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How can mathematics help someone with Glioblastoma Multiforme?

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Glioblastoma Multiforme (GBM) is the deadliest and the most frequent brain tumour, only 5% of patients survive more than 5 years after being diagnosed. Patients go through emergency surgery and are being treated with both chemotherapy (Temozolomide) and radiotherapy. But those treatments still remain inefficient with that cancer because of the cellular heterogeneity.

In this work, the goal is to model and simulate the evolution of the tumorigenesis and the therapeutic response of the GBM. Multiple phenomena are modelled: tumour diffusion, chemotaxis, haptotaxis and reaction. They all correspond to biological systems: the cellular cycle, apoptosis, autophagia or angiogenesis.

The resulting model is a non-linear system with 4 equations and 4 unknowns:

$$\frac{\partial u}{\partial t} - \nabla.(\Lambda(x)a(u)\nabla u) + \nabla.(\Lambda(x)\chi(u)\nabla c) = \rho_1 u(1-u-u_e) - \beta_1 u - T(u) \quad \frac{\partial c}{\partial t} - \nabla.(D_2\nabla c) = \rho_2 u_e - \beta_2 c - \gamma_2 uc \quad \frac{\partial u_e}{\partial t} - \nabla.(\Lambda(x)a(u_e)\nabla \tag{1}$$

$To solve numerically the previous system on a MRI, a nonlinear Control Volume Finite Element scheme is used on a mesh fitting t$

Numerical simulations of this scheme have been done and the usual treatments (surgery, chemotherapy and radiotherapy) are used to understand the behaviour of the tumour-response to treatments.

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