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The Analysis of the Mathematical Stability of a Cholera Disease Model

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Abstract

In this study, we develop a deterministic model for cholera transmission dynamics, incorporating vaccination campaigns, treatment of infected individuals, and water sanitation initiatives. A novel feature of our model is the inclusion of healthcare centers, which enhances the simulation of treatment dynamics, offering new insights into cholera management. The model's central metric is the basic reproduction number R_0 , derived from the disease-free equilibrium (DFE) condition. Stability analysis shows that when $R_0 \leq 1$, the DFE is asymptotically stable, ensuring cholera eradication, while $R_0 > 1$ leads to an endemic equilibrium. Sensitivity analysis highlights that vaccination, treatment, sanitation, and public awareness campaigns are critical for reducing R_0 . The inclusion of healthcare centers further improves the model's effectiveness by ensuring timely treatment. Numerical simulations, validated using MATLAB, confirm that comprehensive public health strategies, including expanded vaccination campaigns and healthcare cholera out breaks. This model underscores the importance of timely medical intervention in reducing infection rates and fatalities.

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