Improving Contemporary Mathematical Models of Metastatic Cancer to Predict Optimal Treatment: Analyzing Glycolysis, Treatment, and PACC Quiescence

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Pancreatic metastatic cancer prompts the aggressive emergence of a subsect of cancer cells known as Poly-aneuploid Cancer Cells (PACCs) which sustain a state of dormancy called quiescence when confronted with stressors, rendering these cells immune to treatments. Contemporary mathematical models have investigated the effects of treatment on malignant cell populations, however, there is currently no common model which investigates the phenomenon of PACC quiescence, hindering the accuracy of contemporary models when predicting tumor volume. This study inserted the average initial conditions of 65 pancreatic metastatic tumors in vivo as parameter values obtained from Haeno et al.[13] into constructed models, one including and one omitting quiescent representations, solving for tumor volume after 20 days to quantify the alterations in end volume prediction accuracy in the model when incorporating quiescence. A Chi-Square test alongside percent error was used to quantify accuracy. The non-quiescent model posed a volume of 0.053 mm3 and a percent error of 22.5%, while the created quiescent model posed a more accurate volume and percent error of 0.026 mm3 and 7.46% compared to in vivo. Applications of this model inserted the concentration and observed reduction of cancer cell metabolism of three glycolysis inhibitors on tumors observed in Pajak et al.[19] to predict optimal treatment for a specific tumor in correlation with the relationships between treatment, stress, and quiescence. This study elicited that incorporating quiescence into models of metastatic cancer may heighten the accuracy of these models when predicting tumor volume for clinical use.

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