Can we Crack Cancer?

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The research story

Contemporary mathematical models of solid tumours constitute an invaluable complement to traditional cancer research [1]. Accordingly, we have developed an in silico framework (a computational framework), capable of simulating solid tumours under multiple conditions, emulating established clinical scenarios. Our framework is based on a mathematical model formulated by biological knowledge, medical experience, experimental observations and mathematical concepts. This tumour model is biologically detailed and mathematically rigorous as we account for the ever-changing tumour on multiple scales. Using our computational framework, multiple aspects of tumour dynamics can be studied, such as tumour growth, drug resistance and intercellular interactions [2]. Importantly, the model can also be used to simulate treatment responses to various combinations of anticancer therapies. These anticancer therapies include traditional treatment strategies such as chemotherapy and radiotherapy as well as novel, pre-clinical therapies currently in development. Simply put, our research premise is that if we can describe cancer using mathematics, then we can predict cancer using mathematics.

The image

The image demonstrates how oxygen levels vary amongst cancer cells in a simulated, cracked open tumour spheroid where the different colours correspond to various oxygen concentrations. Cells with high oxygen concentrations are displayed in warm colours such as yellow and red whilst cells with low oxygen concentrations are displayed in cold colours such as blue. In our simulations, each cell displays individual properties, such as oxygen concentration, that affect how the cell responds to anticancer therapies. The mathematical model is implemented in C++ and visualised using ParaView.

References

[1] Hamis S, Powathil GG, Chaplain MAJ, Blackboard to Bedside: A mathematical modeling bottom-up approach toward personalized cancer treatments, JCO Clin Cancer Inform 3:1–11, 2019.

[2] Hamis S, Nithiarasu P, Powathil GG. What does not kill a tumour may make it stronger: In silico insights into chemotherapeutic drug resistance, J. Theor. Biol. 454:253–267, 2018.

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