ICRAMCS 2026

THE EIGHTH EDITION OF THE INTERNATIONAL CONFERENCE ON RESEARCH IN APPLIED MATHEMATICS AND COMPUTER SCIENCE

April 23-24-25, 2026 | Marrakech, Morocco

An influential study of a time-delayed epidemic model incorporating vaccination and treatment interventions

Communication Info

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Keywords:
(1) Infectious Disease Model
(2) Time Delays
(3) Stability Analysis

Abstract

A mathematical model delineating the dynamics of infectious diseases under appropriate vaccination and treatment efforts is analyzed. The study thoroughly investigates the implications of time delays inherent in vaccine preparation and administration, the transition from treatment to recovery, and the timeline from exposure to infection. The model is strengthened by establishing essential mathematical properties such as nonnegativity, boundedness, existence of solutions, and equilibria. An estimate of the basic reproduction number is provided to facilitate a preliminary understanding of disease behavior. Furthermore, the local stability of disease-free and endemic equilibria is examined in relation to the basic reproduction number, highlighting the model's capacity to predict disease dynamics. Moreover, the global stability of the equilibria is essential for understanding the ultimate impact of the disease, as the initial incidence may or may not continue its influence in the presence of counteracting effects such as vaccination and treatment throughout the system. Finally, the results are tested with parameters chosen from recently collected data on the dynamics of COVID-19, and numerical examples are presented to support the theoretical concepts proposed. Simulations visualize these numerical examples.

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