Random perturbations in a mathematical model of bacterial resistance: analysis and optimal control

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Abstract

In this work, we study a mathematical model for the interaction of sensitive–resistant bacteria to antibiotics and analyze the effects of introducing random perturbations to this model. We compare the results of existence and stability of equilibrium solutions between the deterministic and stochastic formulations, and show that the conditions for the bacteria to die out are weaker in the stochastic model. Moreover, a corresponding optimal control problem is formulated for the unperturbed and the perturbed system, where the control variable is prophylaxis. The results of the optimal control problem reveal that, depending on the antibiotics, the costs of the prophylaxis, such as implementation, ordering and distribution, have to be much lower than the social costs due to resistant bacteria, to achieve an effective control strategy.

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