Dynamics of an Intra-host Diffusive Pathogen Infection Model

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Abstract

In this paper, we first propose a diffusive pathogen infection model with general incidence rate which incorporates cell-to-cell transmission. By applying the theory of monotone dynamical systems, we prove that the model admits the global threshold dynamics in terms of the basic reproduction number R_0, which is defined by the spectral radius of the next generation operator. Then, we derive a discrete counterpart of the continuous model by nonstandard finite difference scheme. The results show that the discrete model preserves the positivity and boundedness of solutions in order to ensure the well-posedness of the problem. Moreover, this method preserves all equilibria of the original continuous model. By constructing appropriate Lyapunov functionals for both models, we show that the global threshold dynamics is completely determined by the basic reproduction number. Further, with the help of sensitivity analysis we also have identified the most sensitive parameters which effectively contribute to change the disease dynamics. Finally, we conclude the paper by an example and numerical simulations to improve and generalize some known results.

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