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Optimal Dosing Strategies against Susceptible and Resistant Bacteria

Abstract: Antibiotic modelling is concerned with the problem of finding efficient and successful dosing techniques against bacterial infections. In this study, we model the problem of treating a bacterial infection where the bacteria is divided into two sub-populations: susceptible and resistant. The susceptible type may acquire the resistance gene via the process of conjugation with a resistant bacterium cell. After proposing a model for horizontal gene transfer, we find the steady state solutions under an antibiotic protocol of discrete periodic doses and analyse their stability. We also prove the result that guarantees the persistence of bacteria. In addition, efficient treatment strategies are devised that ensure bacteria elimination while minimizing the quantity of antibiotic used. Such treatments are necessary to decrease the chances of further development of resistance in bacteria and to minimize the overall treatment cost. We consider the cases of varying antibiotic costs, different initial bacterial densities and bacterial attachment to solid surfaces, and obtain the optimal strategies for all the cases. The results show that the optimal treatments ensure disinfection for a wide range of scenarios.