Mathematical Modeling of Metastatic Prostate Cancer

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Prostate cancer metastasis to the bone is predominantly lethal and results from the ability of successful metastatic prostate cancer cells to co-opt microenvironmental cells and processes involved in bone remodelling. Understanding how the interactions between tumour and stromal cells determine successful metastases and how metastatic tumours respond to treatment is an emergent process that is hard to asses biologically and thus can benefit from mathematical models. In this work a mathematical model of bone remodelling and the establishment of a prostate cancer metastasis in the bone using evolutionary game theory is described. The model mathematically recapitulates the current paradigm of a vicious cycle driving the tumor growth andt this model can be used to investigate the key interactions between the tumour and the bone stroma. Crucially, the model sheds light on the role that the interactions of heterogeneous tumour cells with the bone microenvironment have in the treatment of cancer. Furthermore, the model deviates from the standard binary perception of tumour heterogeneity in favor for a more realistic tumour variety and displays the interactions between these different tumour phenotypes. The results show that resistant populations naturally become dominant in the metastases under a number treatment schemes and that schedules designed by an evolutionary game theory approach could be used to better control the tumour and the associated bone growth than occurs under the current standard of care.