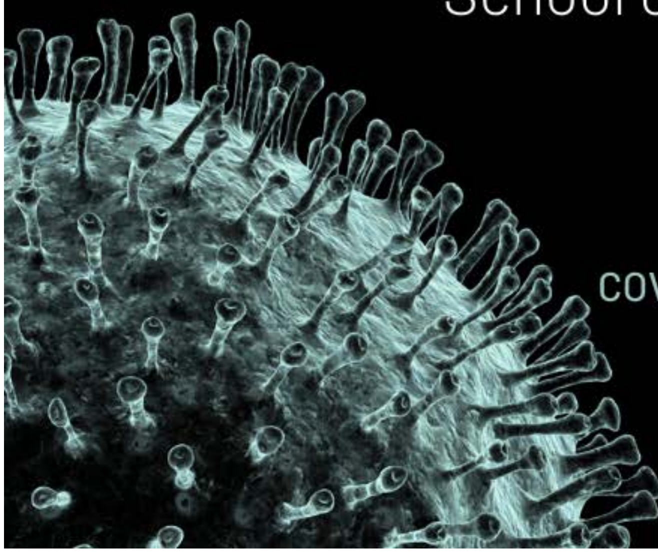
COVID-19 Conversations

Marc Lipsitch, DPhil

Director, Center for Communicable Disease Dynamics, Harvard T. H. Chan School of Public Health



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COVID-19: theory of social distancing

Marc Lipsitch, DPhil

NAM/APHA

25Mar 2020

CENTER *for* COMMUNICABLE DISEASE DYNAMICS

MIDAS Models of Infectious Disease Agent Study

Funded by the National Institutes of Health

CCDD COVID-19 team

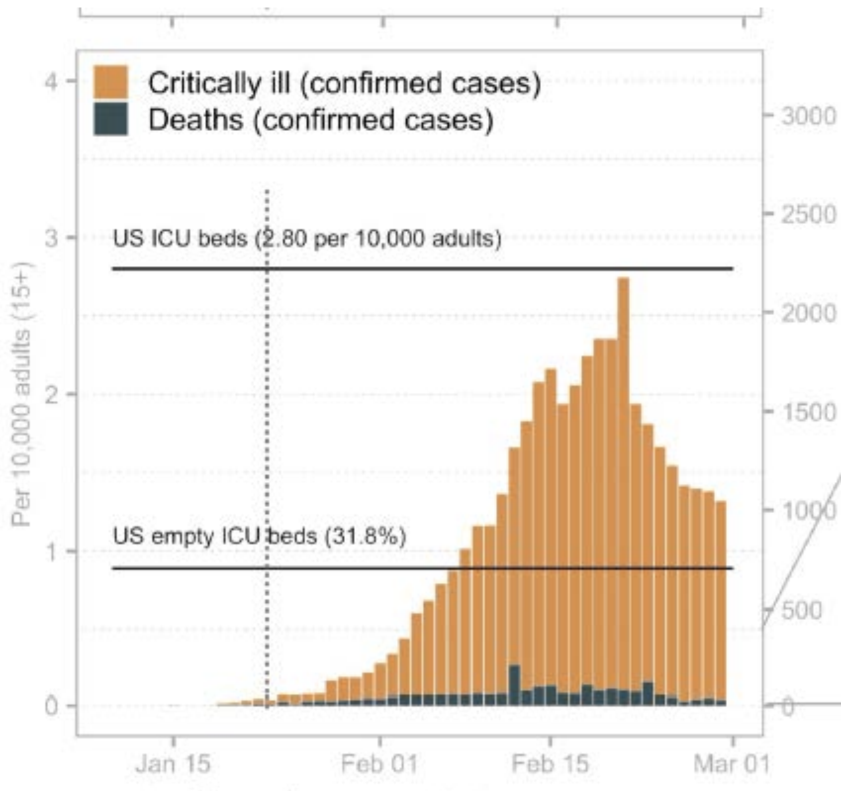
- Bill Hanage
- Caroline Buckee
- Michael Mina
- **Yonatan Grad**
- **Ed Goldstein**
- Xueting Qiu
- Aimee Taylor
- Mary Bushman
- Rene Niehus
- Pablo M de Salazar
- James Hay
- **Stephen Kissler**

- Tigist Menkir
- Taylor Chin
- Rebecca Kahn
- **Christine Tedijanto**
- Nishant Kishore
- Lee Kennedy-Shaffer
- Corey Peak (alum)
- Hsiao-Han Chang (alum)
- Matt Kiang (alum)
- Sarah McGough (alum)
- Francisco Cai (alum)

Collaborators

- **Megan Murray**
- **Caitlin Rivers**
- **Eric Toner**
- **Qi Tan**
- **Ruoran Li**
- Satchit Balsari
- Nick Menzies
- Gabriel Leung
- Joseph Wu
- Kathy Leung
- Ben Cowling
- Lauren Childs (alum)

Letting it go is a bad option

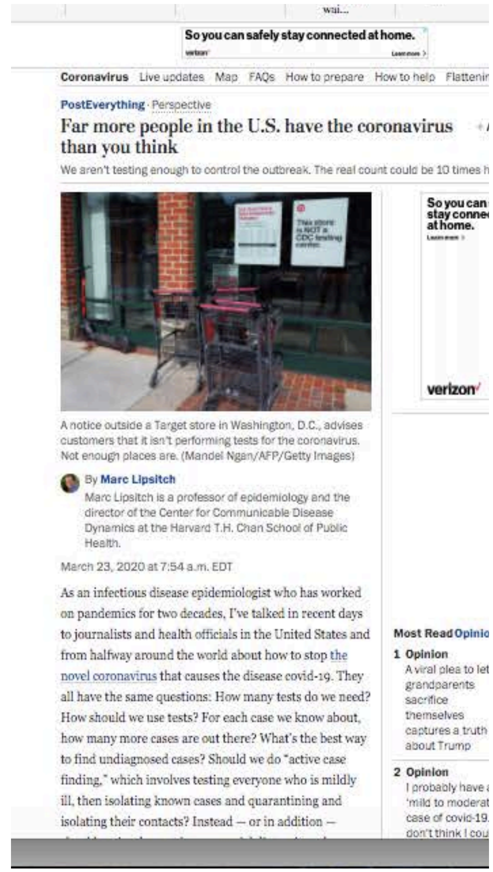


- Wuhan shut the city down when they had ~500 confirmed cases in a population of ~10 million
- They reached a per capita demand for ICU equal to fully occupying ICUs in the US, just for COVID-19
- 4 weeks from shutdown to peak ICU need

R Li, Q Tan, M Murray, C Rivers, E Toner, M Lpisitch preprint

Options:

- Catch nearly every case early, high test capacity, intense individual-level case interventions (isolation, tracing, quarantine), seal borders (islands): Singapore, Iceland, Vo (Italy,), Hong Kong, Taiwan, China outside Wuhan
- Many introductions undetected; widespread community transmission (Wuhan, Europe, USA): Case-focused interventions fail, need social distancing



