

Modeling the spatiotemporal transmission of Cholera disease involving infectiology, epidemiology and controls

Shohel Ahmed, Md. Kamrujjaman

Abstract: This study divided into two parts. First, we consider a mathematical model consisting of systems of ordinary differential equations (ODEs) describing the disease dynamics using general incidence rate. Model parameters are estimated using cholera outbreak data of Bangladesh and stability analysis is performed using the basic reproduction number of the system. Some numerical results for the optimal control problem are investigated where controls representing vaccination of individuals and disposal of a pathogen in order to minimize the number of infected individuals, the cost of vaccination and pathogen disposal. Next, we extend the model to a system of PDEs coupled with ODEs to include spatial movement within a region. Both time and space dependent controls are applied to the hybrid system. Existence and uniqueness results are established for weak solutions of the system. The existence of an optimal control pair is proven and the characterization of the controls is derived from corresponding adjoint systems. Numerical results are completed to illustrate various scenarios.

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- 1) Shohel Ahmed, M.Sc.: Bangladesh University of Engineering and Technology, Assistant Professor, Department of Mathematics, Bangladesh University of Engineering and Technology, Dhaka-1000, Bangladesh., Bangladesh (BD), shohel2443@math.buet.ac.bd.
 - 2) Md. Kamrujjaman, Associate Professor: Department of Mathematics, University of Dhaka., Associate Professor, Department of Mathematics, University of Dhaka, Dhaka 1000, Bangladesh., Bangladesh (BD), kamrujjaman@du.ac.bd.