Chapter 15
A Study on Mathematical Modeling of HIV/AIDS, Malaria, and Dengue Fever

Preety Kalra
https://orcid.org/0000-0003-0720-8384
Lovely Professional University, India

Shoket Ali
Lovely Professional University, India

Ather Aziz Raina
Government Degree College, Thannamandi, India

ABSTRACT

This book chapter delves into the realm of mathematical modeling concerning the spread and dynamics of HIV/AIDS, malaria, and dengue fever. It comprehensively examines existing mathematical models utilized to understand the epidemiology, transmission, and control strategies of these diseases. The review highlights key findings, methodologies, and challenges in modeling each disease, emphasizing their impact on public health interventions. Through this exploration, the chapter aims to provide insights into the multifaceted nature of mathematical models in addressing these crucial health concerns.

INTRODUCTION

Severe diseases wield a profound influence on human populations, causing immense suffering and imposing significant social and economic burdens. These diseases are among the leading causes of mortality, affecting millions worldwide and straining healthcare systems, especially in developing nations. Mathematical modeling emerges as an invaluable tool for delving deep into the vitals of these ailments. The primary goals of mathematical modeling in the context of severe diseases, whether examined over time or across geographical regions, are twofold: to uncover the basic procedure of ailment transference and the most influential factors driving their spread, thus facilitating predictive capabilities; and to de-

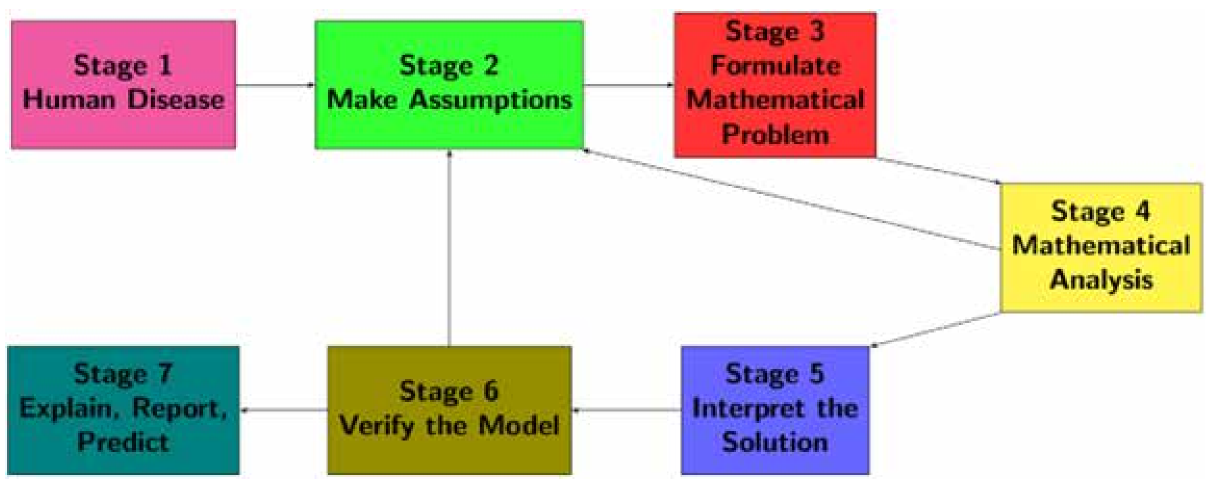
DOI: 10.4018/979-8-3693-2655-8.ch015

vise and assess strategies for their control. Mathematical modeling of severe diseases has a rich history, resulting in a diverse array of models that shed light on the causes and patterns of epidemic outbreaks.

The realm of mathematical modeling is not only vast but also awe-inspiring in its application across biology, genetics, and the medical sciences. It has established itself as a critical instrument for analyzing how infectious diseases spread and is controlled. Mathematical models possess the unique power to translate complex real-world disease scenarios into manageable mathematical structures, allowing for theoretical and numerical analyses that yield valuable insights and practical applications. Model formulation plays a crucial role in clarifying assumptions, identifying variables and parameters, and deriving key metrics, including thresholds, basic reproduction numbers, and contact numbers.

The mathematical modeling process of human disease is depicted in Figure 1, demonstrating how mathematical modeling serves as a bridge between complex real-world scenarios and actionable insights.

Figure 1. Human disease mathematical modeling procedure



In the field of medical sciences, mathematical modeling, in conjunction with physiological fluid dynamics, plays a critical role. It has unraveled longstanding mysteries in biology, leveraging the computational power of computers to reveal insights previously hidden from researchers. Mathematical models and computer simulations play a crucial role as essential tools for experimentation, enabling the development and validation of theories, conducting sensitivity analyses, and deriving key parameter estimates from empirical data. Carefully constructed mathematical models can be potent instruments for unraveling the intricate mechanisms underpinning various severe diseases.

Gaining insights into the spread patterns of communicable diseases across communities, regions, and nations is crucial in the field of biosciences. Mathematical models play a vital role in facilitating the comparison, planning, implementation, evaluation, and optimization of diverse programs related to detection, prevention, therapy, and control. Epidemiological modeling contributes to the planning and analysis of epidemiological surveys by identifying crucial data needs, recognizing trends, providing overarching predictions, and quantifying uncertainties in forecasted outcomes.

Related Content