Modeling Tumor and Cancer Stem Cells in the Presence of TGF-β Treatment, Cancer Immunotherapy in Form of CAR-T, and Effector Cells

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ABSTRACT

In this work, we study a model for capturing cancer stem cells and tumor cells population in the presence of Transforming Growth Factor-Beta (TGF-β) treatment, cancer immunotherapy treatments in form of Chimeric Antigen Receptor (CAR-T) cells, and effector cells. The purpose of the combination therapy is so that the cancer cells do not become resistant to treatment due to their treatment adaptability. The cancer stem cells are a subpopulation of cancer cells that cause the proliferation of the tumor cells. The tumor cells on the other hand, are assumed to be the normal cancer cells. The CAR-T therapy uses immune cells called T cells that are genetically altered in a lab for locating and destroying cancer cells more effectively. The TGF-β cells, which are either tumor promoter or suppressor, are multifunctional cytokine that acts in a cell. The Regulatory T-cells regulate the immune system and stop it from going into overdrive. The model discussed here is made up of a system of differential equations capturing the populations: tumor stem cells (T), cancer stem cells (S), CAR-T cells (E) and (C) targeting the tumor and cancer stem cells, respectively, the TGF-β cells (B), and the T-cells (R). The tumor and cancer stem cells are assumed to have a logistic-like model, a model well known for capturing population counts. The parameters in the model are estimated using the Least-Square estimation scheme. The model is verified by applying it to capture lung cancer stem cells in mice.

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