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COVID-19: Who should get vaccinated first?

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Abstract

In this thesis we investigate what is the most effective vaccination strategy against an epidemic resembling the COVID-19 outbreak in the Stockholm region in Sweden, using a multi-type stochastic epidemic model with a fraction of initially vaccinated of each type, given a varied number of either *perfect* or 90% efficacious *all-or-nothing* vaccines. We extend the SEIR (Susceptible, Exposed, Infectious, Removed) model to an SEIRLD model with Recovered, Long-term ill or Dead as final states, and we vaccinate the population uniformly (where the same fraction of each type is vaccinated), in order of descending probability of early infection, and in descending age order with males first to protect risk groups. The final sizes of the outbreak are computed using a balance equation and the relative probabilities of long-term illness and death, computed from COVID-19 data from the Stockholm region.

The findings suggest that vaccinating the most vulnerable first protects risk groups the most, but reduces the spread the least for both vaccines and all fractions of available vaccines considered. Conversely, uniform vaccination protects the vulnerable groups the least, but reduces the spread more than the former approach. Vaccinating those with a higher risk of early infection reduces the spread quite similarly to the uniform vaccination for some fractions of vaccinated among the population, while also reducing death and long-term illness relatively sufficiently. Therefore, this strategy seems the most efficient overall.

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