Modelling Endemic Malaria and the Dangers of Partial Immunity

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In this talk we present human-mosquito interaction model that describes the development of malaria in a human population. The model accounts for the various phases of the disease in humans and mosquitoes, together with treatment of both sick and partially immune humans. The partially immune humans (termed asymptomatic) have recovered from the worst of the symptoms, but can still transmit the disease. We present a mathematical model consisting of a system of ordinary differential equations that describes the evolution of humans and mosquitoes in a range of malarial states.

A new feature, in what turns out to be a key class, is the consideration of reinfected asymptomatic humans. The analysis to be presented includes establishment of the basic reproduction number, R_0, and asymptotic analysis to draw out the major timescale of events in the process of malaria becoming non-endemic to endemic in a region following introduction of a few infected mosquitoes. The results suggests that intervention programmes may yield better results if implemented during the time scale when the feedback from infectious humans offsets the linear growth effect of the initial small amount of infected mosquitoes.

The reinfected asymptomatic class is significant to the continuation of malaria in endemic areas and in our analysis of a model describing treatment we show evidence of effective control and possible eradication of the disease, with a "moderate" level of treatment, if partially immune carriers of malaria parasites are treated alongside with sick humans.