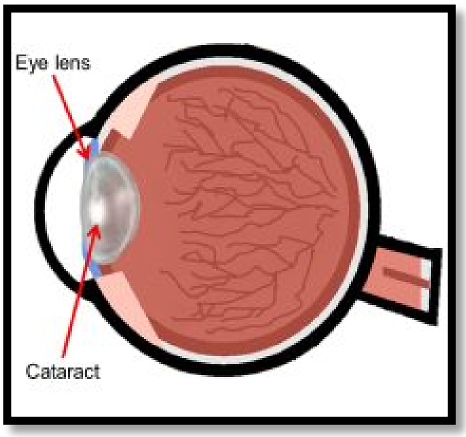
FACT SHEET ON OCCUPATIONAL DOSE LIMIT FOR THE LENS OF THE EYE

RADIATION HEALTH DIVISION
DEPARTMENT OF HEALTH

Introduction

Radiation-induced cataract is an injury to the lens of the eye that can be caused by ionising radiation.



(Cataract in Eye lens, Image from IAEA)

The International Commission on Radiological Protection ("ICRP") has recommended dose limits on the lens of the eye for protection against the risk of this injury. Based on recent scientific findings, the ICRP has revised the dose limit for workers. This revised occupational dose limit has also been adopted by the International Atomic Energy Agency ("IAEA") in its international basic safety standards for protection against ionising radiation[1].

This fact sheet aims to provide useful information on this revised dose limit and usual good practices for compliance with the dose limit.

Revised Occupational Dose Limit on the Lens of the Eye

After reviewing the relevant scientific evidence, the ICRP has lowered the threshold radiation dose for radiation-induced cataract by about a factor of ten to an absorbed dose of 0.5 Gy. In view of the lowering of this threshold radiation dose, the ICRP has correspondingly revised its previous occupational eye lens dose limit of 150 mSv in a year to 20 mSv in a year, averaged over defined periods of 5 years, with no single year exceeding 50 mSv.

Workers Possibly Affected

Workers who could be exposed to highly non-uniform radiation fields and with their lens of eyes preferentially irradiated during their work are of particular concern. They are at greater risk of radiation-induced cataract in view of the possibly higher radiation exposure to their lens of the eyes. Examples of these workers include:

1) Interventional cardiologists
2) Interventional radiologists
3) Paramedics remain close to patients during concerned x-ray procedures
4) Workers involved in the preparation of radiopharmaceuticals

Industrial radiographers who perform non-destructive testing by using high activity radioactive sources (e.g. Ir-192

[1] Entitled "Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards".

radioactive sources) may also receive significant radiation doses to the whole body including the eye lens during their work. However, under normal working circumstances, industrial radiographers work in a relatively homogenous radiation fields so that their whole body radiation exposures are also representative of the radiation exposure to the eye lens. In this case, the existing whole body dose limit as recommended by the ICRP should also serve the purpose of ensuring the compliance with the ICRP's revised eye lens dose limit.

Eye Lens Doses to Medical Workers

As aforesaid, medical workers such as interventional cardiologists and interventional radiologists using fluoroscopy in operating theatres and paramedics who stay close to the patients during the procedures are possibly be affected. Typical eye lens doses to medical workers from various x-ray procedures are provided in Table 1.

Table 1. Typical eye lens doses per procedure for various x-ray procedures (excerpted from IAEA Technical Document no. 1731 "*Implications for Occupational Radiation Protection of the New Dose Limit for the Lens of the Eye*")

Procedure	Eye dose (mSv)	Remark
Hepatic chemoembolisation	0.27-2.1/0.016-0.064	unshielded/shielded
Iliac angioplasty	0.25-2.2/0.015-0.066	unshielded/shielded
Neuroembolisation (head, spine)	1.4-11/0.083-0.34	unshielded/shielded
Pulmonary angiography	0.19-1.5/0.011-0.045	unshielded/shielded
TIPS creation	0.41-3.7/0.025-0.11	unshielded/shielded
Cerebral angiography	0.046 (mean)	unshielded
Cerebral angiography	0.013-0.025 (mean)	shielded
Endovascular aneurysm repair	0.010 (mean)	unshielded
Urology	0.026 (mean)	unshielded
Orthopedic	0.05	unshielded
Hysterosalpingography	0.14 (mean)	unshielded
Endoscopic retrograde cholangiopancreatography	0.094 (mean) 0.55 (mean) 2.8 (maximum)	under-couch x-ray tube over-couch x-ray tube

