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Dynamics of an SEQIHRVS epidemic model with partial immunity, imperfect vaccine and media coverage

A deterministic non-linear epidemic model SEQIHRVS is proposed for the transmission dynamics of an infectious disease. Quarantine, isolation and vaccination are used as control strategies in a community with pre-existing immunity. Impact of the change in the psychological behaviour of the population on infectious force due to media coverage of disease-spreading is incorporated in the model. The dynamical behaviour of the model is analysed and important biological thresholds are derived. The existence and local stability of the disease free and endemic equilibria are explored in terms of the effective reproduction number \mathcal{R}_C . It is observed that media coverage does not affect the effective reproduction number, but it helps to mitigate disease burden by lowering the number of infectious individuals at the endemic steady state and also lowering the infection peak. It is observed that the population level impact of quarantine and isolation depend on the level of transmission by the isolated individuals. Moreover, the higher level of pre-existing immunity in the population decreases the infection peak and causes its early arrival. Critical vaccination rate, critical vaccine efficacy and threshold vaccination coverage at disease-free steady state are derived for the system. Theoretical findings are supported by numerical simulation. Normalised forward sensitivity indices are calculated for \mathcal{R}_C and state variables at endemic steady state with respect to model parameters and respective sensitive parameters are identified.

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