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Estimating Patient-Specific Glioblastoma Multiforme Growth Dynamics

Glioblastoma multiforme (GBM) is a highly aggressive malignant brain tumor with a median survival of just over one year. As observed with MRI, it has a heterogeneous morphology, but typically contains an inner, necrotic core with an outer contrast-enhancing rim and often has extensive tumor-associated edema beyond that. Previous analyses have appeared to show edema as a prognostic indicator of patient survival, however there are many different parameters that may factor into overall survival rates. Given the grim prognosis, a better understanding of GBM growth is needed to help provide more effective therapy options.

Prof. Yang Kuang at Arizona State University has developed a mathematical model to estimate GBM progression. This model enables the determination of patient specific parameters such as cancer cell motility, proliferation and death rates by fitting an approximate wave profile to a tumor profile derived from patient MRIs. In this model the traveling wave speed is an indicator of how fast the cancer progresses and the wave solution shape can profile the cancer size and structure. Several test cases of MRI data of GBM patients were used to yield personalized parameterization of the model.

This novel model may enable personalized treatment design as well as determining drug dosages to ensure ideal penetration.

Potential Applications

- Estimating patient-specific GBM progression (cell proliferation, death and diffusion):
  - Personalized treatment design
  - Calculating ideal drug dosages
  - Treatment monitoring

Benefits and Advantages

- Takes into consideration necrotic/quiescent cells that are present in the

central core region of the glioblastoma as well as the proliferating cells that surrounding the necrotic radius

- Enables measurement of rate of cancer cell proliferation, death and diffusion from MR images acquired at a single time point

- Could help select drug dosages to ensure penetration through the proliferating rim

- Can estimate GBM growth from limited MRI data

o Improved estimates may be possible with multiple time point images

- Useful in monitoring the therapeutic effect of treatments

For more information about this opportunity, please see

Han et al - Math Biosci Eng - 2019

For more information about the inventor(s) and their research, please see

Dr. Kuang's departmental webpage