Coronavirus Live updates Map FAQs How to prepare How to help

PostEverything · Perspective

Far more people in the U.S. have the coronavirus than you think

We aren't testing enough to control the outbreak. The real count could be 10 times

A notice outside a Target store in Washington, D.C., advises customers that it isn't performing tests for the coronavirus. Not enough places are. (Mandel Ngan/AFP/Getty Images)

By Marc Lipsitch

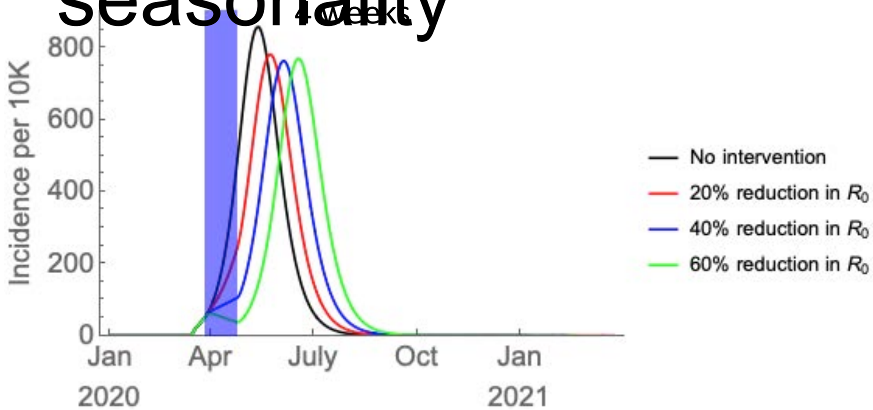
Marc Lipsitch is a professor of epidemiology and the director of the Center for Communicable Disease Dynamics at the Harvard T.H. Chan School of Public Health.

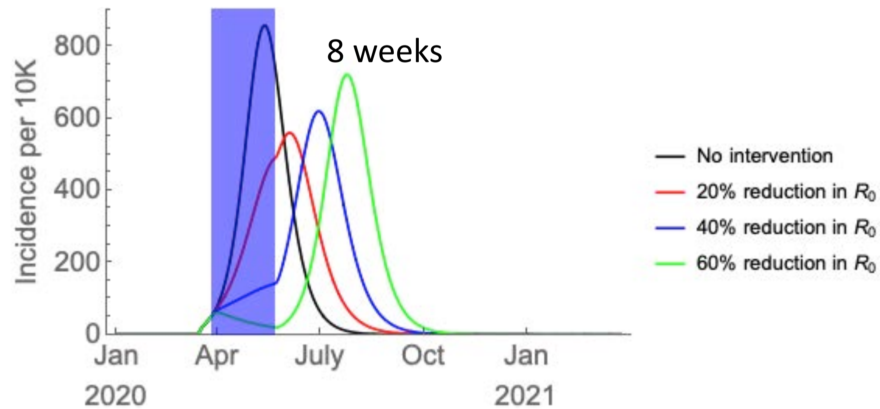
March 23, 2020 at 7:54 a.m. EDT

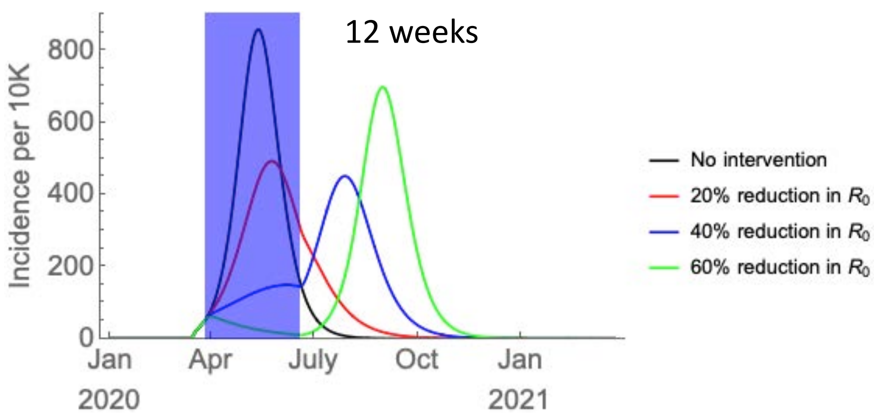
As an infectious disease epidemiologist who has worked on pandemics for two decades, I've talked in recent days to journalists and health officials in the United States and from halfway around the world about how to stop the novel coronavirus that causes the disease covid-19. They all have the same questions: How many tests do we need? How should we use tests? For each case we know about, how many more cases are out there? What's the best way to find undiagnosed cases? Should we do "active case finding," which involves testing everyone who is mildly ill, then isolating known cases and quarantining and isolating their contacts? Instead — or in addition —

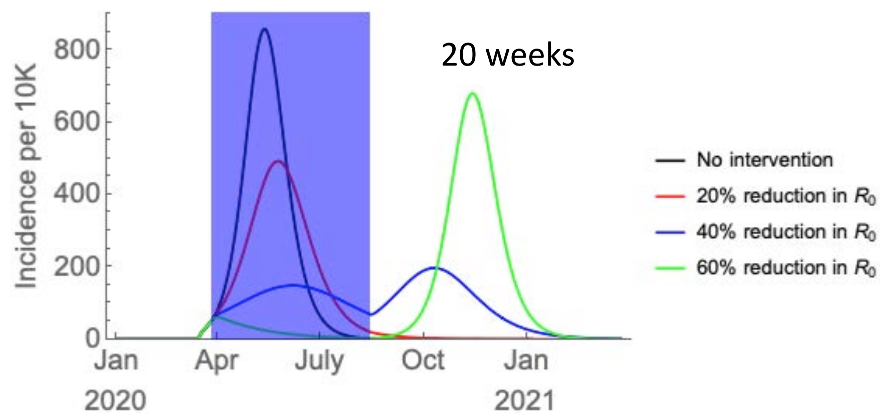
https://www.washingtonpost.com/outlook/2020/03/23/coronavirus-count-confirmed-testing/

