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Optimal control strategies for community and traveler isolation under resource constraints

Health authorities allocate limited resources to support the isolation of infected community members and travelers to reduce infectious disease spread. We consider an epidemic model and characterize the optimal controls. When resources are not limiting, if the maximum daily isolation rate is high, the optimal control corresponds to an elimination strategy, which results in a small outbreak of short duration. However, if the maximum daily isolation rate is low, the optimal control corresponds to a mitigation strategy, which results in a large outbreak of short duration. When resources are limiting, the optimal control is any strategy that uses all available resources, including circuit breaker strategies of this type, which results in a large outbreak of a duration ranging from short to long. We recommend implementing control measures at the start of an outbreak, as this action is always optimal, and is consistent with the precautionary principle, which recommends action even when important information, such whether resources will be limiting, is unknown. The elimination strategy results in substantially smaller outbreaks of short duration, and increasing the maximum daily isolation rate, or increasing the total resources available so as to achieve elimination, is likely optimal in some circumstances. Our modelling could be reformulated to consider multiple outbreaks over a fixed period of time, and would then serve as a suitable framework to further explore the conditions for when travel measures are an optimal control.