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Modelling the daily risk of Ebola in the presence and absence of a potential vaccine

Ebola virus — one of the deadliest viral diseases, with a mortality rate around 90% — damages the immune system and organs, with symptoms including episodic fever, chills, malaise and myalgia. The Recombinant Vesicular Stomatitis Virus-based candidate vaccine (rVSV-ZEBOV) has demonstrated clinical efficacy against Ebola in ring-vaccination clinical trials. In order to evaluate the potential effect of this candidate vaccine, we developed risk equations for the daily risk of Ebola infection both currently and after vaccination. The risk equations account for the basic transmission probability of Ebola and the lowered risk due to various protection protocols: vaccination, hazmat suits, reduced contact with the infected living and dead bodies. Parameter space was sampled using Latin Hypercube Sampling, a statistical method for generating a near-random sample of parameter values. We found that at a high transmission rate of Ebola (i.e., if the transmission rate is greater than 90%), a large fraction of the population must be vaccinated (>80%) to achieve a 50% decrease in the daily risk of infection. If a vaccine is introduced, it must have at least 50% efficacy, and almost everyone in the affected areas must receive it to effectively control outbreaks of Ebola. These results indicate that a low-efficacy Ebola vaccine runs the risk of having vaccinated people be overconfident in a weak vaccine and hence the possibility that the vaccine could make the situation worse, unless the population can be sufficiently educated about the necessity for high vaccine uptake.