MATHEMATICAL MODELS OF THE DYNAMICS OF MAJOR HEMATOPOIETIC LINEAGES IN ACUTELY AND CHRONICALLY IRRADIATED HUMANS

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Biologically motivated mathematical models, which describe the dynamics of the major hematopoietic lineages (the thrombocytopoietic, lymphocytopoietic, granulocytopoietic, and erythropoietic systems) in acutely/chronically irradiated humans are developed. These models are implemented as systems of nonlinear differential equations, which variables and constant parameters have clear biological meaning. It is shown that the developed models are capable of reproducing clinical data on the dynamics of these systems in humans exposed to acute radiation in the result of incidents and accidents, as well as in humans exposed to low-level chronic radiation. Moreover, the averaged value of the "lethal" dose rates of chronic irradiation evaluated within models of these four major hematopoietic lineages coincides with the real minimal dose rate of lethal chronic irradiation. The demonstrated ability of the models of the human thrombocytopoietic, lymphocytopoietic, granulocytopoietic, and erythropoietic systems to predict the dynamical response of these systems to acute/chronic irradiation in wide ranges of doses and dose rates implies that these mathematical models form an universal tool for the investigation and prediction of the dynamics of the major human hematopoietic lineages for a vast pattern of irradiation scenarios. In particular, these models could be applied for the radiation risk assessment for health of astronauts exposed to space radiation during long-term space missions, such as voyages to Mars or Lunar colonies, as well as for health of people exposed to acute/chronic irradiation due to environmental radiological events.

References.

1. Smirnova O.A. Environmental Radiation Effects on Mammals: A Dynamical Modeling Approach. – NY: Springer, 2011. 214 pages.
2. Smirnova O.A. Modeling study of radiation effects on thrombocytopoietic and granulocytopoietic systems in humans // Advances in Space Research Vol. 48, Year 2011. Pp. 184-198.
3. Smirnova O.A. Comparative analysis of the dynamics of thrombocytopoietic, granulocytopoietic, and erythropoietic systems in irradiated humans: A modeling approach // Health Physics Vol. 103, Year 2012. Pp. 787-801.
4. Smirnova O.A., Hu S., and Cucinotta F.A. Analysis of the Lymphocytopoiesis Dynamics in Nonirradiated and Irradiated Humans: A Modeling Approach // Radiation Research Vol. 181, Year 2014. Pp. 240-250.