EVENT 201 MODEL

Disclaimer: this model was used exclusively for the exercise in October 2019 and does not relate to and cannot be applied to the current 2019-nCoV outbreaks because the epidemiologic inputs in this model differ from what is observed in 2019-nCoV.

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The Event 201 model simulates an outbreak of a moderately transmissible pathogen in a fully susceptible population. The model is intended to be a realistic representation of how a novel infectious disease could become a pandemic in the absence of adequate control measures.

Model Description

We used an ordinary differential equation approach to simulate the Event 201 pandemic. A graphical depiction of the model structure and a table of the key parameters are available in the Appendix. The model contains six compartments representing different stages of infection. Key features of the model include two compartments for individuals infectious in the community: half develop mild illness (I_M) and half develop severe illness (I_S). Patients with severe infection either die (D) or recover (R) at rate α. Those with a mild infection move to the recovered compartment at rate δ.

Global Spread

Following the initial spillover event in a large city in South America, 300 of the largest cities in the world were stochastically seeded with infectious cases to represent disease spread through international travel. The rate at which new cities were added to the model accelerates as time progresses, much like the growth of the epidemic itself. The number of imported cases ranged between 1 and 4 for each city.

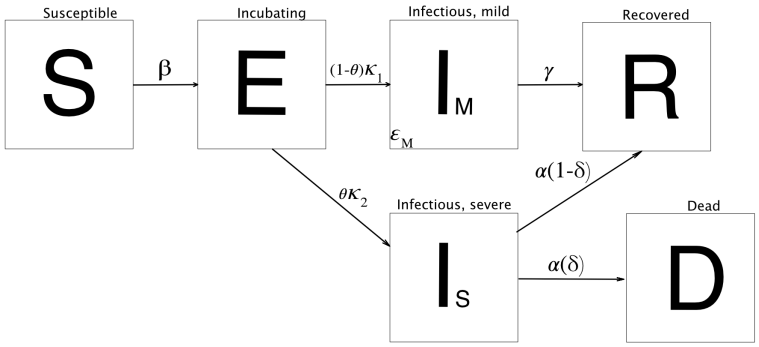
The model was run for each individual city in turn. To simulate the stochastic nature of outbreaks, parameters for each city were randomly selected from realistic distributions. The force of infection, β, was chosen from a normal distribution calibrated to produce an overall basic reproduction number of 1.7 (the reproduction number of individual cities ranged from 1.1 to 2.6). The case fatality risk (CFR) of hospitalized patients was chosen from a normal distribution with a mean of 14%, reflecting expected variation in the ability of healthcare systems to provide high quality care when faced with large numbers of critically ill patients. Patients with mild illness have a CFR of 0%, for an overall estimate of 7%.

The case counts reported in the exercise represent infections the severe compartment exclusively, under the assumption that mild illnesses in the community are less likely to be captured by surveillance systems. The exercise also reports only on the 300 global and 300 US cities represented in the model. For these reasons, the numbers reported in the scenario are conservative. However, like all models of this type, a core assumption is that the trajectory of the outbreak remains continuous. In real outbreaks, the trajectory is constantly changing in response to a number of factors like collective behavior change, which tend to slow outbreak growth.

EVENT 201

A GLOBAL PANDEMIC EXERCISE

Appendix: Key model parameters



β	transmission rate	variable	ε_M	reduced infectiousness	none
κ_1	incubation period, mild	5 days	θ	fraction severe	50%
κ_2	incubation period, severe	5 days	α	days to outcome in hospitalized	10 days
γ	days to recovery	7 days	δ	case fatality risk in hospitalized	variable - 14% on average