Who is the infector? Epidemic models with symptomatic and asymptomatic cases

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Abstract

What role do asymptomatically infected individuals play in the transmission dynamics? There are many diseases, such as norovirus and influenza, where some infected hosts show symptoms of the disease while others are asymptomatically infected, i.e. do not show any symptoms. The current paper considers a class of epidemic models following an SEIR (Susceptible $\rightarrow$ Exposed $\rightarrow$ Infectious $\rightarrow$ Recovered) structure that allows for both symptomatic and asymptomatic cases. The following question is addressed: what fraction ρ of those individuals getting infected are infected by symptomatic (asymptomatic) cases? This is a more complicated question than the related question for the beginning of the epidemic: what fraction of the expected number of secondary cases of a typical newly infected individual, i.e. what fraction of the basic reproduction number R_0, is caused by symptomatic individuals? The latter fraction only depends on the type-specific reproduction numbers, while the former fraction ρ also depends on timing and hence on the probabilistic distributions of latent and infectious periods of the two types (not only their means). Bounds on ρ are derived for the situation where these distributions (and even their means) are unknown. Special attention is given to the class of Markov models and the class of continuous-time Reed-Frost models as two classes of distribution functions. We show how these two classes of models can exhibit very different behaviour.

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