Incidence for one-shot interventions w/out seasonality

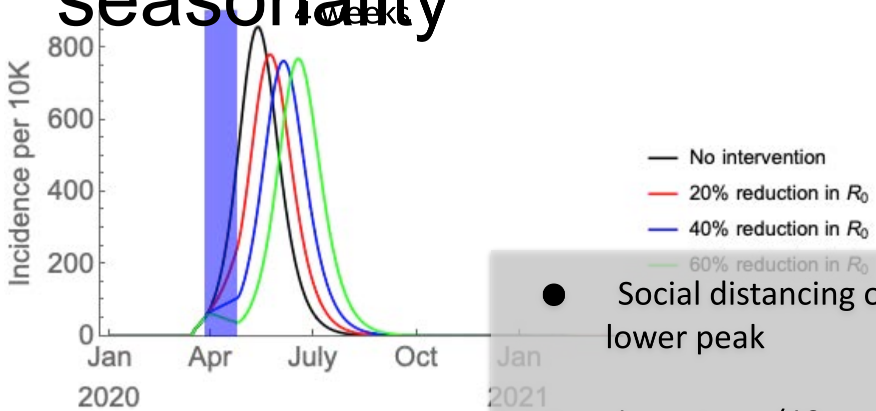


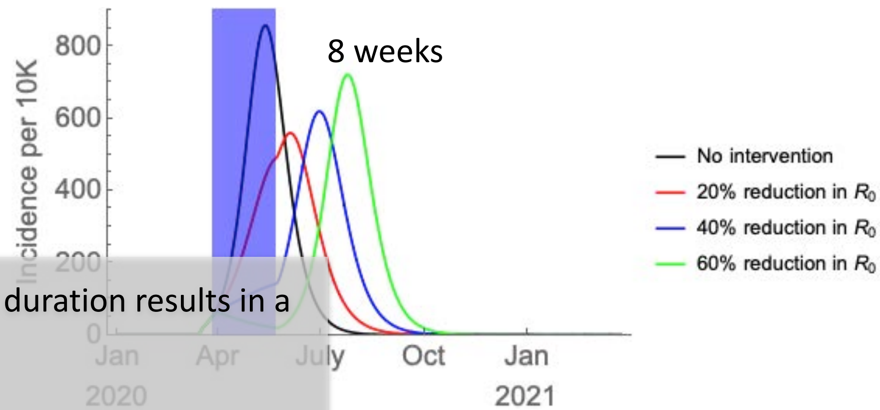




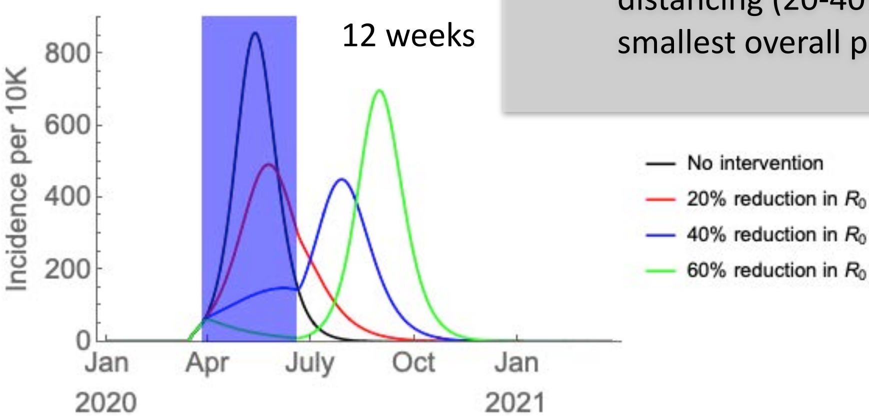


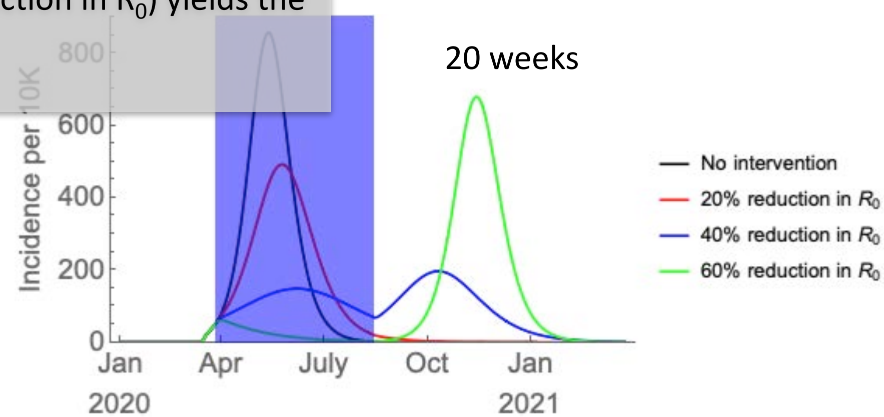
Incidence for one-shot interventions w/out seasonality



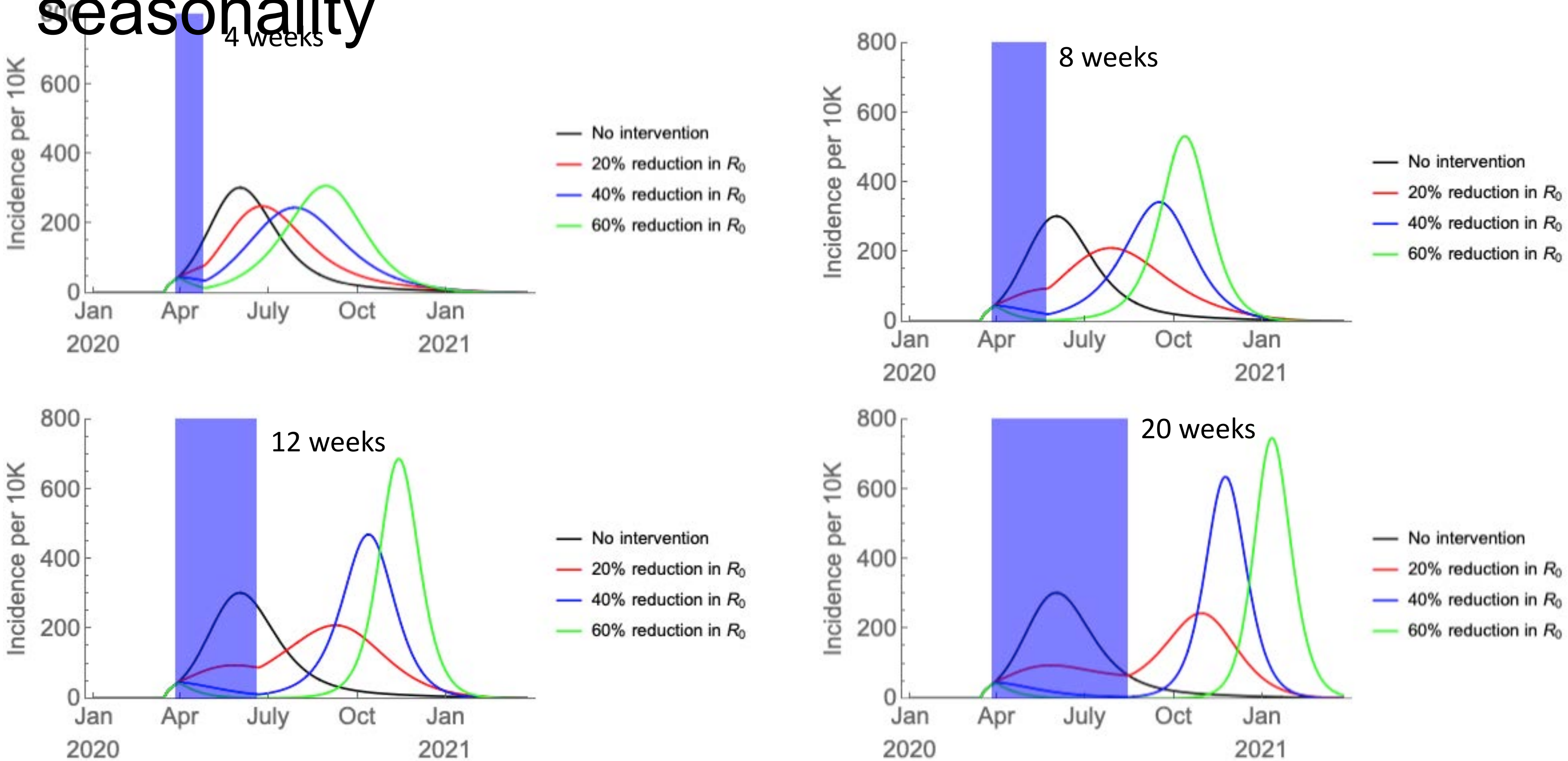


- Social distancing of any duration results in a lower peak
- Long-term (12- or 20-week) intermediate distancing (20-40% reduction in R_0) yields the smallest overall peaks

