Mathematical modeling of COVID-19 vaccine allocation strategies

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Abstract

Applied mathematics is useful in a variety of fields. It enables the study of several real-world-related issues. We propose some mathematical models to study vaccine allocation strategies for COVID-19 pandemic. Some nations, including Israel, the UK, and the US, began immunizing people at the end of 2020. However, vaccination was limited by the availability of COVID-19 vaccines and resources to roll-out them. Under these circumstances the health authorities can implement a variety of vaccination strategies. There was a lot of controversy and discussion over the optimal strategy for the vaccination programs. This problem is very complex due to the large number of variables that affect the outcomes. Furthermore, it can be difficult to determine what constitutes the best outcome because the objective might be to reduce the number of fatalities, infected individuals, or years of life lost. In this talk, we propose some mathematical models that can be applied to better our understanding of the best vaccination plans. These models take into account demographic risk factors as age, comorbidities, and social connections. The models are based on large systems of nonlinear differential equations and take into account a specific vaccination roll-out implemented in the USA. We examine various vaccination approaches and their effects on the overall number of COVID-19-related illnesses and fatalities. The models account for how people behave in social situations according on their age and comorbidity status. Based on varying pandemic conditions, including disease transmissibility and case fatality rate, the optimal vaccination strategy shifts. The results of these analyses provide valuable information for the design of vaccination programs in relation to the COVID pandemic. Moreover, the results presented here provide scientific vaccination guidelines for other future pandemics.

References

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