# **OPTIMISING THE EFFICACY OF TIME-LIMITED INTERVENTIONS FOR EPIDEMIC CONTROL**

## **DISCUSSION – (1500-2000) words**

**Description of Results**

This work builds on previous epidemiological modelling to explore the optimal parameter space to minimise maximum peak prevalence () and total cumulative incidence () across five different intervention scenarios. This was explored in the context of a simulated COVID-19 outbreak. We note that there is no single optimal combination of intervention strategies, with each scenario was capable of minimizing both Imax and Ic() for a given set of unique parameter values.

The optimal parameter space to minimise Imax for each intervention scenario can be directly attributed to two key characteristics: 1) Intervention peak timing and 2) Intervention *cmin* balance. Timing of the intervention to the epidemic peak is not a novel concept (LAuro). However, we demonstrate that for scenarios with varying education to transmission, it is necessary to also time the greatest extent of the intervention (cmin/cmin1/cmin2) with the epidemic peak. This can be intuitively observed by observing the difference between scenario2 (cmin at the intervention start) and scenario 3(cmin at intervention terminus). In accordance with cmin peak timing, scenario 2 is optimal with a later trigger day to coincide with the earlier cmin reduction and scenario 3 is optimal with an earlier intervention trigger to coincide with a later cmin reduction. Additionally, as highlighted by previous modelling (), it is also necessary to balance the strength of an intervention to prevent either an unmitigated epidemic due to an insufficient intervention or the maintenance of a pool of susceptibles due to an intervention which is too strong. We note that for a given cmin value, the presence of an intervention ramp up/down () can expedite the build up of population immunity, facilitating this cmin balance with a lower relative cmin value compared to scenarios with a constant ebeta(t) reduction.

As huighlgihted from the work we built upon, we highlight that it is unrealistic to assume that these parameter optimums can be achieved. Additionally, we note that for aideal optimal parameter space for Imax, this often differs for Ic(). instead we must look to finding the best of the worst case scenarios

1. It is much better to aim for an intervention which gives you a “wider” room for error – not a sharp decrease in Figure 2.
   1. What intervention is the best for this?

* For the single intervention it is often….
* For the double intervention it is often better…
* In all intervention scenarios its better to be too long than too short (apart from scenario 3 and 4 where there is some sort of ramping back down allowed)
* It is overwhelming better to have too strict of an intervention than one that is too mild
* For time limited interventions it is unclear whether it is better to be too early or too late when applying the interventions in the conext of allowing natura/herd-immunity to cause epidemic decline, and in the context of timie limited interventions.
* Being too late is often disastrously wrong – no way to reoptimize. Show that depending on whether you want to ramp up or ramp down the outcomes and the optimal points are extremely different – coincides with trigger point differently Altering the length for the interventions may actually have detrminetal outcomes since it goes past the eoidemic peak.
* As seen with our results it isn’t the case where the longer, the stronger and the early intervention is the most effective for ytime limited interventions, there are many nuances with the dynamics in how you role out your interventrions

**Applications of Work in Real World + Summary**

* Optimisations
* What is more important is some parameters are more important to alter to minimise – but not the exact number
* We note that it is almost impossible to do this in reality, both the delay (SEIR) and the dynamic nature of the intervention- the stronger an itnervention you shift the timing of the peak around. It is therefore better to focus on what is the bet the dynamic nature of the intervention make it impossible to react to a peak
* We note that the multiple intervention snceario is incredibly nuanced compared to the single itnervention snceario
* Optimising a single itnervention seems deceptively simple but there are mutlipel cavcetas in this which are amplified when the number of parameters are increased with a multiple intervention scenario.
* Scenario 5 is analogous to a mitigation scenario – real life pulsing such as in the imperial report – maitaning re just above 1 aswell
* Important to note that under an SEIR framework the matching of the cmin timing and the epidemic peak will be subtly different, under realistic disease dynamics it is almost impossible to match this exactly, with effects of the interventions likely being delayed, it therefore becomes a question of what is the best of the worst options in terms of choosing unoptimized parameters
* Note that less emphasis should be placed on the xact toiming of the peak, instead on the messages associated with what is the best of the worst, such as choosing an itnervention which is too strong etc. to minimise the worst effects
* We address the notion that interventions will often not occur in isolation and that, in line with current thinking it is note realistic to consider disease induced herd immunity to cause the decline of the epidemic. In the situation where there is a constant suppression of susceptibility or transmission past a certain date (vaccination or highly effective contact tracing), we note that the mode supports a greater dt and early typ to minimise the two outcome measures.

Interesting to place this study in the context of not just deliberate differences in intervention strategies, but also the effect of human behaviour. An intervention such as lockdown might aim for a constant reduction in transmission. But human behaviour over time (lockdown fatigue) might cause a constant reduction to slowly creep and become less effective. You essentially transform one intervention scenario into another.

This analysis is probably applicable to any immunising human-to-human transmittable viral infection.

**Caveats + Limitations**

We could have conducted a multiparameter sensitivity analysis toi identify which parameter can reduce either outcome measure the best – but we realised that this would ultimately not be userful as we were more interested in identifying the optimal patterns associated with each aprameter

SIR not SEIR Model

1. Obviously a VERY simple model, does not describe age heterogeneity or super spreading or anything like that (Gomes paper).
2. If we don’t use a SEIR - talk about in real life there is a delay between the intervention and the effect on the epidemic curve
3. Very difficult to assign a quantitative number to the “magnitude of any intervention
4. Only considers lifelong immunity
5. Downsides to not “parameterising” the model with data
6. No deaths in the models
7. We do NOT aim to predict anything – this looks at the dynamics of social distancing measures. We do not consider that the effect of any other intervention (contact tracing) which may prevent an increase in cases after the cessation of social distancing measures.

**Summary**

I’m not 100% sure about advertising the paper as an alternative to hit it hard and hit it fast because our approach relies on a number of caveats – so its only good to hit it hard and hit it fast in the context of the paper (time limited SDM) and no further intervention

Also for many of the scenarios the optimal parameter space is extremely narrow – you cannot really hope to optimise this since you don’t really know the true number of infections, exact strength of your intervention or anything – I guess my point is that this window is very narrow and the sweet spot is very difficult ot hit in practice

Maybe that there is an existence of a sweetspot? But its very difficult to hit and if you are not sure then maybe it might be better to just do it earlier

Also depends on your aim – if you rely on herd or natural immunity to cause the epidemic decline then

* We therefore note there is more nuanced than previous epidemiological assumptions of hitting an epidemic hard and fast to achieve epidemic control.