An Age-Structured Model for the Coupled Dynamics of HIV and HSV-2

G. Kapitanov, C. Alvey, K. Vogt-Geisse, and Z. Feng
Purdue University, United States
gkapitan@purdue.edu, clorenzo@math.purdue.edu,
kvogtgei@math.purdue.edu, zfeng@math.purdue.edu

Evidence suggests a strong correlation between the prevalence of HSV-2 (genital herpes) and the perseverance of the HIV epidemic. HSV-2 is an incurable viral infection, characterized by periodic reactivation. We construct a model of the co-infection dynamics between the two diseases by incorporating a time-since-infection variable to track the alternating periods of infectiousness of HSV-2. The model considers only heterosexual relationships and distinguishes three population groups: males, general population females, and female sex workers. We calculate the basic reproduction numbers for each disease that provide threshold conditions, which determine whether a disease dies out or becomes endemic in the absence of the other disease. We also derive the invasion reproduction numbers that determine whether or not a disease can invade into a population in which the other disease is endemic. The calculations of the invasion reproduction numbers suggest a new aspect in their interpretation - the class from which the initial disease carrier arises is important for understanding the invasion dynamics and biological interpretation of the expressions of the reproduction numbers. Sensitivity analysis is conducted to examine the role of model parameters in influencing the model outcomes.