Optimal control of treatment in a mathematical model of neuroblastoma dynamics

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Neuroblastoma, an embryonal tumor of the autonomic nervous system, primarily affects young children. Currently, various cancer therapies are available, including radiotherapy, cytotoxic chemotherapy, and targeted therapies. Among these, targeted therapies, such as oncolytic viruses, specifically target processes exclusive to tumor cells, infecting and lysing them while sparing healthy cells. Additionally, oncolytic virus therapy triggers both innate and adaptive immune responses. In this study, we develop a mathematical model of neuroblastoma dynamics to explain the complicated interaction between cancer progression, the immune system, and adenoviruses. Specifically, we focus on Celyvir, an innovative therapeutic approach encompassing mesenchymal stem cells containing the oncolytic virus ICOVIR 5. To understand the dynamics of the model and its response to treatment, we formulate an optimal control problem with a nonlinear objective functional. Our therapeutic goal is not only to minimize tumor cell population and treatment costs but also to prevent the tumor from reaching a critical size. We show that employing a periodic bang-bang control strategy optimizes Celyvir treatment efficacy.

References

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