Delay Epidemic Model with and without Vaccine

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Abstract: In this work, two models with and without vaccine are constucted. For both model basic reproduction numbers are founded as a

$$R_0^1 = \frac{e^{-\mu\tau}\beta\Lambda}{\gamma+\mu+d}, R_0^2 = \frac{e^{-\mu\tau}\Lambda}{(\gamma+\mu+d)(\mu+r)}\left(\beta + \frac{kr}{\mu+1-k}\right).$$

From the basic reproduction ratios it can be seen that when there is no vacccine, disease can only controled with reducing the infectious rate β or decreasing the incubation period. However, when there is a vaccine it is enough to increase the rate of the vaccine r to controlled the disease. In addition to this if transmission rate of infectious also decrease then the disease will disappear faster.

Delay effect on this model is very rare. When we are talking about delay on this paper we mean that incubation period. If we have enough vaccine the effect of delay is very tiny. However if there is no vaccine you can see the effect of delay.

Two equilibria which are disease free and endemic equilibriums are found and with using Lyapunov function it is shown that the global stabilities of each equilibria for both model. For the first model it is found that DFE E_0 is globally asymtotically stable when $R_0^1 < 1$ and endemic equilibrium E_1 is always asymtotically stable. With using similar method it is shown that E_0 is asymtotically stable when $R_0^2 < 1$ and E_1 is always global asymtotically stable for model 2. In last section numerical simulations are given for both model.

Keywords: Delay, Epidemic, Modelling, Vaccine differential equation.

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