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Evaluation of the effectiveness of health countermeasures against infectious disease arrival times

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Public health measures to curb the international spread of infectious diseases include stricter quarantine and border blockades. While these measures are effective in delaying the importation of infectious diseases, they also have a significant economic impact by stopping the flow of people and goods. Arrival times of infectious diseases are often used to assess the effectiveness of quarantine. Although arrival times are highly dependent on the number of infected cases in the endemic country, direct comparisons have not yet been made. Therefore, in this study, we explicitly derive the relationship between the number of infectious cases and arrival time.

Infection behavior is stochastic, and deterministic models are not always realistic. In this study, random differential equations, which are differential equations with stochastic processes, are used to describe the infection dynamics in endemic countries. The flow of travelers from the endemic country is expressed in terms of survival time, and arrival time to each country is calculated. We also considered scenarios in which PCR kits are distributed between endemic and disease-free countries, and evaluated the impact of different distribution rates on arrival times.

Simulation results showed that increasing the distribution of PCR kits in the epidemic country was more effective in delaying arrival times than using PCR kits in quarantine in disease-free countries. Increasing the proportion of infected individuals identified for quarantine in the endemic country was also found to be more important and effective in delaying arrival time than increasing the number of PCR tests.

Keywords: infectious disease, arrival time, quarantine, mathematical model

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