It is evident from Table 1 that use of radiation shielding tools and optimised positioning of the x-ray tube could substantially reduce the radiation doses to the workers' eye lens.

Radiation Protection Measures

a) Time, distance and shielding

Time, distance and shielding are three major considerations in optimising radiation protection measures. As regards time, radiation exposure could be reduced by minimising the duration on operating the x-ray machines or radioactive sources. Using pulsed fluoroscopy, minimising fluoroscopy time and making good use of the freeze fluoroscopy image are effective means to reduce exposure time.

Intensity of radiation falls off rapidly with distance according to the inverse square law. An example of good practice is to position the x-ray tube below the table as far away from the patient as possible and to position oneself as far away as clinically possible from the x-ray tube and patient.

Provision of shielding tools is also a highly effective means to reduce eye lens radiation exposure. For those concerned medical x-ray procedures (like interventional or fluoroscopy procedures), ceiling suspended shielding screens could be installed at the x-ray machines so as to attenuate the scattered radiation to the workers from the patients. Other personal protective equipment such as leaded glasses could also be used for reducing the workers' eye lens exposures. According to the IAEA[2], the use of leaded glasses alone reduced the lens dose rate by a factor of 5 to 10; scatter-shielding screens alone reduced the dose rate by a factor of 5 to 25. Use of both simultaneously is even more efficient than either used alone, reducing the dose rate by a factor of 25 or more.

(Ceiling-suspended leaded glass, Image from Australian Radiation Protection and Nuclear Safety Agency)

b) Administrative control

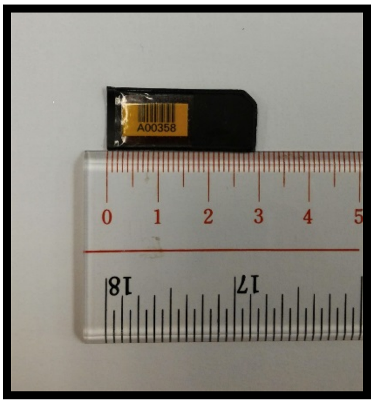
Effective operational procedures and restrictions on minimising eye lens radiation exposures should also be established. They should be expressed

[2]https://rpop.iaea.org/RPOP/RPoP/Content/InformationFor/HealthProfessionals/6_OtherClinicalSpecialities/radiation-cataract/Radiation-and_cataract.htm

in clear written local rules and procedures. Controlled areas in which specific measures for protection and safety are required should be adequately designated. All these administrative controls should be well communicated to the concerned workers. Suitable training should also be conducted in order to maintain workers' awareness on radiation protection for the lens of the eye.

c) <u>How to monitor eye lens dose</u>

The operational quantity $H_p(3)$ (known as personal dose equivalent at 3 mm depth of tissue), is the most appropriate quantity for measuring eye lens dose. However, this quantity is not commonly in use and dosimeters measuring $H_p(3)$ are not commonly available. However, personal dosimeters designed for measuring the superficial radiation dose $H_p(0.07)$ are able to sufficiently well estimate the eye lens dose in many cases. Some of these dosimeters, which are small and light, can be placed near the eyes or at the forehead of the workers. These dosimeters serve well to monitor the radiation doses received by workers and are means to ascertain whether their eye lens radiation exposures are reduced to levels as low as reasonably achievable and comply with the revised ICRP's occupational eye lens dose limit.



(Personal radiation dosimeter that can be used for eye lens dose monitoring.)

More Information

Further information about this fact sheet can be obtained from:

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October 2019