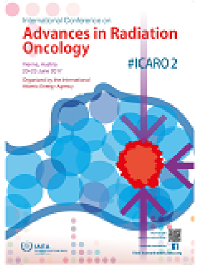

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Mathematical modeling and optimization of radiation therapy dose-time treatment scheme

Wednesday, 21 June 2017 10:45 (5 minutes)

Optimization of radiation therapy treatment scheme using mathematical modeling is one of the topical problems in modern radiation oncology. For these purposes formalized description of dynamic processes in clinical radiobiology is used.

Task of justification of radiotherapy dose fractionation schedules can be formulated in terms of the optimal control theory. For example, we fix a total radiation dose value D Gy and duration of radiation therapy treatment T. Then the optimization task can be formalized as follows: it is possible to reduce the number of survived cancer cells using radiotherapy dose fractionation schedule, provided that the total radiotherapy dose does not exceed D Gy and radiotherapy duration is T days.

Let consider the main biological assumptions used in mathematical models:
1. Cancer tumor consists both oxygenated and hypoxic cells. The volume of oxygenated fraction consisting of X cancer cells is Xoxygen/X=exp(-b·X), b=const.
2. The fraction of oxygenated cancer cells consists of cells in different phases of the cell cycle - G1, S, G2, M phases. Hypoxic cells are in G0 phase.
3. Conventional survival equations are used for description of radiation effects on tumor cells at different stages of the cell cycle G1, S, G2, M, G0. Cells in G0 phase are more resistant to radiation therapy.
4. Radiotherapy induces arrest of proliferative activity of tumor cells, which is proportionate to the radiation dose delivered.

With account of the above assumptions of mathematical models various scenarios of dose fractionation were examined. On figure 1 survival of cancer cells following delivery of equal-dose fractions (2 Gy/day) and nonuniform dose fractions (increasing fraction size up to 5 Gy/day) is presented. In both cases the total dose D is 50 Gy, the treatment period T is 5 weeks. It is seen that due to the use of dynamic fractionation of total radiation therapy dose the number of survived tumor cells can be reduced by a factor of 10 as compared to the original number (1010 cancer cells).

So, modern methods of mathematical and computer modeling in clinical radiobiology are effective tools for optimization of radiation therapy dose-time. treatment scheme.

Country

Russia

Institution

A. Tsyb Medical Radiological Research Centre, branch of the National Medical Research Radiological Centre of the Ministry of Health RF

Primary author: IVANOV, Victor (A. Tsyb Medical Radiological Research Centre - branch of the National Medical Research Radiological Centre of the Ministry of Health of the Russian Federation)

Co-authors: MENIAILO, Aleksandr (A. Tsyb Medical Radiological Research Centre - branch of the National Medical Research Radiological Centre of the Ministry of Health of the Russian Federation); KAPRIN, Andrey (National Medical Research Radiological Centre of the Ministry of Health of the Russian Federation); KASHCHEEV, Valeriy (A. Tsyb Medical Radiological Research Centre - branch of the National Medical Research Radiological Centre of the Ministry of Health of the Russian Federation); GALKIN, Vsevolod (A. Tsyb Medical Radiological Research Centre - branch of the National Medical Research Radiological Centre of the Ministry of Health of the Russian Federation); MARDYNSKY, Yuriy (A. Tsyb Medical Radiological Research Centre - branch of the National Medical Research Radiological Centre of the Ministry of Health of the Russian Federation)

Presenter: MENIAILO, Aleksandr (A. Tsyb Medical Radiological Research Centre - branch of the National Medical Research Radiological Centre of the Ministry of Health of the Russian Federation)

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