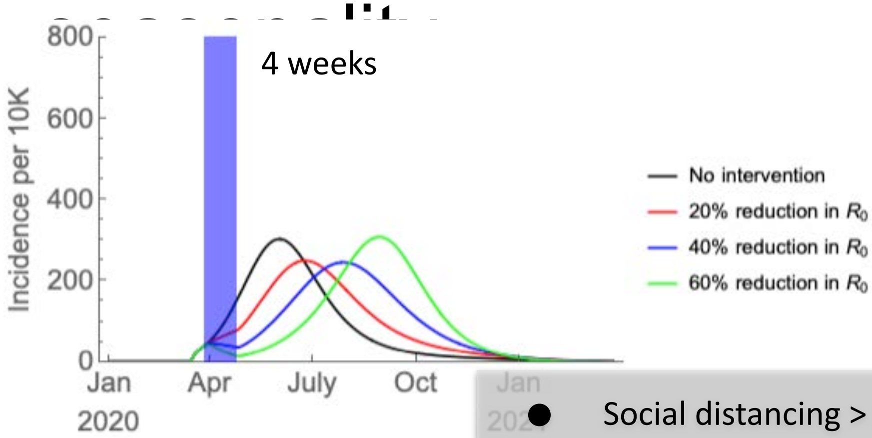


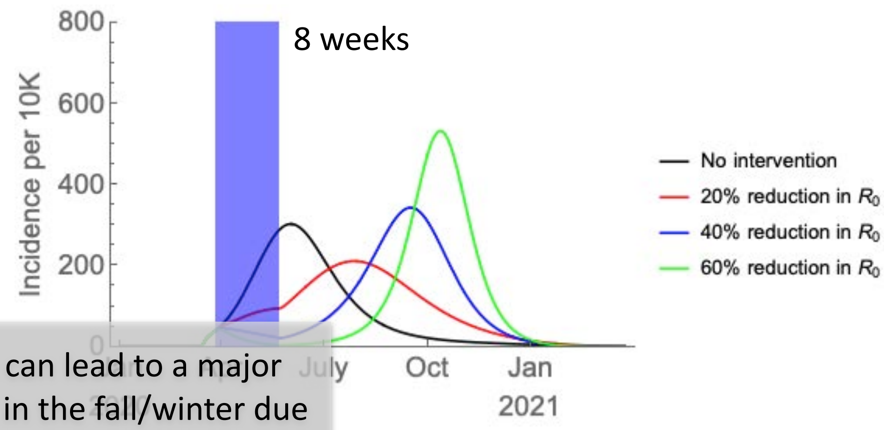


Incidence for one-shot interventions with seasonality

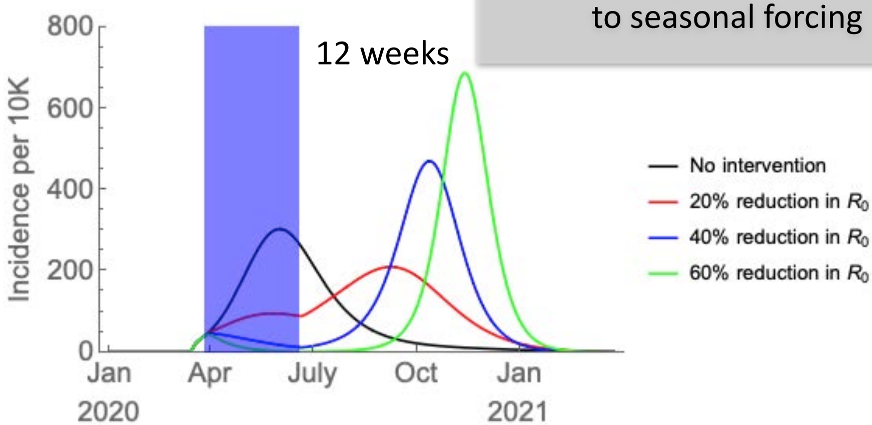


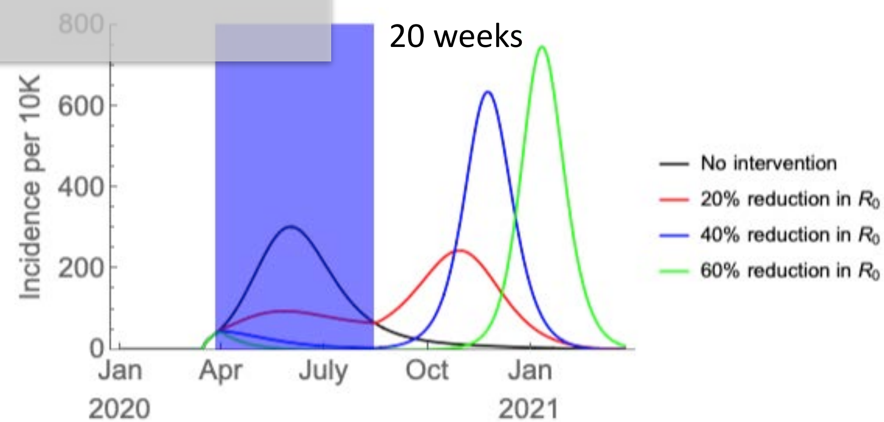
Incidence for one-shot interventions with





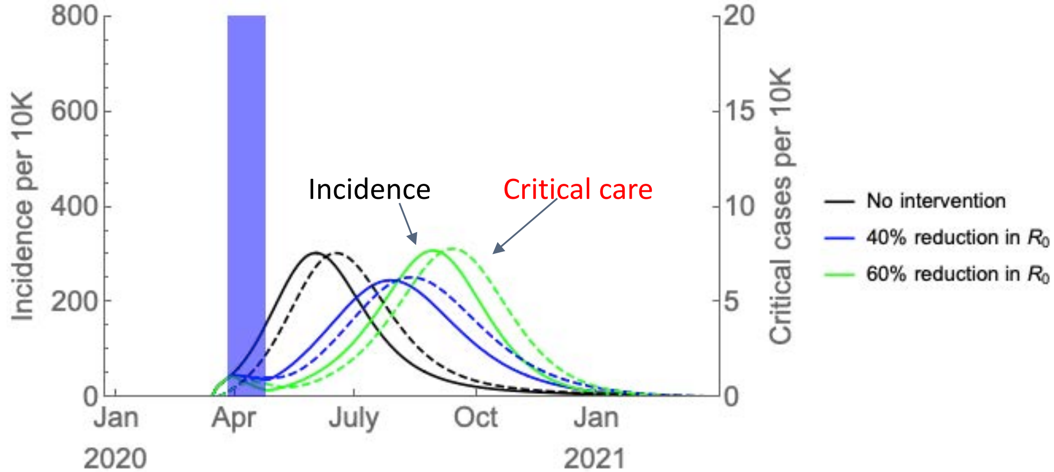
- Social distancing > 20% can lead to a major resurgence of incidence in the fall/winter due to seasonal forcing



