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Global Dynamics of an SP Model with Random Amelioration and Deterioration

We analyze the global dynamics of a mathematical model for infectious diseases that progress through distinct stages within infected hosts with possibility of random amelioration and deterioration. An example of such diseases is HIV/AIDS which progresses through several stages with varying degrees of infectivity; amelioration can results from a host's immune action or more commonly from anti-retroviral therapies such as HARRT, and deterioration results from other diseases such as TB co-infection which could accelerate the progression to AIDS. For a general n-stage model with constant recruitment and bilinear incidence that incorporates amelioration and deterioration, we prove that the global dynamics are completely determined by the basic reproduction number R_0. If $R_0 \leq 1$, then the disease-free equilibrium P_0 is globally asymptotically stable, and the disease always dies out. If $R_0 > 1$, P_0 is unstable, a unique endemic equilibrium P^* is globally asymptotically stable, and the disease persists at the endemic equilibrium. The proof for global stability of the endemic equilibrium uses the graph-theoretical approach to the method of Lyapunov functions recently proposed by Guo, Li and Shuai.