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Size Structured Model for Tissue Cyst Growth of *Toxoplasma gondii*

When a host becomes infected with *Toxoplasma gondii*, the host undergoes acute infection for several weeks. Once acute infection is complete, the parasites migrate mostly in the brain and some muscle tissue and reach a chronic steady-state of the number of cysts observed. The chronic steady-state is typically reached by 3 months after the initial infection. There are two competing phenomenon that control cyst growth during chronic infection. Parasites naturally replicate within a host cell, and thus the volume of the cyst increases as the parasites replicate. On the other hand, cysts can burst, which release parasites that are then free to infect healthy host cells, thereby restarting the cycle of cyst growth. This process of bursting is mediated by a natural bursting rate and by an immune response suppression of bursting. The two bursting factors, natural and immune response, are represented by a single function. By proposing a general cyst-size distribution model that takes into account different growth and bursting functions, a maximum likelihood approach to fit the model to the existing data is used.

This research carries three components: existing data analysis, hypothesizing various size-growth and bursting functions for tissue cysts, and model selection and validation. Existing data is analyzed by finding the appropriate time to quantify the dynamics of the cyst-size distribution as a steady-state through an appropriate mean-difference p-test. The size-growth functions that may be used to fit the data are of the following forms: constant, linear, or exponential. The possible bursting functions can be in the form of a linear, exponential, type II, or type III function. The above size-growth and bursting functions are analyzed within a time-size partial differential equation at steady state to find the best match to the available cyst-size distribution data.

The results of the model analysis show that by using the AIC as a criteria for suggesting good and bad fits of the growth and bursting functions in the size-growth model, it is possible to show that the growth and bursting functions are best described by one of several cases. The best cases appear to have a nearly constant (i.e. constant or exponential with a very slight decrease from the initial value over the range of observable data) size-growth rate function combined with a type II or type III bursting function. This suggests that over the typical observable range of sizes, the size growth function that best describes the data is nearly constant and the bursting function that best describes the data is a type II or type III response function. The function with the best AIC is a type III bursting function that is slowest of the three type III cases (when paired with the three size growth functions) in reaching the asymptote of the predicted magnitude.