

Within-Host Modeling of Cholera and Immune Dynamics: A Virtual Patient Approach

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Cholera remains a critical global health concern, particularly in regions with compromised water and sanitation infrastructure. Existing population-level models capture epidemic trends but fail to account for how malnutrition and other stressors impair immune function, potentially exacerbating disease severity. In this talk, we present a novel mechanistic framework that models Cholera's within-host pathogen-immune system dynamics as an ordinary differential equation (ODE) system, incorporating key variables such as bacterial load in the gut and epithelium—factors not easily measured in clinical settings, as well as bacterial loads in stool—factors that can be measured with fecal samples. By leveraging available clinical and laboratory data, we construct “virtual patients” to explore the interplay between immune health and infection risk at an individual level. This first-of-its-kind approach lays the groundwork for coupling detailed within-host simulations with person-to-person transmission models, ultimately enabling more accurate forecasts of epidemic trajectories under varying immune conditions. We will discuss the model's design, its potential for guiding targeted interventions, and future directions aimed at bridging micro-scale immune dynamics with macro-scale epidemiological outcomes.

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