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Homotopy Perturbation Method For Host Dynamics Of Hiv Infection.

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ABSTRACT

This paper explores on Homotopy perturbation method (HPM) and is associated with handle frameworks of nonlinear differential conditions which is making in HIV contaminations of CD4+ T cell. This procedure gives arrangements in central educated sorts with absolutely quantifiable terms. The result explains that this strategy is exceptionally appropriate and can be connected to extensive class of issues. A few plots are displayed to appear the ardent quality and effortlessness of the strategies

Keywords: Homotopy Perturbation Method, HIV, CD4+T cells

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INTRODUCTION

HIV is an extremely minor, basic living being. HIV can't copy autonomously. They should depend on a host to help propagation. Most infections convey duplicates of their DNA and embed this into the host cell's DNA. At that point, when the host cell is animated to duplicate, it repeats duplicates of the infection [1-19]. At the point when HIV taints the body, its objective is CD4+ T cells [2, 4, 8, 9]. These cells assume the major part in the sheltered reaction; this is motivation to stress and a key purpose behind HIV's irresistible effect. Restricting happens, and the substance of the HIV is infused into the host T cell.

HIV contrasts for the most part infections in that it is a retrovirus: it conveys a duplicate of its RNA which should first be translated into DNA. Later than the DNA of the infection has been copied by the host cell, it is recreated with most recent infection particles grow from the cover of the host cell. These growing will happen gradually, saving the host cell; or quickly, blasting and slaughtering the host cell [3, 5, 6, 7, 10].

Antiretroviral medications are able to control the disease along with assist in expanding the living expectancy of the tainted individual. These medications follow up on various phases of the viral living succession. A definitive outcome of mutually is in the direction of square popular reproduction nevertheless in an alternate way. Scientific displaying of HIV disease has given a great deal of understandings of the flow of HIV contamination with an ART treatment intercession [11, 13, 15, 17]. This article is basically bothered to grow the use of the diagnostic HPM to comprehend a model for HIV contamination of CD4+T cells. Numerical reproductions are done to demonstrate the outcomes [12, 14, 16, 18].

MATERIAL AND METHODS

Consider the Dynamic demonstrate for HIV contamination of CD4+T cells [7], for the following differential equations:

$$\begin{aligned} \frac{dX}{dt} &= q - \phi ZX - eX + aY \\ \frac{dY}{dt} &= \phi ZX - aY - \lambda Y \\ \frac{dZ}{dt} &= M \lambda Y - \alpha Z \end{aligned} \tag{1}$$

with the primary conditions
 $X(0) = r_1, Y(0) = r_2, Z(0) = r_3.$
 (2)

We think about the three populaces: uninfected CD⁺ T cell X (t), contaminated CD⁺ T cell Y (t), and the virus population V (t). Here q is arrival rate of CD⁺ T cells and e is the normal demise rate. The parameter ϕ is the rate of contamination cells. The λ is the demise rate of contaminated cells and a is the rate at which contaminated cells come back to uninfected class. M is the normal number of viral particles created by a tainted cell. The α is the demise rate of virus.

HOMOTOPY PERTURBATION METHOD (HPM)

We consider the HPM model for all the nonlinear system of equations. We have

$$C(w) = h(q), \quad q \in \Omega \tag{3}$$

and

$$D\left(w, \frac{\partial w}{\partial n}\right) = 0, \quad q \in \Gamma. \tag{4}$$

Then the linear and nonlinear system becomes

$$M(w) + N(w) = h(q), q \in \Omega \tag{5}$$

and applying the given set of equations of the form

$$H(v, p) = (1-p)[M(v) - M(w_0)] + p[A(v) - h(q)] = 0. \tag{6}$$

Let us consider the initial system

$$H(v, 0) = M(v) - M(w_0) = 0, H(v, 1) = A(v) - h(q) = 0 \tag{7}$$

be the nonlinear differential equations. Hence, the power series becomes

$$v = v_0 + pv_1 + p^2v_2 + p^3v_3 + \dots + \infty. \tag{8}$$

When $p \rightarrow 1$, the approximate solution is

$$w = \lim_{p \rightarrow 1} v = v_0 + v_1 + v_2 + v_3 + \dots + \infty, \tag{9}$$

by He [19].

