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Computational investigation of influence of Quorum Sensing inhibition on biofilm growth and disinfection

An important feature of biofilms that makes them distinct from freely moving planktonic cells is their resistance against chemical and mechanical washout. It has been reported that Quorum Sensing (QS), cell-cell communication mechanism, can influence the resistance of bacteria against antibiotics and make them more protective. There are several ways, by which QS can increase the biofilm resistance. One connection is that antibiotics are a stressor for the bacteria, and QS has been characterized as a method of stress response, forcing the bacteria for example to more cooperation or other changes in behavior. One strategy to make the biofilms susceptible against antibiotics is QS disruption. We present a mathematical model to describe the interaction between quorum sensing and quorum quenching, an inhibitory enzyme that can disrupt quorum sensing upregulation, and its effect on biofilm response to antibiotics that act as a stressor. The model is a highly nonlinear system of partial differential equations that we investigate in computer simulations. Our results show that adding QQ at the beginning of treatment or before QS upregulation leaves the biofilms in an unprotected mode of growth. Moreover, our results suggest that periodic administration of antibiotics can remove bacteria if QS is prohibited by QQ whereas in a system without quorum quenching periodic treatment strategy is not efficient in the sense of removing biofilms.