

A “SMALL-WORLD-LIKE” MODEL FOR COMPARING INTERVENTIONS DIRECTED AGAINST INFLUENZA EPIDEMICS

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In the current context of a growing risk of a world-wide influenza pandemic, we have built a simulation model of influenza in the community that allows to test different types of intervention such as vaccination, prophylaxis, quarantine and closing of public places.

The model includes: (1) an individual level, in which the risk of influenza infection and the dynamic evolution of the viral shedding are simulated according to age, treatment or vaccination status; and (2) a community level, in which contacts between individuals are simulated using the so-called “scale-free network”. The scale-free network realistically describes the physical contact patterns that result from movements of individuals between specific locations, and was recently applied for modelling disease outbreaks (Eubank S et al. Nature 2004;429:10-4).

A user-friendly interface has been built. It allows to specify the age and the sociodemographic structure of the simulated population (district, households, schools, nursing-homes, hospital), the infection parameters (latent and infectious periods, complication and mortality rates), and the different types of intervention, isolated or in combination.

We explore different interventions for controlling influenza epidemics in a virtual town of two-thousand individuals. The reference scenario assumes no vaccination, no use of chemoprophylaxis or chemotherapy, and a preexisting herd immunity in adults or the elderly: a 30-days epidemic is simulated, affecting 10.9% of the population (22.8% of children, 8% of adults, 3.2% of the elderly) and leading to 0.13 physician visit and 0.0015 hospitalization per inhabitant.

In a first scenario, we assume that all non-infected individuals are vaccinated within the first 5 days of the epidemic, a vaccine effectiveness of 80% and 12-days for vaccine induced protective immunity. Even this unfavourable scenario reduces by 27% the total number of cases, and by 16% the number of hospitalizations. We also compare two scenarios involving chemoprophylaxis with a 70% effectiveness. The first one assumes that prophylaxis is systematically given to all non infected individuals from the first day and for the entire course of the epidemic and the second one assumes a first-order contact prophylaxis. The two scenarios give roughly the same results as regards the decrease of the epidemic size (94% and 91% respectively), but the systematic prophylaxis is associated with economic losses (-9 €per inhabitant) whereas contact prophylaxis is associated with cost-savings (+6 €per inhabitant). Finally, we explore a scenario where each school (3 are simulated in the model) is closed as soon as 5 cases are reported within the school and where access to the nursing-home (100 beds) is limited to personal only, when 5 cases of influenza are reported in the community. This scenario gives a 74% decrease of the epidemic size, but is associated with huge economic losses (+130 € per inhabitant), due to the absence from work of parents whose children do not go any more to the schools. A thorough analysis of these interventions will be presented.