SOLUTION OF THE MODEL BY HPM

From the above HPM model is applied to the system of the equations (1):

$$\begin{aligned} (1-p)\left(\dot{v}_1 - \dot{x}_0\right) + p\left(\dot{v}_1 - q + \phi v_1 v_3 + e v_1 - a v_2\right) &= 0 \\ (1-p)\left(\dot{v}_2 - \dot{y}_0\right) + p\left(\dot{v}_2 - \phi v_1 v_3 + a v_2 + \lambda v_2\right) &= 0 \\ (1-p)\left(\dot{v}_3 - \dot{z}_0\right) + p\left(\dot{v}_3 - M \lambda v_2 + \alpha v_3\right) &= 0 \end{aligned} \tag{10}$$

With initial conditions is:

$$v_{1,0}(t) = x_0(t) = X(0) = r_1$$

$$v_{2,0}(t) = y_0(t) = Y(0) = r_2$$

$$v_{3,0}(t) = z_0(t) = Z(0) = r_3$$

And the power series of the given model equation:

$$v_1 = v_{1,0} + p v_{1,1} + p^2 v_{1,2} + p^3 v_{1,3} + \dots + \infty$$

$$v_2 = v_{2,0} + p v_{2,1} + p^2 v_{2,2} + p^3 v_{2,3} + \dots + \infty$$

(11)

$$v_3 = v_{3,0} + p v_{3,1} + p^2 v_{3,2} + p^3 v_{3,3} + \dots + \infty$$

$$p\left(\dot{v}_{1,1} - q + \phi r_1 r_3 + e r_1 - a r_2\right) + p^2\left(\dot{v}_{1,2} + \phi r_1 v_{3,1} + \phi r_3 v_{1,1} + e v_{1,1} - a v_{2,1}\right)$$

$$+ p^3\left(\dot{v}_{1,3} + \phi r_1 v_{3,2} + \phi v_{1,1} v_{3,1} + \phi r_3 v_{1,2} + e v_{1,2} - a v_{2,2}\right) + \dots = 0.$$

$$p\left(\dot{v}_{2,1} - \phi r_1 r_3 + \lambda r_2\right) + p^2\left(\dot{v}_{2,2} - \phi r_1 v_{3,1} - \phi r_3 v_{1,1} + \lambda v_{2,1} + a v_{2,1}\right)$$

$$+ p^3\left(\dot{v}_{2,3} - \phi r_1 v_{3,2} - \phi v_{1,1} v_{3,1} - \phi r_3 v_{1,2} + \lambda v_{2,2} + a v_{2,2}\right) + \dots = 0.$$

$$p\left(\dot{v}_{3,1} - M \lambda r_2 + \alpha r_3\right) + p^2\left(\dot{v}_{3,2} - M \lambda v_{2,1} + \alpha v_{3,1}\right) + p^3\left(\dot{v}_{3,3} - M \lambda v_{2,2} + \alpha v_{3,2}\right) + \dots = 0.$$

The solutions of the given set of nonlinear differential equations are:

$$\begin{aligned}
 X(t) &= r_1 + (q - \phi r_1 r_3 - e r_1 + a r_2)t \\
 &+ \frac{1}{2}(\phi r_1 r_3 \alpha - \phi r_1 r_2 M \lambda - q \phi r_3 + \phi^2 r_1 r_3^2 + 2 \phi e r_1 r_3 - \phi a r_2 r_3 - q e + e^2 r_1 - a e r_2 + a \phi r_1 r_3 - a \lambda r_2 - a^2 r_2)t^2 \\
 Y(t) &= r_2 + (\phi r_1 r_3 - \lambda r_2 - a r_2)t \\
 &+ \frac{1}{2}(\phi r_1 r_2 M \lambda - \phi r_1 r_3 \alpha + q \phi r_3 - \phi^2 r_1 r_3^2 - \phi e r_1 r_3 + \phi a r_2 r_3 - \lambda \phi r_1 r_3 + \lambda^2 r_2 + 2 a \lambda r_2 - a \phi r_1 r_3 + a^2 r_2)t^2 \\
 Z(t) &= r_3 + (M \lambda r_2 - \alpha r_3)t + \frac{1}{2}(M \lambda \phi r_1 r_3 - M \lambda^2 r_2 - M \lambda a r_2 - M \alpha \lambda r_2 + \alpha^2 r_3)t^2
 \end{aligned}$$

RESULTS AND DISCUSSION

Our methodical result gives that for non-linear only a couple of cycles of HPM with great outcomes. We numerically explain the framework by HPM utilizing the parameters [12, 13]. Here the parameters values are assumed to the model: $q = 10$, $a=0.2$, $\phi = 0.0027$, $M = 10$, $e=0.2$, $\lambda = 0.3$, $\alpha = 2.4$ and $r_1 = 300$, $r_2 = 10$, $r_3 = 10$.