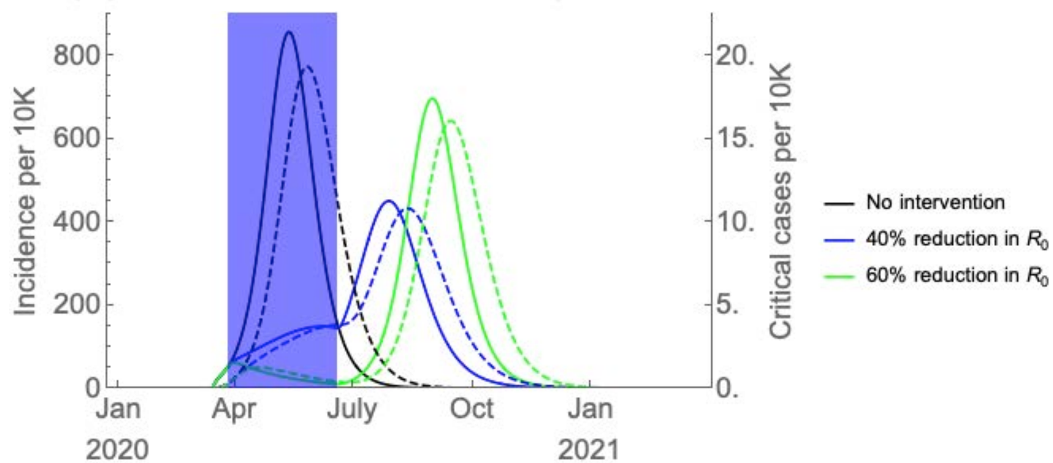


Critical care demand lags behind incidence

With seasonality,
4-week intervention



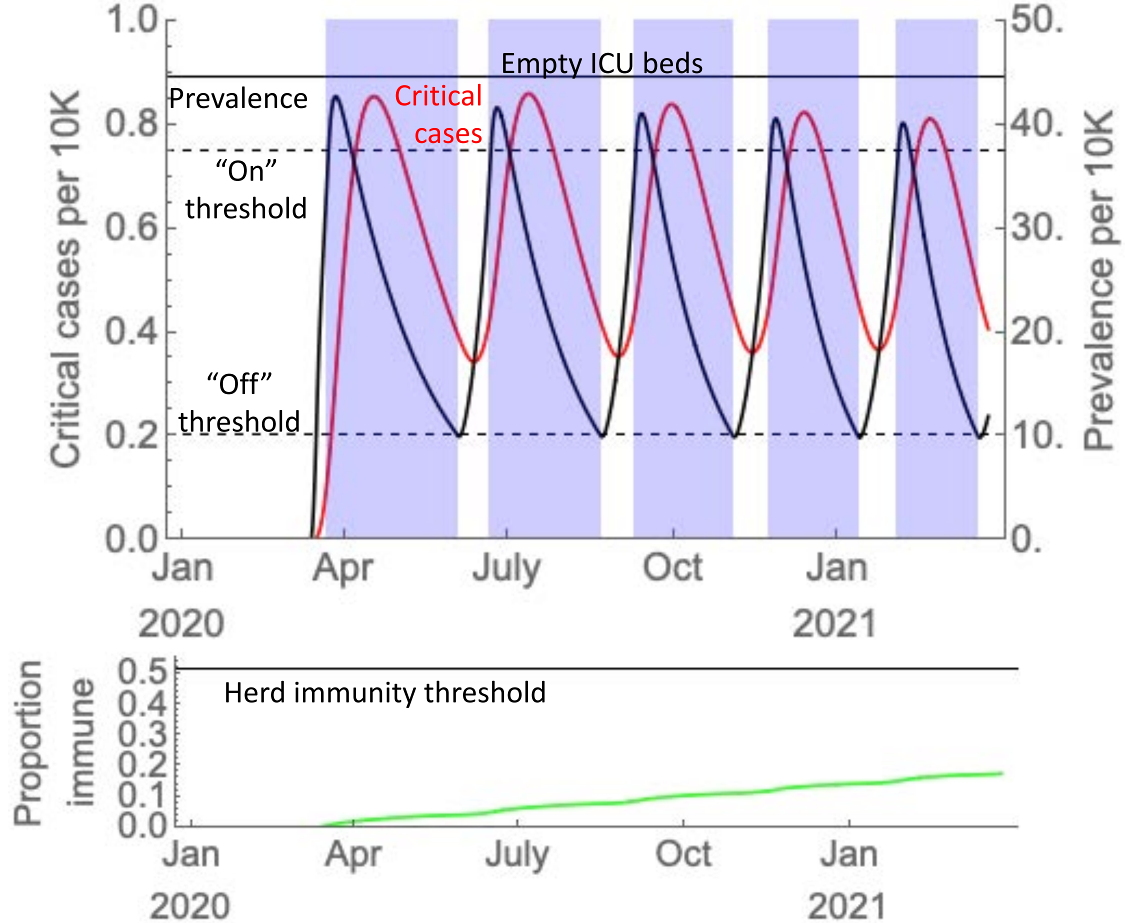
Without seasonality,
12- week intervention



