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Summary: The tumor control probability (TCP) is a metric used to calculate the probability of controlling or eradicating tumors through radiotherapy. Cancer cells vary in their response to radiation, and although many factors are involved, the tumor microenvironment is a crucial one that determines radiation efficacy. The tumor microenvironment plays a significant role in cancer initiation and propagation, as well as in treatment outcome. We have developed stochastic formulations to study the impact of arbitrary microenvironmental fluctuations on TCP and extinction probability (EP), which is defined as the probability of cancer cells removal in the absence of treatment. Since the derivation of analytical solutions are not possible for complicated cases, we employ a modified Gillespie algorithm to analyze TCP and EP, considering the random variations in cellular proliferation and death rates. Our results show that increasing the standard deviation in kinetic rates initially enhances the probability of tumor eradication. However, if the EP does not reach a probability of 1, the increase in the standard deviation subsequently has a negative impact on probability of cancer cells removal, decreasing the EP over time. The greatest effect on EP has been observed when both birth and death rates are being randomly modified and are anticorrelated. In addition, similar results are observed for TCP, where radiotherapy is included, indicating that increasing the standard deviation in kinetic rates at first enhances the probability of tumor eradication. But, it has a negative impact on treatment effectiveness if the TCP does not reach a probability of 1.

MSC:

92C50 Medical applications (general)

Keywords:

stochastic model; Gillespie algorithm; tumor control probability; random fluctuations

Full Text: DOI

References:


