

setting $p = 0$

$$\Rightarrow A_T = A_{T_0}$$

setting $p = 1$ we have

$$A_T(t) = A_{T_0} + (r_1 c A_0 + q_{10} A_{T_0})t + (r_1 c (\eta c_3 I_0 + (q_8 - q_{10}) A_0) + (r_1 c (1 - \sigma_3) - q_{10}^2) A_{T_0}) \frac{t^2}{2} + \dots \quad (127)$$

And from (77), we have

$$y_2' = r_1 a_1 - q_{11} y_1 \quad (128)$$

substituting (98), and (103) into (128) we have

$$\begin{aligned} \Rightarrow y_2' &= r_1 (\eta c_3 I_0 + (1 - \sigma_3) A_{T_0} + q_8 A_0) t \\ &- q_{11} (r_1 A_0 - q_{11} A_{2,0}) t \\ &= (r_1 \eta c_3 I_0 + r_1 (1 - \sigma_3) A_{T_0} + r_1 q_8 A_0 \\ &- q_{11} r_1 A_0 + q_{11}^2 A_{2,0}) t \\ &= (r_1 (\eta c_3 I_0 + (1 - \sigma_3) A_{T_0}) \end{aligned}$$

$$\begin{aligned} &+ r_1 (q_8 - q_{11}) A_0 + q_{11}^2 A_{2,0}) t \\ y_2' &= (r_1 (\eta c_3 I_0 + r_1 (1 - \sigma_3) A_{T_0}) \\ &+ (q_8 - q_{11}) A_0) + q_{11}^2 A_{2,0}) t \end{aligned}$$

integrating

$$y_2 = (r_1 (\eta c_3 I_0 + (1 - \sigma_3) A_{T_0} + (q_8 - q_{11}) A_0) + q_{11}^2 A_{2,0}) \frac{t^2}{2} + c_{26}$$

where c_{26} is the constant of integration,

applying the initial condition

this implies that $c_{26} = 0$

therefore

$$y_2 = (r_1 (\eta c_3 I_0 + (1 - \sigma_3) A_{T_0} + (q_8 - q_{11}) A_0) + q_{11}^2 A_{2,0}) \frac{t^2}{2} \quad (129)$$

Substituting (86), (101) and (129) in (37) we have

$$A_2 = A_{2,0} + p (r_1 A_0 - q_{11} A_{2,0}) t + p^2 (r_1 (\eta c_3 I_0 + (1 - \sigma_3) A_{T_0} + (q_8 - q_{11}) A_0 + q_{11}^2 A_{2,0}) \frac{t^2}{2} + \dots + \quad (130)$$

setting $p = 0$ in (130) we have

$$\Rightarrow A_2 = A_{2,0}$$

setting $p = 1$ we have

$$A_2(t) = A_{2,0} + (r_1 A_0 - q_{11} A_{2,0}) + (r_1 (\eta c_3 I_0 + (1 - \sigma_3) A_{T_0} + (q_8 - q_{11}) A_0 + q_{11}^2 A_{2,0}) \frac{t^2}{2} \quad (131)$$

Therefore (105), (108), (111), (114), (120), (123), (125), (127) and (131) are the solution of our models using the Homotopy perturbation method (HPM).

4. CONCLUSION

The non-linear deterministic compartmental models with controls were solved analytically using the Homotopy perturbation method. The solutions of the models show a series of solution in form of power series. Homotopy perturbation method is an elegant method and a good approach to solve any non-linear, linear partial differential models analytically.

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