In fig. 1 when ϕ increases from 0.0027 to 0.0040, the viral level augmentations. Therefore we will reason that the ailment spread and increase the HIV individuals. In fig. 2 when ϕ increases to 0.0052, the infection rate increases and virus level also increases. So we will decide that the disease spread and increase the HIV individuals. In fig 3-4 the parameter value 'a' increases from 0.4 and 0.6, the viral level diminishes. It can be effectively seen that contaminated cells return to uninfected class.

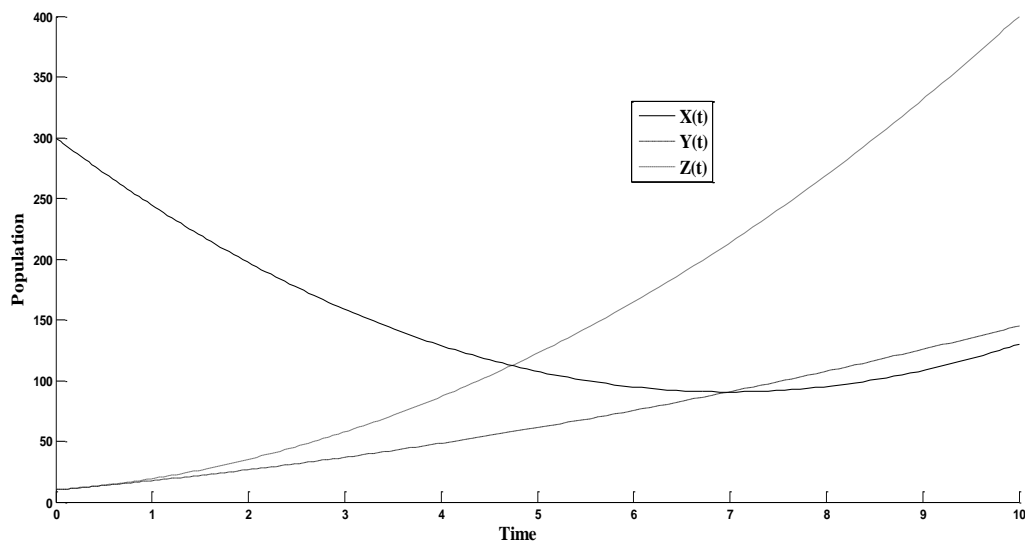


Fig 1: The parameter estimation of the rate of contamination cells increases in viral level augmentations

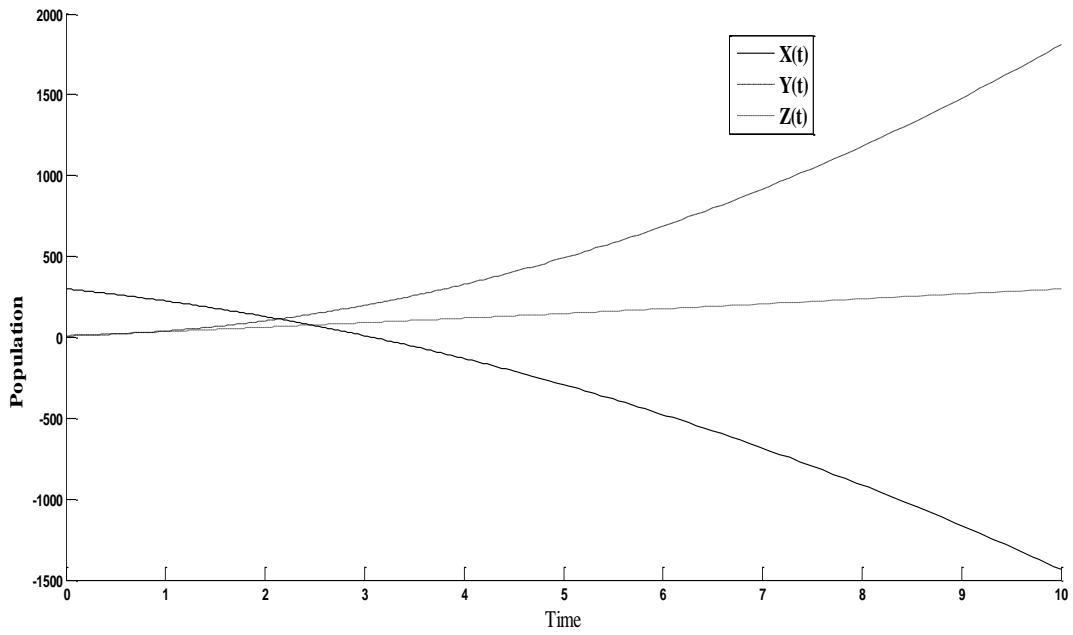


Fig 2: The parameter estimation of the rate of contamination cells increases in disease spread and increases the HIV individuals

