Nonlinear Dynamics	Date: *04.04.2021*
Instructor: *Dr. Vinod Palakkad*	Team: Sarthak Singhal , Sayantan Jana

Study of Epidemic Models with Nonlinear Infection Forces

1 Abstract

The goal is to understand the evolution of epidemic models over time. A lot of classical epidemic models admit threshold dynamics. Looking at the work of Badshah, Porwal and Tiwari [2001], *Mathematical Modeling and Role of Dynamics in Epidemiology*, certain thresholds are suggested which are capable of forecasting either the disease persists or not.

A showcasing of such thresholding goes as, if a basic reproduction number R_0 is below 1, a disease-free equilibrium is globally stable while if it is above 1, an endemic equilibrium is globally stable. Putting it simplistically, the disease dies out if $R_0 < 1$ and persists if $R_0 > 1$. These models tend to be lacking limit cycles as well.

However, as models evolved, it became known that a bistable case is more likely to occur. Here, bistability means a disease-free equilibrium and an endemic equilibrium are stable at the same time. In fact, periodic oscillations have been observed in the incidence of many infectious diseases, including measles, mumps, etc.

Why is it that classical epidemic models cannot explain these important phenomena? Classical models often consider mass action incidence and standard incidence, implying the contact rates and infection probability per contact, which are assumed to be constant over time. However, there are the infection forces that include the adaptation of individuals to infection risks.
Consider the COVID epidemic in India, during second wave, as numbers seem to rise significantly in India, 89.1 K daily rise(as of date April 2, 2021), various states have implemented various protection measures, close of academic institutions in Telangana, night curfews in Maharashtra or limitation on entries of vehicles in Bengal, raising frequent questions on possibility of a forthcoming lockdown. These are the intervention forces that are employed to limit the spread. Along with this, there is possibility of an infection force being saturated over time. These factors probably seem to be missing in the classical models.

Through this project, we aim to study the epidemic models with intervention strategies, a saturated infection force and a quadratic infection force. We hope to realise how the result of disease evolution depends on the initial conditions, how the intervention policies can help decrease the epidemic level and understand if it is significant to just drive the quantity of control variables as suggested by the classical models.

References

[1] Mathematical Modeling and Role of Dynamics in Epidemiology, Dr. V.H. Badshah , Pradeep Porwal, Dr. Vishwas Tiwari
`https://bit.ly/3sQrQRF`

[2] Epidemic Models with Nonlinear Infection Forces, Wendi Wang
`https://bit.ly/2PST6QX`