

Modeling HIV Immune Response and Validation with Clinical Data

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Abstract

A system of ordinary differential equations is formulated to describe the pathogenesis of HIV infection, wherein certain features that have been shown to be important by recent experimental research are incorporated in the model. These include the role of CD4+ memory cells that serve as a major reservoir of latently infected cells, a critical role for T-helper cells in the generation of CD8 memory cells capable of efficient recall response, and stimulation by antigens other than HIV. A stability analysis illustrates the capability of this model in admitting multiple *locally asymptotically stable* (locally a.s.) off-treatment equilibria. We show that this more biologically-detailed model can exhibit the phenomenon of transient viremia experienced by some patients on therapy with viral load levels suppressed below the detection limit. We also show that the loss of CD4+ T-cell help in the generation of CD8+ memory cells leads to larger peak values for the viral load during transient viremia. Censored clinical data is used to obtain parameter estimates. We demonstrate that using a reduced set of 16 free parameters, obtained by fixing some parameters at their population averages, the model provides reasonable fits to the patient data and, moreover, that it exhibits good predictive capability. We further show that parameter values obtained for most clinical patients do not admit multiple locally a.s. off-treatment equilibria. This suggests that treatment to move from a high viral load equilibrium state to an equilibrium state with a lower (or zero) viral load is not possible for these patients.

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