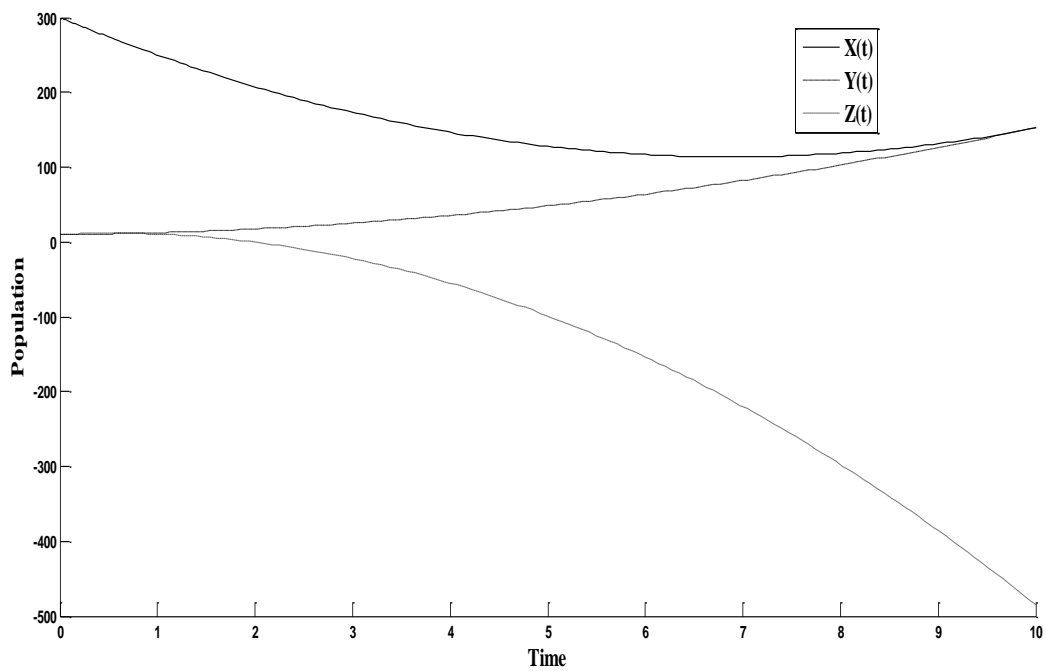


Fig 3: The parameter estimation of contaminated cells comes back to uninfected class

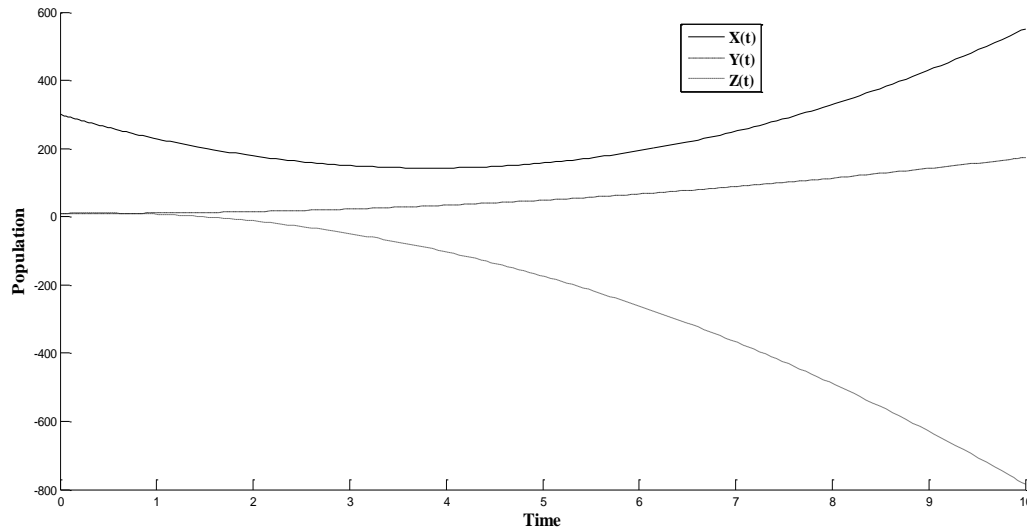


Fig 4: The parameter estimation of contaminated cells increases comes back to uninfected class in the viral level diminishes

CONCLUSIONS

On this paper, nonlinear differential conditions are determined by applying HPM for HIV contamination model. Our purpose has been to advise that logical arrangement gotten with the aid of this method is agreeable same as the appropriate outcomes to these fashions. HPM is effective strategy to take care of nonlinear issues and gives rapidly merged approximations that prompt correct arrangement. In this article, a numerical model to understand the best approach to manipulate the spread of HIV has been produced.

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