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Exploring optimal control strategies in seasonally varying flu-like epidemics

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Abstract

The impact of optimal control strategies in the context of seasonally varying infectious disease transmission remains a wide open area of research. We investigate optimal control strategies for flu-like epidemics using an SIR (susceptible-infectious-recovered) type epidemic model where the transmission rate varies seasonally together with treatment and vaccination strategies. Specifically, we explore optimal control strategies using time-dependent treatment and vaccination as control functions alone or in combination. Optimal strategies and associated epidemic outcomes are contrasted for epidemics with constant and seasonal transmission rates. Our results show that the epidemic outcomes assessed in terms of the timing and size of seasonal epidemics subject to optimal control strategies are highly sensitive to various parameters including $\mathcal{R}_0$, the timing of the introduction of the initial number of infectious individuals into the population, the time at which interventions start, and the strength of the seasonal forcing that modulates the time-dependent transmission rate. Findings highlight the difficult challenge in predicting short-term epidemic impact in the context of seasonally varying infectious disease transmission with some interventions scenarios exhibiting larger epidemic size compared to scenarios with no control interventions.

1 Introduction

Mathematical models of disease transmission and control have become established tools for gaining an improved understanding of the transmission dynamics of infectious diseases and the potential impact of control interventions. In particular, the availability of computational power has allowed the numerical simulation of complex transmission models that involve multiple sets of rates of change equations or even models that keep track of detailed individual-level interactions and epidemiological transitions (e.g., [13, 14, 8]). More recently, researchers have started to

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