An immuno-epidemiological model of Leishmaniasis

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We introduce for the first time a within-dog model of Leishmania infection. The model illustrates the dynamics of the parasite on the skin and within the bone marrow, as well as the dynamics of a class of antibodies. Simulations suggest that within-host pathogen persists either in oscillatory regime or at an equilibrium. The model is fitted to within-dog data of these three dynamical variables. Furthermore, we develop a vector-host epidemiological model of population level dynamics of Leishmaniasis in dogs [1]. The within-dog and the population level models are linked through transmission and disease-induced mortality. The newly developed is mathematically well-posed. We compute the epidemiological reproduction number which depends on the within-host parasite load and immune response. We find that the model has a disease-free equilibrium. We show that it has at least one endemic equilibrium if the reproduction number is above one. If the reproduction number is below one, the model may have no endemic equilibria or it may have even number of endemic equilibria, at least of of which is locally stable. Thus, even if the reproduction number is below one, Leishmania can persist in dog populations, if it is introduced at sufficiently high level, meaning that even dog populations with sufficiently high immunity can sustain the disease.

References

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