Analysis of a Hepatitis C Virus Infection Model with Interval Drug Effectiveness and Target Cells

Z. Dadi
Department of Mathematics, Faculty of Basic Sciences, University of Bojnord, Bojnord, 9453155111, Iran
dadizohreh@gmail.com; z.dadi@ub.ac.ir

Abstract: One of the assumption in simple models of therapy for infection diseases such as human immunodeficiency virus (HIV), hepatitis B virus (HBV) or hepatitis C virus (HCV) is that the drug has a constant effectiveness. It is clear that the drug concentration or the drug effectiveness varies over time and it is important to investigate dynamical behaviors of these models. In [1], a general varying-effectiveness differential equation model is studied in the context of HCV infection. In this model, they considered two variables as infected cells and viral load. They showed that this model can be transformed into a Bessel equation. Then they obtained an analytic solution. In this model, the effectiveness of therapy is assumed as a bounded function, $0 \leq \varepsilon(t) \leq 1$. They showed that the HCV model with time-varying effectiveness can be solved explicitly in terms of modified Bessel functions. Also, they assumed that the number of target cells is constant. This assumption is valid when analyzing clinical trial data obtained over a period of one or two weeks. In this paper, the drug efficacy in blocking viral production and the number of target cells are assumed time dependent. This is obvious that they are bounded. Our assumptions on this model get us an interval system. We use the results of [2, 3] for investigating this interval system. In fact, we obtain the necessary and sufficient conditions which imply the asymptotic stability of this system. For this aim, we compute the majorant matrix of this system, U. Then we prove that the interval system is asymptotically stable if and only if U is Hurwitz stable.

Keywords : HCV infection model; Interval system; Asymptotically stable; Hurwitz stable.

References

[1] M.J. Conway, A.S. Perelson, "A hepatitis C virus infection model with time-varying drug effectiveness: solution and analysis," PLoS Comput. Biol., 10:8 (2014) e1003769.

[2] O. Pastravanu, M.H. Matcovschi, "Invariance properties of interval dynamical systems," Int. J. Syst. Sci., 42:12 (2011) 1993-2007.

[3] O. Pastravanu, M. Voicu, "Generalized matrix diagonal stability and linear dynamical systems," Linear Algebra Appl. 419(2006) 299-310.