European Flight Restrictions May Inhibit International Propagation of Ebola

The rise of aviation as the dominant form of international transportation has increased the potential for the spread of infectious diseases. The 2014 West African Ebola Outbreak is no exception, with localized outbreaks in multiple countries caused by infected individuals traveling by plane. To inhibit the spread of Ebola to the United States it has been suggested that airlines cancel direct inbound flights from the affected region. To examine the effects of this approach, we developed and analyzed an agent-based metapopulation network model to simulate the international flight-based spread of Ebola. A metapopulation network consisting of 3,052 subpopulations connected by 83,295 flights was developed to simulate the transportation and infection of individuals in discrete timesteps of 30 minutes. To simulate the transmission dynamics of Ebola within subpopulations, airports, and flights, we constructed an SEIR model in which individuals are classified as either susceptible, exposed, infectious, or removed. The spread of Ebola was simulated using an R_0 of 2.1, as estimated for the 2014 West African Ebola outbreak, and extrapolated to scenarios of unilateral flight restrictions. We tested situations in which the United States, the European Union, or other African nations refused inbound flights. We found that flight restrictions can decrease the number of subpopulations with infectious or exposed individuals, with European-bound flight restrictions decreasing the spread of Ebola by as much as 80%. While flight restrictions may be politically and economically infeasible, our model suggests that the implementation of flight restrictions on European-bound flights may effectively mitigate the international spread of Ebola.

Keywords: Ebola, Epidemiology, Computational Modelling, Public Health, Network Models