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Within-host virus model with age-structure in the infected cell compartment

Age-since-infection structure is added to the infected cell compartment of a standard within-host virus model in order to account for heterogeneity in the infected cell life cycle. We provide a global analysis of the model. The analysis is complicated by the fact that the underlying state space for the model is infinite dimensional. We formulate the model as a Volterra integro-differential equation coupled with an ODE and study the nonlinear semigroup generated by the family of solutions. The basic reproduction number, R_0 , is calculated. When $R_0 < 1$, the infection-free equilibrium is globally asymptotically stable. The semigroup is found to be asymptotically smooth, which allows us to establish uniform persistence when $R_0 > 1$. A Lyapunov functional is then utilized in order to prove global stability of the unique positive equilibrium in the case of $R_0 > 1$. As an application of the model, we provide insight into recent experimental results pertaining to the $CD8^+$ immune response in HIV infected individuals.