

## Diseases caused by ionizing radiation

### Definition of causal agent

Charged corpuscular radiation (alpha and beta particles) is the cause of internal irradiation (e.g. inhalation of radon). Neutral corpuscular radiation (neutrons) or electromagnetic radiation (X- or gamma-rays) is dangerous in terms of external irradiation.

Sources of exposure and main occupational uses:  
X-ray machines, particle accelerators, gamma radiography sources, cobalt bombs, nuclear reactors, laboratory equipment, work involving isotopes, uranium mines.

### Adverse effects

#### *I. Non-random (non-stochastic) effects*

##### Acute effects:

These are early effects which depend on the dose and the dose rate.

#### I. Whole body irradiation

##### **Medullar aplasia**

With initial lymphopenia and chromosomal aberrations.

##### ***Exposure criteria:***

*Minimum intensity of exposure:* Occupational exposure assessed by:

History and study of working conditions providing evidence of external whole-body irradiation in excess of 1 Gray for X-ray or gamma-ray irradiation and 0.3 Gray for neutrons.

*Minimum duration of exposure:* A few minutes.

*Maximum latent period:* Two months.

#### II. II. Partial-body irradiation

##### **Acute radio-epidermatitis**

Exudative lesions developing approximately three weeks after transient erythema, with necrosis as a possible complication.

##### ***Exposure criteria:***

*Minimum intensity of exposure:* Occupational exposure assessed by:

History and study of working conditions providing evidence of external X-ray or gamma-ray irradiation in excess of 10 Gray.

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*Minimum duration of exposure:* A few minutes.

*Maximum latent period:* Two months.

## **Alopecia**

Temporary hair loss after localized irradiation of the scalp.

### ***Exposure criteria:***

*Minimum intensity of exposure:* Occupational exposure assessed by: History and study of working conditions providing evidence of external X-ray or gamma-ray irradiation in excess of 3 Gray.

*Minimum duration of exposure:* A few minutes.

*Maximum latent period:* Two months.

*Minimum induction period:* 15 days.

## **Oligospermia and azoospermia**

### ***Exposure criteria:***

*Minimum intensity of exposure:* Occupational exposure assessed by: History and study of working conditions providing evidence of external X-ray or gamma-ray irradiation in excess of 0.3 Gray.

*Minimum duration of exposure:* A few minutes.

*Maximum latent period:* Two months.

## **□ Delayed effects**

These appear some time after irradiation, whether this has been brief or prolonged.

### **Cataract**

Crystalline opacities in the lens.

### ***Exposure criteria:***

*Minimum intensity of exposure:* Occupational exposure assessed by: History and study of working conditions providing evidence of external irradiation involving cumulative doses to the eye exceeding 10 Gray for X-rays and 8 Sv for neutrons (0.8 Gy).

*Minimum duration of exposure:* Can be brief.

*Maximum latent period:* Five years.

*Minimum induction period:* One year.

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## Chronic radiodermatitis

Atrophy, hyperkeratosis or telangiectasia, possibly complicated by radionecrosis.

### ***Exposure criteria:***

*Minimum intensity of exposure:* Occupational exposure assessed by:

History and study of working conditions providing evidence of repeated external irradiation in excess of 5 mGy/day. Total skin dose > 10Gy.

*Minimum duration of exposure:* six month.

*Maximum latent period:* Five years.

## **☐ Effects on reproduction and teratogenesis**

Ionizing radiation is mutagenic to germ cells

In certain accidental circumstances, exposure of a pregnant woman radiation can cause foetal deformities depending on dose received by the foetus and the age of the foetus at the time of irradiation.

## Cerebral deformities (e.g. mikrocephalus) and skeletal deformities

### ***Exposure criteria:***

*Minimum intensity of exposure:* Occupational exposure assessed by:

History and study of working conditions providing evidence of brief X-ray irradiation of the foetus in excess of 0.3 Gy during the period of organogenesis.

## **Mental retardation**

### ***Exposure criteria:***

*Minimum intensity of exposure:* Occupational exposure assessed by:

History and study of working conditions providing evidence of brief X-ray irradiation of the foetus in excess of 0.5 Gy beyond the eighth week of intra-uterine life.

## ***2. Random (stochastic) effects***

These are delayed effects arising after brief or prolonged irradiation as cutaneous spinocellular epithelioma, leukaemia, primary cancer of the lung, osteosarcoma. There is a causative correlation between the working in uranium mines and the increased incidence of lung cancer.

*Minimum intensity:* cumulative X-ray dose to the skin in excess of 15 Gy for cutaneous spinocellular epithelioma, cumulative dose in excess of 1 Sv for leukaemia und primary carcinoma of the lung and cumulative dose of the skeleton in excess of 8 Gy for osteosarcoma. For workers in uranium mines with an exposure of 200 WLM (Working Level Month, energy of the alpha radiation multiplied by the number of working month) or more, there is an adequate probability for

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occupational induced lung cancer. In individual cases, an exposure of 50 WLM or less can be sufficient. The individual risk can be estimated according to the model of Jacobi.

*Minimum induction period:* 10 years for the cutaneous spinocellular epithelioma, three years for leukaemia and five years for primary cancer of the lung and osteosarcoma.

See section on **Occupational cancers** in the **Preface**.

Some isotopes present a particular affinity for specific organs (for example: iodine for the thyroid gland). Increased exposure to cosmic radiation during flights has been proposed as a potential occupational risk factor and there is ongoing discussion on the aetiology of the increased risks for breast cancer (females) and malignant melanoma in pilots and flight attendants.