Control the Hepatitis C Disease Using Optimal Control theory and Stability Assessment Using Next Generation Matrix

Mahmoud Mahmoudi*, Elham mohammadi
Faculty of Basic Sciences, University of Qom, Qom, Iran

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Extended Abstract

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Introduction

Hepatitis C virus (HCV) was first identified in the year 1989. Globally, hepatitis has infected an estimated ۲۰۰ million people, most of whom are chronically infected. Mathematical modeling of the spread of infectious diseases continues to provide important insights into diseases behavior and control. Over the years, it has also become an important tool in understanding the dynamics of diseases and in decision making processes regarding intervention programs for controlling these diseases in many countries. The impact of a chronic stage on the disease transmission and behavior in an exponentially growing or decaying population, is the focus of this paper. In this article a new approach for controlling hepatitis C disease for a homogeneous population based on optimal control theory and next generation matrix is proposed. In the first, we consider the Hepatitis C model using predefined parameters and variables by Yuan and Young paper [20]. The model is a SEIR epidemiological model, that the factors are Corresponds to special blocks of possible states for individuals and next calculate reproduction number ([21], [22]). In fact, we divide the population in researched area into four classes: *S*—susceptible, *E*—exposed, *I*—infected with acute hepatitis C, *V*—infected with chronic hepatitis C. The total number in time *t* is $N(t) = S(t) + E(t) + I(t) + V(t)$. In this paper, it is assumed that, after the initial infection, a host stays in a latent period before becoming infectious. We obtain the basic reproduction number of this model, which completely decides the dynamics of this model. If $R_0 < 1$ the disease cannot be prevalent and If $R_0 > 1$ the disease can be prevalent. In the following by the optimal control theory, we check the infectious states to control the outbreak, and then solve the control problem. So we get the numerical solution and we will check witch of them (variables) is the best control and compare the results.

Material and methods

In this scheme, first we Consider the disease model and then check it. This model is a four-dimensional SEIR model. There are a few chronic diseases that have been analyzed in a chronic fashion. We consider the population in four Blocks. (infected people (i), exposed population(e) and Chronic infected population)

The costs associated with each of these strategies are also investigated by formulating the costs function problem as an optimal control problem, and we then use the Pontryagin's Maximum Principle to solve the optimal control problems.

Then we create the optimal control problem, next with using Pontryagin's maximum principle we will solve the problem.

Results and discussion

After the modelling the hepatitis C Disease, a nonlinear ordinary differential equations system is obtained, and with simplifying the system by applying the appropriate variable change, we can optimize some of the variables that can be controlled (for reducing the prevalence) until converted to zero.

Also, the numerical results reported in the tables that controlling on infected people(i), exposed population(e) and Chronic infected population. The reported results demonstrate that the disease can be have the maximum reduction by controlling on the Chronic infected population (v).
These populations can be controlled by medication, using different therapies, Quarantine them to reduce the spread of the disease or with Other medical procedures.

Conclusion

The following conclusions were drawn from this research.

- The epidemic is transmitted through people's direct contacts, so It is important to reduce the incidence of the disease and we can use the Optimal control theory for some of the variables that can be controlled by reducing the prevalence until converted to zero.
- The results show that control over the variable sensitive(s) is weak and studying it does not lead to a desirable result.
- The reported results demonstrate that the disease can be the maximum reduction by controlling on the Chronic infected population (v).

Keywords: Hepatitis C disease, Optimal control, Pontryagin's Maximum Principle, Basic reproductive number, Chronic disease

*Corresponding author: M.mahmoudi@qom.ac.ir