Summary: One shot

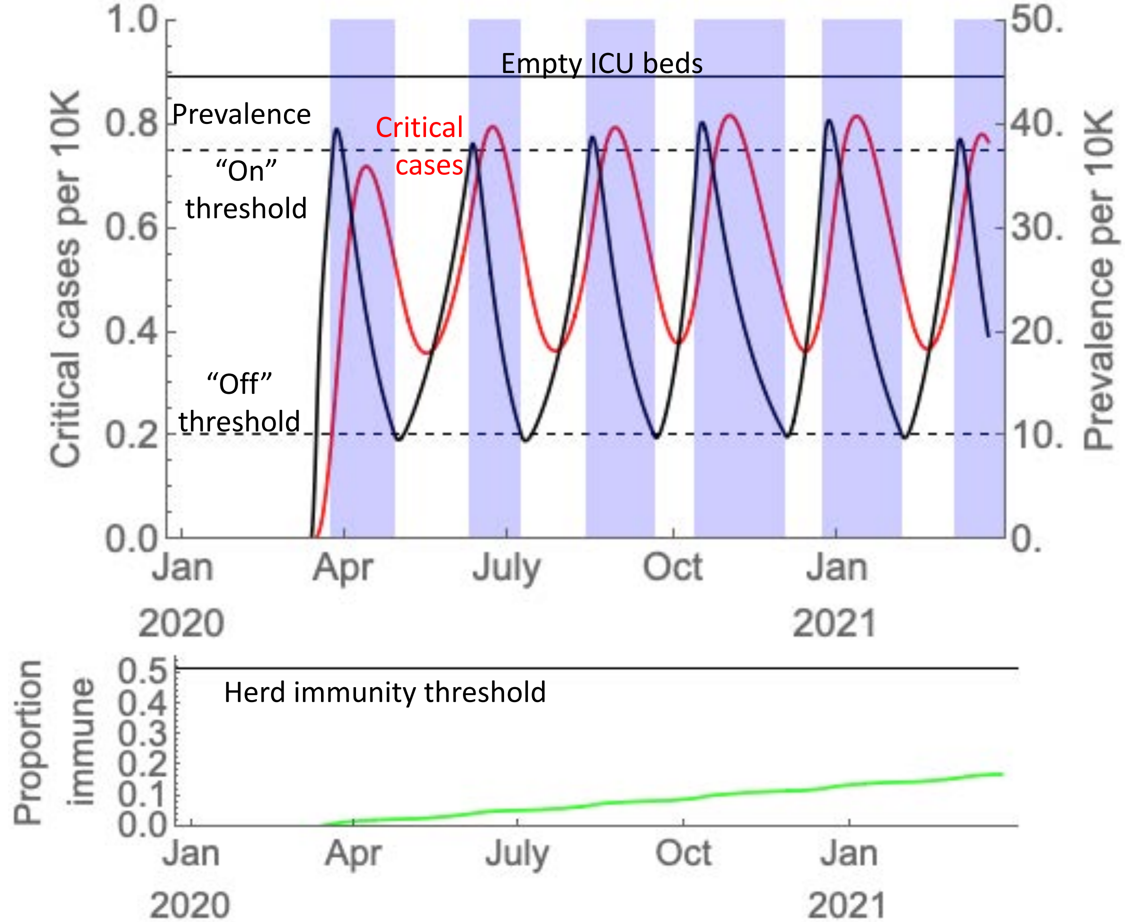
- If seasonality is negligible, then all social distancing helps, and long, moderate social distancing is best
- If seasonality, then long, weakly effective social distancing is best, but strongly effective social distancing makes it worse by delaying the peak into the winter (more cases because more transmission, plus coincides with flu season)
- This is treacherous – please ask others, but we suspect there will be some seasonality, so one-shot could make things worse

Cycled social distancing, 60% R_0 reduction, no seasonality



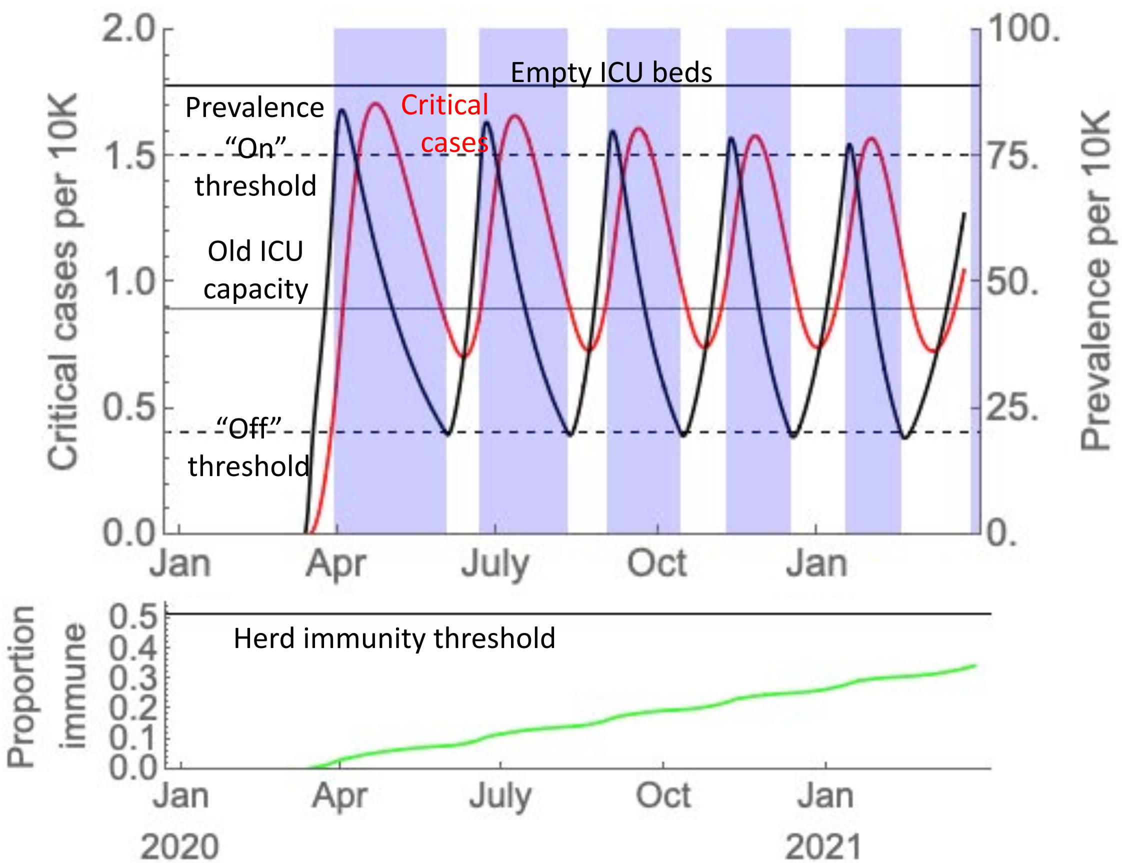
Lag between intervention and peak ICU demand is ~ 3 weeks

