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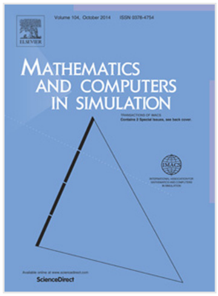

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A mechanistic model of high dose irradiation damage

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Abstract

The main goal of our study is to develop a realistic mechanistic model of the effect of ionizing radiation on DNA in mammalian cells. We consider a population of cells structured by the number of DNA double strand breaks due to radiation. Using the system of linear differential equation, the model describes the evolution of the irradiated population of cells in time. The work is in three parts. First, we consider the effect of a single dose of radiation, while in the second part we work on the model parameter estimation using Nelder-Mead simplex algorithm which allows us to relate the clinically useful parameters of the LQ relation to aspects of cellular activity that can be manipulated experimentally. In the third part, we deal with cell killing effects of fractioned doses of radiation. Using MATLAB, we observed the cell survival fractions can be well approximated by the Linear-Quadratic relation and also show fewer cell will die if the dose is fractionated in two or more fractions.

Keywords: Low LET radiation; LQ relation; survival curves; dose fractionation; structured population theory; parameter estimation; Nelder-Mead simplex.
2000 MSC: 34A30; 92C45; 92C50

1. Introduction

It is vitally important to be able to account for the effects of radiation on living tissues. Such a need arises in many contexts, for example in radiation protection legislation which demands a profound understanding of the influ-