

Effects of Ionising Radiation on Diseases of the Circulatory System and their  
Consideration in the System of Radiological Protection

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In the 10th revision of the International Classification of Diseases (ICD 10), diseases of the circulatory system (DCS; class IX) include different groups of conditions damaging heart and blood vessels: rheumatic heart diseases, hypertension, ischemic heart disease (IHD), cerebrovascular diseases (CeVD), diseases of arteries and veins and others. DCS are the main cause of death (30–50%) in many developed and developing countries. IHD is one of the main causes of death worldwide being a leader in lost life year rates. CeVD hold the second position in the mortality structure and are acknowledged as the leading cause of permanent disability.

To date, numerous risk factors have been found to contribute to DCS development. These include non-modifiable biological factors (sex, age, genetic background) and modifiable factors (lifestyle and nutrition, metabolic and physiological parameters, environmental factors).

Earlier, the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) and the International Commission on Radiological Protection (ICRP) published reports in which they provided evaluations of ionizing radiation effects on the risk of DCS. The UNSCEAR 1993 Report concluded that fractionated high doses from radiotherapy for the treatment of intrathoracic malignancies cause damage to the heart and blood vessels (e.g., carotid and coronary arteries) in humans and induce an increase of DCS incidence and mortality one or two decades after exposure. The UNSCEAR 2006 Report stated that there was clear evidence for increased risks of DCS following heart irradiation at high therapeutic doses but the association of DCS mortality from radiation exposure at doses below 2.0 Gy was provided only for the Japanese cohort of the atomic bomb survivors. It was underlined that the evidence was insufficient to infer on the impact of 1–2 Gy exposure on the circulatory system.

ICRP Publication 118 (2012) classified DCS as tissue reactions, with a suggested approximate threshold for acute and fractionated/prolonged exposures of 0.5 Gy (absorbed dose to the brain and heart) to be used for radiological protection purposes.

Evidence for increased risks of incidence and mortality from DCS and specific diseases following radiation exposure at various levels of lower doses and dose rates (e.g., at atomic bombings of Hiroshima and Nagasaki, nuclear accidents, occupational exposures, diagnostic exposures) has accumulated over the recent decade.

However, many authors acknowledged that uncertainties relating to the shape of the dose-response, dose threshold (if there is one), and contribution of other DCS risk factors, that are inherent in the low dose region, are considerable. Also, the classification of DCS in the category of “tissue reactions” is controversial. It should be noted that despite the lack of fundamental knowledge on mechanisms of

radiation-related DCS for exposures at low doses, efforts are being made to give insights into the associated underlying biological events.

As the baseline rates of incidence/mortality for DCS are high, the impact of taking them into account in estimating the lifetime risk from radiation exposure would be significant, even if the current estimates of radiation-induced relative risks for DCS appear to be lower than those estimated for cancer.

The ICRP launched in 2021 a task group (TG119) on the ‘Effects of Ionising Radiation on Diseases of the Circulatory System (DCS) and their Consideration in the System of Radiological Protection’.

The objectives of TG119 are:

- to review the recent scientific literature related to radio-epidemiological and radiobiological studies of DCS taking into consideration current activities of relevant international organizations;
- to provide advice on radiation dose response for DCS, including whether there is a threshold;
- to provide advice on the dose-rate dependence and radiation quality-dependence of DCS risk and;
- to provide advice on how to reflect current knowledge of radiogenic DCS in the system of radiological protection.

To achieve main objectives, TG119 will:

- perform a comprehensive review of the recent scientific literature reporting findings of epidemiological studies of DCS incidence and mortality, including those investigating the shape of the dose-response relationship for DCS and certain sub-types, assessing risk modification by the main known non-radiation factors for DCS, as well as the results of radiobiological investigations of potential mechanisms of DCS following radiation exposure at low doses. The existence of a causal link between radiation and DCS risk will be assessed;
- use a review of the literature to refine the identification of target organs and - if pertinent - sub-areas of those target organs for radiation-induced DCS which will inform on the organ absorbed radiation dose to be considered in DCS risk analyses;
- examine how the available information relate to the current classifications of DCS either as tissue reactions or as stochastic effects, suggest alternatives as may be appropriate, and identify gaps in knowledge; and
- determine if it might be appropriate to include DCS in the calculation of radiation detriment and assess the feasibility to do so using appropriate risk models.

TG119 activities will be performed in close collaboration with the UNSCEAR Expert Group on DCS from radiation exposure.

TG119 will prepare a report for publication in the Annals of the ICRP that gives a review of literature data on ionizing radiation effects on DCS incidence and mortality and provides advice on how best to manage the DCS risk for radiological protection purposes.

## REFERENCES

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3. ICRP, 2012 ICRP Statement on Tissue Reactions / Early and Late Effects of Radiation in Normal Tissues and Organs – Threshold Doses for Tissue Reactions in a Radiation Protection Context. ICRP Publication 118. Ann. ICRP 41(1/2).