Cycled social distancing, 60% R_0 reduction, with seasonality



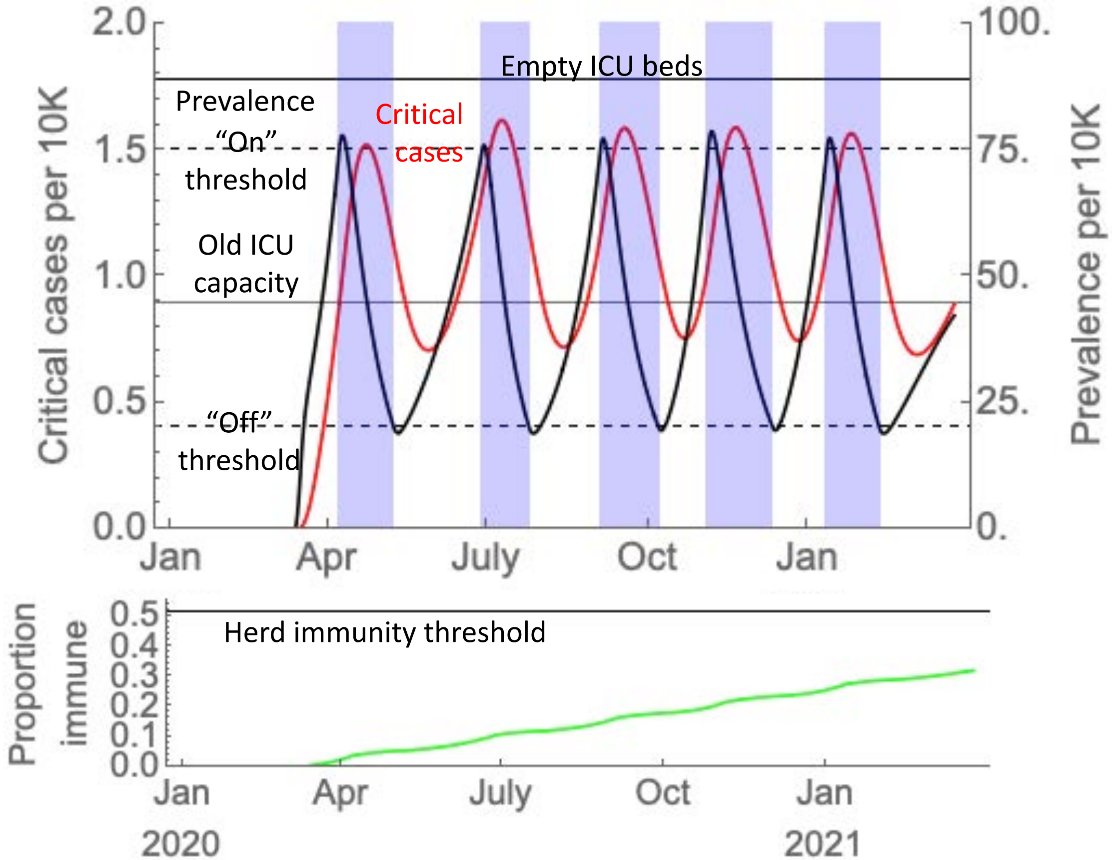
Summer reduction in transmissibility keeps peak ICU utilization lower and lengths breaks between interventions

Cycled social distancing, 60% R_0 reduction, with no seasonality with double the ICU capacity



Doubling ICU capacity allows higher on threshold, lengthens the time between interventions while accelerating herd immunity

Cycled social distancing, 60% R_0 reduction, with seasonality with double the ICU capacity



Doubling ICU capacity allows higher on threshold, lengthens the time between interventions while accelerating herd immunity. Seasonality helps further

Summary: cycled distancing

- If no seasonality, approx 4:1 on to off time, slow accumulation of herd immunity
- Seasonality helpful in this scenario: longer off time thanks to summer slowdown
- Doubling ICU capacity allows longer breaks and faster accumulation of herd immunity
- ***Must have good surveillance in place to avoid overshooting ICU capacity

- https://www.medrxiv.org/content/10.1101/2020.03.22.20041079v1

Comment on this paper

Social distancing strategies for curbing the COVID-19 epidemic

Stephen M Kissler, Christine Tedijanto, Marc Lipsitch, Yonatan Grad

doi: https://doi.org/10.1101/2020.03.22.20041079

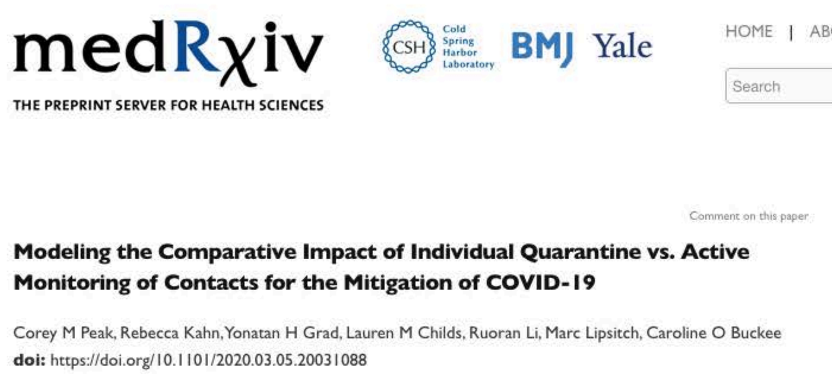
Pos

Exit strategy?

- If we can get cases down, and testing up, we could approach a situation like Singapore/Iceland/Taiwan/etc
  - Case numbers small enough that we can trace them all
  - Most cases are detected
  - Case-based interventions can become useful again as a mainstay of strategy
- Major caveat: importations

Synergy of social distancing and contact tracing/quarantine

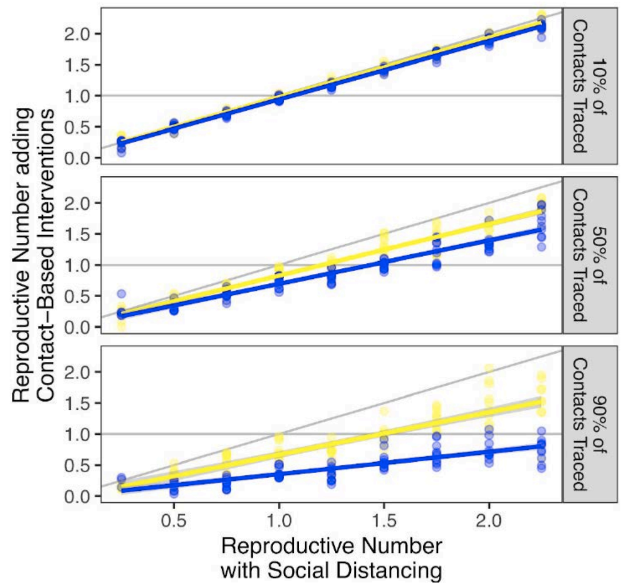
- https://www.medrxiv.org/content/10.1101/2020.03.05.20031088v1



Modeling the Comparative Impact of Individual Quarantine vs. Active Monitoring of Contacts for the Mitigation of COVID-19

Corey M Peak, Rebecca Kahn, Yonatan H Grad, Lauren M Childs, Ruoran Li, Marc Lipsitch, Caroline O Buckee

