Modelling Visceral Leishmaniasis Transmission and Control

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Within the KalaDrugR project, the workgroup in Tübingen is in charge of work package 12 which contributes modelling studies and parameter estimations into the natural history of disease and transmission dynamics, into the effect of different intervention strategies and into the risk of the emergence and spread of resistance.
A mathematical model has been developed which is structured into a human, an animal, and a vector part, in which the human part of the model follows the general susceptible - infectious - recovered - susceptible structure and considering the diagnostic states of PCR-, DAT-, and LST- positivity or negativity. It furthermore allows studying the effects of first and second line treatment, early case detection, relapse after treatment, and the effects of vector control.
The model has been calibrated to data of a previous EU study, KalaNet, yielding parameter estimates which should discussed with a perspective from the field: (1) the feeding cycle duration of Phlebotomus of about 7 days under a human-vector ratio of 1 to 5, (2) duration of PCR positivity of about two months, (3) duration of DAT positivity of two months, too, and (4) loss of immunity according to LST positivity over a period of several months. An important finding of the data fitting process was that the observed prevalence of about 50% susceptibles cannot be explained without loss of immunity. From the KalaNet data, the vector related threshold above which endemic transmission is possible, is predicted with a human to vector ratio of about 1:3. This threshold strongly depends, among others, on assumptions on (1) the relevance of animals for transmission (reservoir or sink for infection?) (2) the contagiousness of the different human infectious states, (3) the contribution of PKDL and HIV to transmission. KalaDrugR modelling needs more input from entomological and veterinary experts, in particular there should be a better basis for estimates on the contact rate (biting rate of vectors and hosts). We recommend a concerted discussion of these general questions which came up during modelling and of the parameters of the vector’s life cycle.