

Commentary

How to cope with radiation accidents: the medical management

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Abstract. A concerted action, termed METREPOL, was accepted by the Commission of the European Communities and was started in December 1997. Its purpose was to develop a new approach to the medical management of radiation accident victims with respect to diagnostic procedures and therapeutic options, based on recognition and evaluation of health impairments after acute radiation exposure. The result of this interdisciplinary project is a manual entitled “Medical management of radiation accidents: manual on the acute radiation syndrome”. The manual compiles recommendations for assessing the state and outcome of a radiation accident victim in the shortest possible time. Furthermore, it provides guiding support for the medical management of patients accidentally exposed to ionising radiation, based on a new strategic approach for the diagnosis of the acute radiation syndrome: the response category concept. This commentary outlines the background for the development of such a manual and the realisation of the response category concept.

Approximately 135 radiation accidents occurring in the nuclear industry, research establishments and medical facilities were recorded by the International Atomic Energy Agency between 1945 and 1997, with more than 750 persons receiving significant exposure of more than 0.25 Sv to the whole body, blood-forming organs or other critical organs. In some cases an acute or chronic radiation exposure syndrome occurred [1].

Experience during the last few years has shown that accidental radiation exposures generally occur under particular circumstances, *i.e.* loss of sealed γ -radiation sources, radiation sources found and opened in scrap yards, careless use of industrial or medical radiation facilities etc. However, such accidents are still relatively rare. Thus, whenever medical doctors are confronted with the health consequences of such unexpected radiation exposures they may be unable to offer professional help owing to a lack of sufficient expertise.

Therefore, the European Commission initiated a research and training programme within the Fourth Framework Programme (1994–1998) in the field of nuclear safety, with the main objective of developing a new global and dynamic approach to nuclear safety issues and safeguards [2, 3]. Several lines of action were pursued in these programmes, such as reactor safety, reactor waste

management, disposal and decommissioning, and the mastering of past events. Biomedical consequences of radiation exposure were considered in projects such as “New approaches to diagnosis and treatment of individuals exposed accidentally to ionising radiation”. Within this context, a “concerted action” was launched to establish a “state of the art consensus” in the field of diagnosis and treatment of acute radiation syndrome. The main purpose of this action, entitled “Medical treatment protocols for radiation accident victims as a basis for a computerised guidance system” (METREPOL), was to develop an internationally acceptable concept for the clinical and scientific assessment of the health impairments in radiation accident victims as a basis for performing the necessary therapeutic actions. Expert groups from Rotterdam (The Netherlands), Oxford (UK), Paris (France) and Ulm (Germany) participated; 14 experts from European countries and the United States served as reviewers.

Dose estimates

In the past, assessment and reconstruction of radiation dose has often been used as the key parameter for medical decision-making and determining a patient’s prognosis after a radiation accident. The rationale for this approach was derived from experimental studies in pre-clinical models. It is well established that there is a characteristic dose–response survival curve if experimental animals are subjected to a

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homogeneous whole body exposure. However, such a homogeneous exposure of human beings is rarely if ever observed in radiation accidents. The quality and quantity of ionising radiation, and therefore the dose distribution as well as the dose rate, is initially not known and cannot easily be determined with enough accuracy to assist in the early clinical management of patients.

The new approach

In the forthcoming manual, entitled "Medical management of radiation accidents: manual on the acute radiation syndrome" (to be published by the British Institute of Radiology in 2001), a new strategic approach to the diagnosis of the acute radiation syndrome (ARS) is proposed: the response category (RC) concept. The approach focuses on an integrative quantification of the radiation-induced impairments to the organism. Hence, it does not rely on either physical or biological estimates of radiation dose. The aim is to assess damage to critical organ systems as a function of time using indicators of effect, *i.e.* observable clinical signs and symptoms. In any radiation accident situation it is of major importance to assess the severity of effects within the first 3–6 days in order to select the most appropriate options for therapy and to prepare and mobilise the necessary resources. During this early phase after accidental exposure, specific signs and symptoms can be used to assess the severity of effect, to predict the possible clinical course of the patient and to assign a patient to one of four "response categories".

Based on knowledge and experience gained from previous radiation accidents, the following four organ systems were considered to be of critical significance for the development of the ARS: neurovascular, hematopoietic, cutaneous and gastrointestinal systems. In total, 27 different clinically observable signs and symptoms are used as indicators of effect. The degree of severity of impairment is described by (semi-)quantitative criteria, rating each symptom with a severity index of 1–4. Thus, it is possible to derive an organ-specific grading that describes the effects and the probability of repair at a given time point after accidental exposure. Combining the organ-specific gradings, a corresponding grading code can be determined, giving a weighted description of the major radiation-induced clinical problem areas. This grading code is then translated into a response category, which can be used as a basis for decision-making in medical management as it assigns patients to different therapeutic and

institutional levels of care. It also facilitates comparison of intraindividual and interindividual data on a national as well as an international level.

Conclusions

The RC concept, which is described extensively in the "Manual on the acute radiation syndrome", is a way of assessing the state and outcome of a radiation accident victim in the shortest possible time (*i.e.* hours after the accident). This new approach was developed based on current scientific and pathophysiological knowledge in radiation medicine. Within the forthcoming manual, practical tools for the medical management of patients accidentally exposed to ionising radiation are also provided.

It is hoped that this manual will make a useful contribution to the management, harmonisation and standardisation of diagnosis and therapy of future radiation accident victims. It is also hoped that an international standard for scientific evaluation of health impairments of radiation accident victims is promoted.

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