Non-Targeted Effects of Radiation: the Use of Computer Model

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The data on the effects of low doses of radiation on the organism were originally extrapolated from the study of survivors of the atomic bombs in Japan and the accident of the nuclear central of Chernobyl. The linear non-threshold model was used, on the assumption that those effects would linearly decrease with dose, and that the radiation primarily affected the DNA. However, new techniques appeared in the late 80's that allowed biologists to directly measure the effects of low doses of radiation of different qualities on cells. It was discovered that radiation effects in the low dose domain were not linear neither was DNA the main target: those effects were termed the non-targeted effects and include the bystander effect, the low dose hyper radio-sensitivity, the genomic instability, the adaptive response and the inverse dose rate effect. The question has been raised on the link between those phenomena, but to our knowledge, no unified theory has been found yet. In our study, we propose a cellular automaton model of a population of cells reproducing the laboratory conditions, for testing assumptions on the mechanisms underlying the non-targeted effects. The population of cells is irradiated and colonies bigger than 50 cells after a period of growth are counted to determine the survival fraction of the population. We have been interested in testing whether the bystander effect could be responsible for the hyper radio-sensitivity. Cells receiving irradiation may produce a bystander signal, whose concentration decreases with time and which may kill cells in G2 phase of the cell cycle. The model has been run to simulate the response of a human glioblastoma cell line and a hamster lung cell line to 250keV X-rays, C_K X-rays and 3.2MeV protons. We show that it is possible that a bystander signal released by irradiated cells, and killing neighbours produce a hyper sensitivity of the population; the mechanisms of release of this signal are however different for different radiation qualities.