# Optimal control of a malaria model with asymptomatic class and superinfection

Xue-Zhi Li

**Abstract**

In this talk, we introduce a malaria model with an asymptomatic class in human population and exposed classes in both human and vector populations. The model assumes that asymptomatic individuals can get re-infected and move to the symptomatic class. In the case of an incomplete treatment, symptomatic individuals move to the asymptomatic class. If successfully treated, the symptomatic individuals recover and move to the susceptible class. The basic reproduction number, $R_0$, is computed using the next generation approach. The system has a disease-free equilibrium (DFE) which is locally asymptomatically stable when $R_0 < 1$, and may have up to four endemic equilibria. The model exhibits backward bifurcation generated by two mechanisms; standard incidence and superinfection. If the model does not allow for superinfection or deaths due to the disease, then DFE is globally stable which suggests that backward bifurcation is no longer possible. Simulations suggest that total prevalence of malaria is the highest if all individuals show symptoms upon infection, but then undergoes an incomplete treatment and the lowest when all the individuals first move to the symptomatic class then treated successfully. Total prevalence is average if more individuals upon infection move to the asymptomatic class. We study optimal control strategies applied to bed-net use and treatment as main tools for reducing the total number of symptomatic and asymptomatic individuals. Simulations suggest that the optimal control strategies are very dynamic. Although they always lead to decrease in the symptomatic infectious individuals, they may lead to increase in the number of asymptomatic infectious individuals. This last scenario occurs if a large portion of newly infected individuals move to the symptomatic class but many of them do not complete treatment or if they all complete treatment but the superinfection rate of asymptomatic individuals is average.