Mathematical model of neuroblastoma dynamics and optimization of its treatment

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José García Otero [1], Mariusz Bodzioch[2], Juan Belmonte Beitia[3]

[1]Mathematical Oncology Laboratory (MOLAB),
University of Castilla-La Mancha, Ciudad Real, Spain
jose.garciaotero@uclm.es

[2]Faculty of Mathematics and Computer Science,
University of Warmia and Mazury in Olsztyn, Poland
mariusz.bodzioch@matman.uwm.edu.pl

[3]Mathematical Oncology Laboratory (MOLAB),
University of Castilla-La Mancha, Ciudad Real, Spain
juan.belmonte@uclm.es

Neuroblastoma is an embryonal tumor of the autonomic nervous system that usually occurs in young children. Today, there are many different types of cancer therapies available. The most commonly used are radiotherapy or cytotoxic chemotherapy. Another type of therapy are targeted therapies. Targeted therapies, such as oncolytic viruses, are techniques aimed at specific processes carried out exclusively by tumor cells. Oncolytic viruses infect and lyse tumor cells, leaving healthy cells intact. Moreover, oncolytic virus therapy intrinsically leads to both innate and adaptive responses. In this study, we formulate a mathematical model of neuroblastoma dynamics, which attempts to capture the fundamental relationships between cancer, the immune system, and adenoviruses. We focus on a specific type of oncolytic virotherapy, Celyvir, which is an advanced therapy medicine consisting of mesenchymal stem cells containing the oncolytic virus ICOVIR 5. To gain insight into the model dynamics and its response to treatment, we formulate an optimal control problem with a non-linear objective functional. The therapeutic goal is not only to minimize the size of the tumor cell population and the total cost of treatment but also to prevent the tumor from reaching a critical size. We show that a periodic bang-bang regime should be used to optimize treatment with Celyvir.

Keywords: mathematical model, neuroblastoma, oncolytic virus, Celyvir, optimal control

MSC2020: 92B05, 92F05, 34C25, 49J30

References

[1] J. García Otero, M. Bodzioch, J. Belmonte-Beitia J., On the Dynamics and Optimal Control of a Mathematical Model of Neuroblastoma and its Treatment: Insights from a Mathematical Model, *Mathematical Models and Methods in Applied Sciences*, 2024.