	20
Pelvis/hip/abdomen X ray	0.6 - 0.7	30 - 35
Knee/other extremities	0.001 - 0.005	0.05 - 0.25
Intra-oral/panoramic X ray	0.005 - 0.01	0.25 - 0.5
Spine Computed tomography (CT)	6	300
Chest CT/pulmonary embolism	1-16	50-800
Abdomen/pelvis CT	6 - 8	300 - 400
Head/neck CT	2 - 3	100 - 150
CT coronary angiography	16	800
CT virtual colonoscopy	10	500

*Sources: RPOP Website: http://rpop.iaea.org and FA Mettler et al, Radiology 2008;**248**:254-63*

6 Is there a limit to the radiation I can receive from X rays?

No. In order not to restrict the benefits of X rays which are generally higher than radiation risk, no international organization has provided a limit for patient dose. The risk associated with radiation is considered to be acceptable for medically justified examinations. The referring physician and the radiologist are responsible for ensuring that health benefit to the patient from the examination is greater than the radiation risks.

7 How much is the risk for radiation induced cancer? Is this risk additive?

The risk for radiation induced cancer is low but additive. Each examination the patient undergoes slightly increases the risk. Keeping patient doses minimum while getting images of adequate diagnostic quality is therefore recommended. The probability for radiation induced cancer increases by 5-6% for every 1000 mSv of dose. Cancer risk increase arising from most examinations is relatively small as compared with the risk of naturally occurring cancer which ranges between 14% and 40%.

8 Can pregnant women undergo X ray examinations?

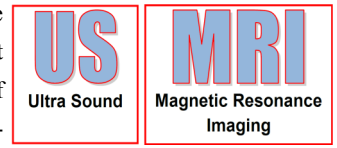
As long as clinical benefits exceed the very small potential radiation risk, there is nothing precluding the use of X rays in pregnancy. With modern equipment and good technique, examination of the head, feet, neck, shoulder and even chest can be safely carried out during pregnancy. For other examinations specific considerations are needed. Pregnant women should inform the physician and concerned healthcare provider about pregnancy or even the possibility of pregnancy. Having been made aware of this information, for investigations of the abdominal and pelvic region, especially for relatively high dose procedures (computed tomography and fluoroscopy), the physician or healthcare provider, in cooperation with the radiation protection specialist, will balance benefits and risk.

9 Is it safe for children to be exposed to X ray radiation during a diagnostic examination?

There are no restrictions to the use of X rays in children, provided that clinical benefit exceeds small potential radiation risks. Some organs in children have higher radiation sensitivity than in adults. Children also have a longer life expectancy. Therefore, imaging techniques that do not use ionizing radiation should always be considered as an alternative. Children's radiological procedures should be individually planned and limited to what is sufficient for a correct diagnosis.

10 Are there safer alternatives to X ray imaging?

Yes. Although the risk with single X ray study is mostly very small, it is a question of minimization of risk. Imaging examinations utilizing non-ionizing radiation such as MRI or ultrasound (US) should always be considered for appropriateness. Unlike X rays, they are not known to increase the risk for cancer. However it may not always be possible to replace X ray with non-ionizing radiation examinations. There are other considerations than this risk, since sometimes in young children sedation is needed for MRI as opposed to a CT examination.



Diagnostic imaging is an integral part of modern medical practice. It is widely used and has been around since the discovery of X rays by Wilhelm Conrad Röntgen back in 1895. Most of us have almost certainly undergone one or more diagnostic examinations involving X ray exposure.

The technology has advanced considerably and X ray imaging has become much safer. Despite these advances, it is important for the users of radiation in medicine to stay informed of developments and apply the principles of radiation protection of patients in daily practice. The best approach is to use as low radiation as possible (**A**s **L**ow **A**s **R**easonably **A**chievable), without compromising on intended clinical purpose.

This leaflet aims to inform patients and the public on utility and risks of X ray imaging and to help in keeping exposure to the lowest possible levels.

International Atomic Energy Agency

Vienna International Centre
PO Box 100
1400 Vienna, Austria
E-mail: patient.protection@iaea.org

X rays
What patients need to know

IAEA RPOP Radiation Protection of Patients

http://rpop.iaea.org