Maximizing Malaria Elimination: A Mathematical Model for Optimizing IRS, LLINs, and ATSB Interventions

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Malaria is a public health problem for more than 2 billion people globally. About 219 million cases of malaria occur worldwide and 660,000 people die, mostly (91%) in the African Region despite decades of efforts to control the disease. Although the disease is preventable, it is life-threatening and parasitically transmitted by the bite of the female Anopheles mosquito. A deterministic mathematical model with intervention strategies is developed in order to investigate the effectiveness and optimal control strategies of indoor residual spraying (IRS), long lasting insecticide nets (LLINs) and attractive toxic sugar bait (ATSB). This model executed two equilibrium points, namely the disease-free equilibrium (DFE) point and epidemic equilibrium (EE) point. The DFE was proved to be stable when $R_0 < 1$ and the EE was proved to be stable when $R_0 > 1$. The sensitivity analysis was computed using the PRCC technique. MATLAB ode45 solver is used for the numerical results. Optimal control analysis was introduced and solved using Pontryagin's maximum principle. The dynamics of the optimal control showed that the infections decrease with an increase in the control to reduce the disease.

References

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