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Mathematical Modelling of COVID-19 Transmission in Sonoma County: Impact of Shelter-in-Place Orders and Related Interventions & Scenarios for Reducing/Lifting the Order

This follow-up report serves to: a) assess the impact of Sonoma County's Shelter in Place (SIP) order on COVID-19 transmission in the County; and b) consider the effect of two different scenarios in reducing or lifting the SIP order.

Our initial report (4/2/2020) on the transmission and control of coronavirus in Sonoma County used mathematical models to address the following questions:

- What is the impact of shelter-in-place (SIP) orders in Sonoma County on reducing cases of morbidity, mortality and demand for hospital beds in the county?
- How can SIP orders ultimately be safely lifted?
- What is the role of community-based testing in suppressing COVID-19 transmission when SIP orders are lifted?

The first report adopted conservative assumptions in the absence of data. The models were not intended to predict what *would* happen, but rather to estimate the *minimum* level of effectiveness that SIP would need to achieve to prevent overwhelming capacity in Sonoma County's hospitals.

Based on current data, SIP measures combined with ongoing contact tracing, targeted testing, social distancing, face covering among other mitigation strategies have succeeded in interrupting transmission—resulting in substantially higher impact on suppressing transmission than initially modelled. The figure below illustrates expected hospitalizations under three different epidemic trajectories based on different assumptions for the effectiveness of SIP where the transmission rate is $R_0 = 2.5$ (one case will infect two and a half other people). The blue curve (representing 75% transmission rate reduction) is most consistent with evidence observed in the County to date that reflect how our efforts "flatten-the-curve."

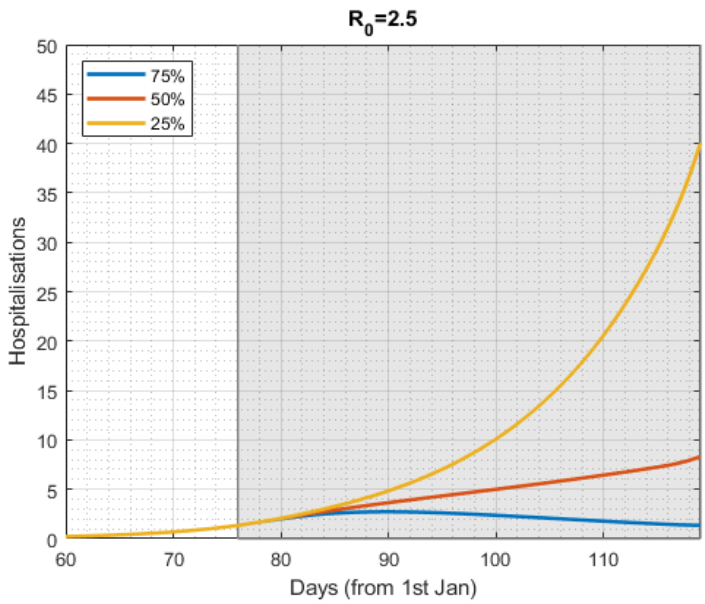

Figure 1: Modelled Hospitalizations under SIP, where SIP reduces effective R_0 by 25%, 50% and 75%.

We consider the potential implications of lifting SIP under the following two scenarios:

1. Lifting SIP *with no other control measures* in place
2. Lifting SIP *but maintaining intensive contact tracing*

The contact tracing scenario assumes that: (a) symptomatic cases can be identified and isolated within a certain duration from onset of symptoms (say *n* days), and (b) a certain proportion of asymptomatic cases can be identified and isolated before they recover or develop symptoms (say, a proportion *p*).

The figure below illustrates the potential implications of different combinations of *n* and *p*.

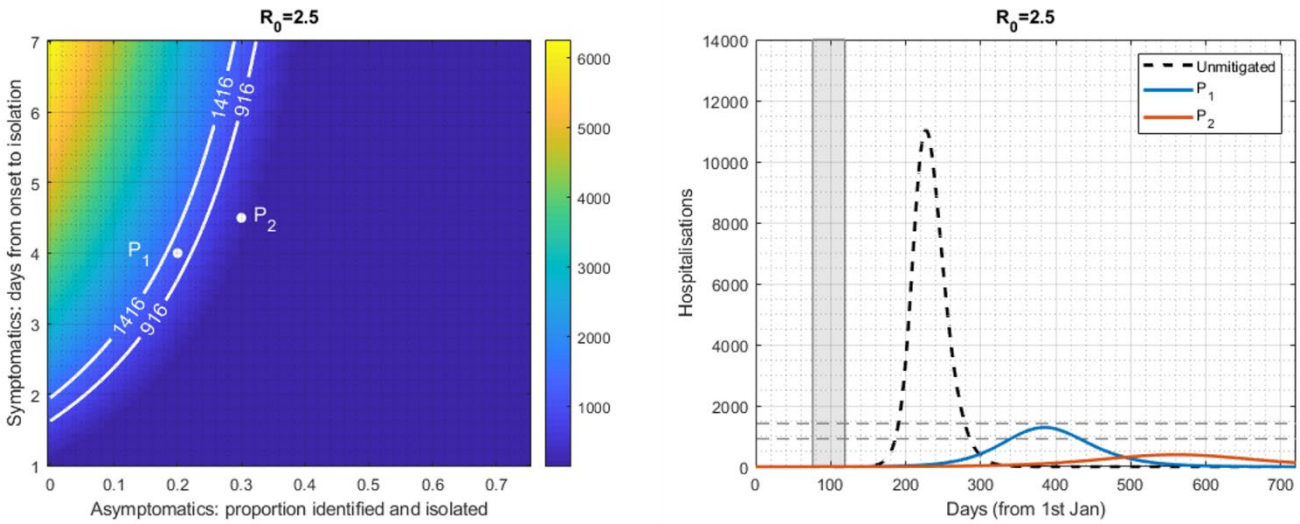

Figure 2: Peak hospitalizations under different scenarios for contact tracing, upon lifting SIP in Sonoma County.

<u>Left-hand panel</u>: Model projections for the peak hospitalisations following the lifting of SIP, under a range of scenarios for: a) the proportion of *asymptomatics* being identified and isolated (horizontal axis) and, b) among symptomatic cases, the delay from symptom onset to isolation (vertical axis).

- Isoclines in white show hospital bed capacity.
- The two points labelled P1 and P2 are used as illustrative examples only.

Right-hand panel: Model hospitalization projections after lifting the SIP order under each of the contact tracing scenarios.