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Assessing potential insights of an imperfect testing strategy: Parameter estimation and practical identifiability using early COVID-19 data in India

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A deterministic model with testing of infected individuals has been proposed to investigate the potential consequences of the impact of testing strategy. The model exhibits global dynamics concerning the disease-free and a unique endemic equilibrium depending on the basic reproduction number when the recruitment of infected individuals is zero; otherwise, the model does not have a disease-free equilibrium, and disease never dies out in the community. Model parameters have been estimated using the maximum likelihood method with respect to the data of early COVID-19 outbreak in India. The practical identifiability analysis shows that the model parameters are estimated uniquely. The consequences of the testing rate for the weekly new cases of early COVID-19 data in India tell that if the testing rate is increased by 20% and 30% from its baseline value, the weekly new cases at the peak are decreased by 37.63% and 52.90%; and it also delayed the peak time by four and fourteen weeks, respectively. Similar findings are obtained for the testing efficacy that if it is increased by 12.67% from its baseline value, the weekly new cases at the peak are decreased by 59.05% and delayed the peak by 15 weeks. Therefore, a higher testing rate and efficacy reduce the disease burden by tumbling the new cases, representing a real scenario. It is also obtained that the testing rate and efficacy reduce the epidemic's severity by increasing the final size of the susceptible population. The testing rate is found more significant if testing efficacy is high. Global sensitivity analysis using partial rank correlation coefficients (PRCCs) and Latin hypercube sampling (LHS) determine the key parameters that must be targeted to worsen/contain the epidemic.

References

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