A model for the treatment and competition of malaria parasite strains

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We develop an ODE compartment model to investigate the effects of treatment pharmacokinetics and pharmacodyanmics on the spread of drug-resistant malaria. This model is an extension of the Ross-MacDonald model for malaria transmission in which we incorporate treatment compartments into an SIRS-SI model framework for vector-borne diseases. Due to parasite mutation, selection pressure from available drug treatments, and adherence to treatment regimens, drug-resistant malaria strains have emerged and become more prominent over time. Hence, we explicitly incorporate infection due to a sensitive and a resistant strain of the malaria parasite that account for changing drug concentrations and parasite densities within treated individuals. We discuss the competition between these two strains. Since resistant strains are harder to treat, we include two disease-induced mortality parameters in the human population for the corresponding sensitive and resistant strains. In the model, the compartments are categorized by malaria strain-type infection and treatment status. The treatment stage is broken up into n compartments through which individuals progress as the drug concentration and parasite density in their system declines after being treated. It is of interest to note that the competition between these two strains may depend on the number of treated compartments. We investigate this dependency for several values of n.