Contribution ID: **2019** Type: **Oral**

Comparison of models of neural stem cell heterogeneity for radiation research

Friday 31 October 2025 14:00 (20 minutes)

Radiation-induced impairments in memory and learning are associated to the death of neural stem cells (NSCs) in the dentate gyrus of the hippocampus [1, 2]. Three types of NSCs have been identified distinguished by their self-renewal rates: active cells, long-term self-renewing cells, and resting cells [3]. Additionally, has been established the coexistence of three NSC types —alpha, beta, and omega, which differ in morphological characteristics, proliferative activity, and response to external stimuli [4, 5]. Differences in the sensitivity of various NSC types to radiation may determine the extent of radiation-induced impairments in the hippocampus.

Previously, we proposed a model describing the dynamics of NSCs with varying self-renewal rates [6]. In this study, we focused on modeling the morphological heterogeneity of NSCs. We developed a model describing the dynamics of alpha and beta NSCs in response to irradiation. The modeling results were compared with models of homogeneous and heterogeneous NSC populations after irradiation with iron particles. Models according to populations of long-term self-renewing and resting cells demonstrated the highest accuracy. Further development of models that account for the effects of radiation on different NSC types may facilitate a more precise assessment of the risks of memory and learning impairments after irradiation.

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Session Classification: Radiation research in Life Science

Track Classification: Radiation Research in Life Science