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Modeling the trade-off between transmissibility and contact in infectious disease dynamics

Symptom severity affects disease transmission both by impacting contact rates, as well as by influencing the probability of transmission given contact. This involves a trade-off between these two factors, as increased symptom severity will tend to decrease contact rates, but increase the probability of transmission given contact (as pathogen shedding rates increase with symptom severity). This talk explores this trade-off between contact and transmission given contact, using a simple compartmental susceptible- infected-recovered type model. Under mild assumptions on how contact and transmission probability vary with symptom severity, we give sufficient, biologically intuitive criteria for when the basic reproduction number varies non-monotonically with symptom severity. Multiple critical points are possible. We give a complete characterization of the region in parameter space where multiple critical points are located in the special case where contact rate decreases exponentially with symptom severity. We consider a multi-strain version of the model with complete cross-immunity and no super-infection. In this model, we prove that the strain with highest basic reproduction number drives the other strains to extinction. This has both evolutionary and epidemiological implications, including the possibility of an intervention paradoxically resulting in increased infection prevalence. (jointly with K. A Deger and J. H. Tien)