The impact of interventions on the COVID19 Virus spread in India- A report

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The present study is targeted to investigate the impact of various comprehensive and stringent interventions (as advised by the Government of India) implemented to decelerate the spread of the COVID19 virus. We consider a stochastic modelbased on discrete renewal process that includes various controlling measures to systematically evaluate their effects on the disease transmission dynamics through three inter-linked components. The stochastic nature is important to account for uncertainty in prediction. A Bayesian model has been considered for the infection cycle to observe deaths with upper and lower bounds of the total population infected (attack rates), case detection probabilities, and the reproduction number over time. MCMC technique has been adopted for analyzing the data.This model is related to the widely used **s**usceptible-**i**nfected-**r**ecovered (SIR) model, except the renewal is not expressed in differential form.

Under various interventions, we are able to predict the reproduction number and are also capable of estimating the baseline secondary infection number estimated before interventions .The number of infected cases at any day can be predicted using the reproduction number and the weighted average of previous days' affected figures with the chance of secondary infection as weights.An adjustment has been made to consider the fact that even in the absence of interventions, herd immunity may reduce the number of daily infected. The mortality at any day can similarly be predicted using the case fatality ratio (CFR) and the weighted average of previously affected figures with chance of mortality as weights.

Clearly the average reproduction number, a pivotal quantity, can be controlled with the help of certain interventions. In this study, we treat interventions as covariates in modeling the average reproduction number. Here the time-varying reproduction number has been assumed to be a piecewise constant function which starts from a baseline prior.

The incubation period is critical to determine the time period required for monitoring and restricting the movement of healthy individuals (i.e., the quarantine period). The incubation period also aids in understanding the relative infectiousness of COVID-19 and can be used to estimate the epidemic size .We have borrowed the idea from previous studies.

Results:

Using hierarchical Bayesian framework, this stochastic model has been used to see the effects of all the interventions on the spread of COVID-19. A clear indication from our study is that all the interventions reflect appropriate measures in reducing the spread of the virus. It may be noted that, more stringent interventions like continuing lockdown for more days along with increased testing may give better result. Intensive testing has shown a positive effect to reduce the number of daily infectee or deaths in all situations.

Assumptions:

Number of deaths is assumed to follow a negative binomial model with appropriate parameters. CFR has been assumed to be 1.8%. As per the epidemiological dynamics, the expected time for secondary infection has been assumed to be 6.5 days. The average time to infection and onset of symptoms (incubation period)is around 5 days with small variability being allowed and that to onset of symptom and death is nearly 19 days. All these information has been used for the selection of priors. The advantageof this virus spread model is that the reproduction number can be derived for any kind of intervention provided it is possible to quantify.

Remarks :

As regard our modeling, we have some problems in dealing appropriately with the interventions where 50% reduction in contact till a certain date is desired. Currently percentage reduction in contacts has been incorporated through an adjustment over basic reproduction number. We are actively working for a better prediction under this scenario.

We understand that there have been many more infections than are reported actually. The high level of under-ascertainment of infections that we estimate here is likely due to the focus on testing in hospital settings rather than in the community. We must mention that in our model we have not explicitly accounted for hospital bed capacity, which may play an important role in affecting both the outbreak dynamics and the intervention efforts.

In summary, we used a Bayesian epidemiological model to study the effect of various measures on COVID19 transmission dynamics. The effectiveness of isolation, early and massive diagnosis ofpre-symptomatic individuals with rapid testing may seem to be beneficial for reduction in the transmission of thedisease.

References:

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