

Computer assisted severity of effect assessment of hematopoietic cell renewal after radiation exposure based on mathematical models

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Abstract

After accidental radiation exposure one of the most dangerous health impairments is the partial or complete failure of the blood forming system. Depending on the degree of damage a suitable therapy must be prepared in time. In severe cases this may involve the transplantation of stem cells. The key question of treatment is to assess the degree of damage of the blood forming system. Since there exists no simple diagnostic method, a new approach for prognosis based on reaction patterns of granulocyte, platelet and lymphocyte counts in the peripheral blood during the first days after radiation exposure is suggested, since these patterns reflect the extent of damage of the stem and precursor cell compartments.

Mathematical compartment models of human blood cell renewal of the three lineages were used to characterize the observed reaction patterns of individual radiation exposed patients in the form of numerical values. These values in connection with medical expert assessed clinical data collected in the database Search were used by automatic classification methods to train a supervised learning system.

The trained system provides a possibility for computer based support for medical decision making by assigning a new and unknown patient to a particular “severity of effect” group (described by the METREPOL concept) using only peripheral blood counts and their times of sampling.

The METREPOL concept distinguishes between four clinically related severity of effect groups of hematopoietic impairment (such as reversible and irreversible damage of the stem cell pool) as discussed in the “Manual on the Acute Radiation Syndrome” [1].

The model based mathematical method described in this paper is up to now able to assign a “new case” into the appropriate “severity of effect” group with a probability of 81% within 5 days after exposure. It seems to be possible in future to improve the method regarding the observation time necessary for assignment and the accuracy of prediction by further development of the mathematical approaches and the extension of the set of clinical data used for training.

1 | Fliedner, T.M., ed; Friesecke, I., ed; Beyrer, K., ed.: Medical management of radiation accidents. The British Institute of Radiology (BIR); 2001. 66