doi: https://doi.org/10.1101/2020.03.05.20031088



Objectives

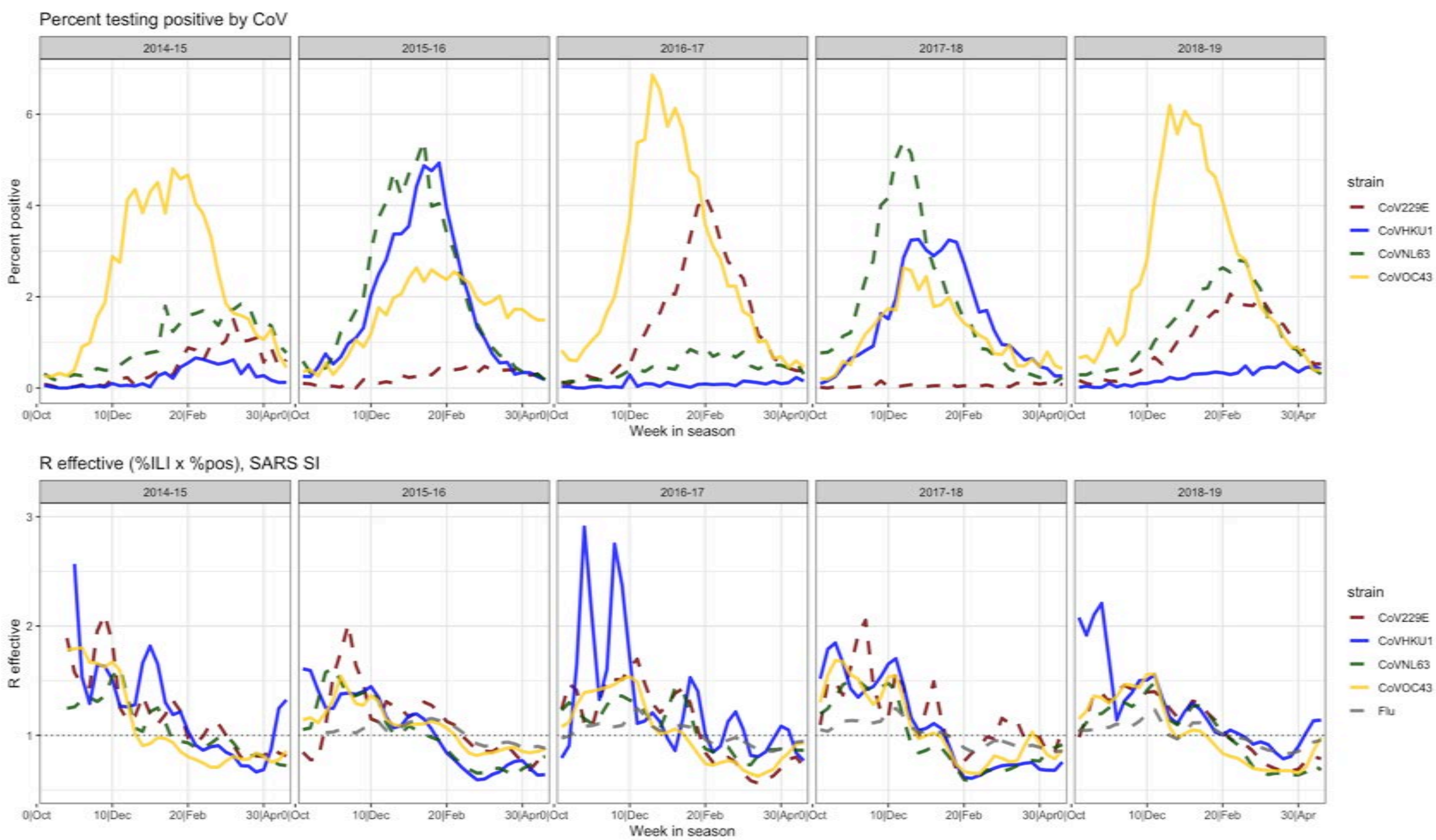
How might the establishment of SARS-CoV-2 in the US affect coronavirus dynamics over the next five years?

Potential scenarios:

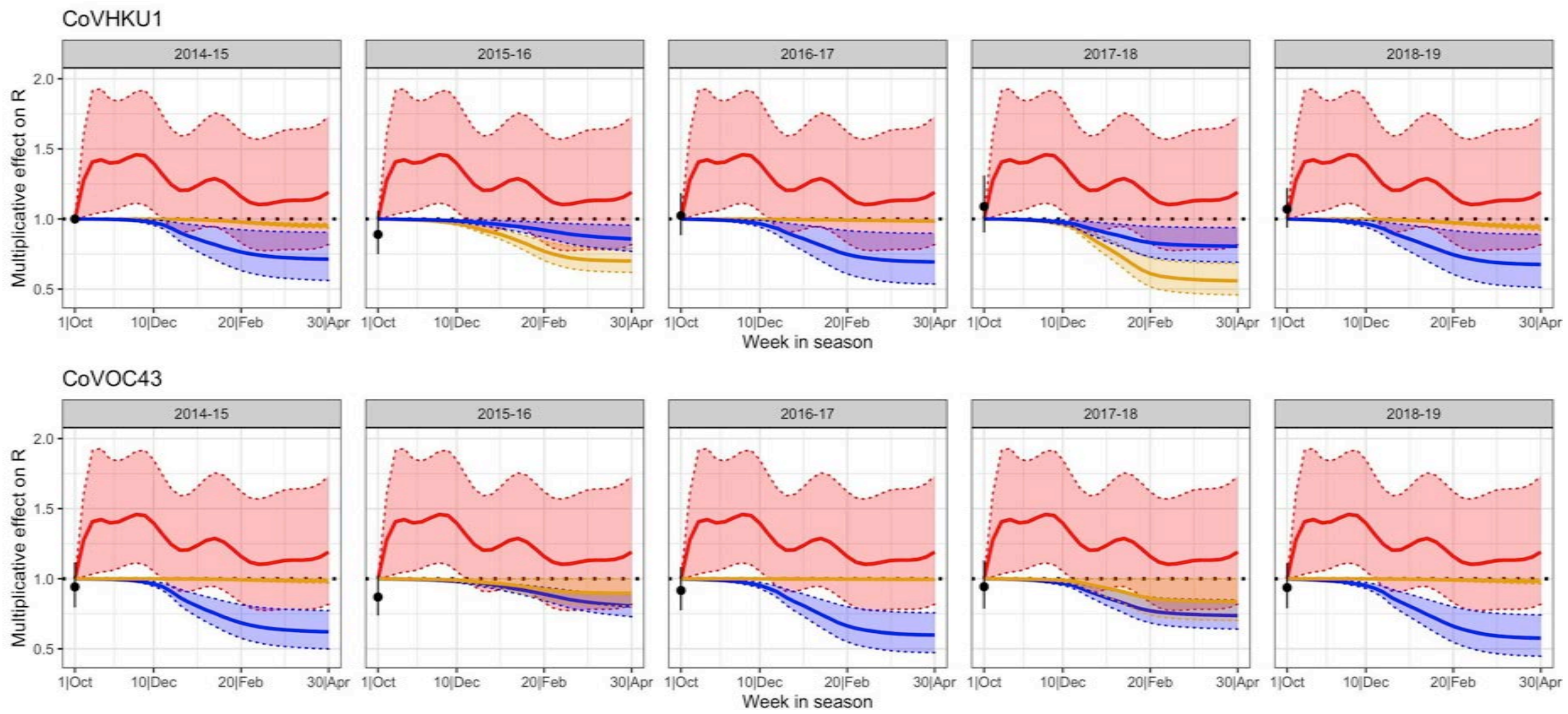
- *SARS-CoV-2 will enter into circulation with the other four coronaviruses*
- *SARS-CoV-2 will drive the other betacoronaviruses to extinction and enter circulation, leaving only itself and the alpha coronaviruses*
- *SARS-CoV-2 will drive the other betacoronaviruses to extinction, cause a major epidemic, and will die out itself*

Dynamics will depend on **duration of immunity** to SARS-CoV-2**, cross-immunity** between coronaviruses**,** and **seasonal forcing**

Estimated seasonality of seasonal CoV from NREVSS data



We found evidence of seasonal forcing, cross-immunity between the betacoronaviruses, and rapidly waning immunity

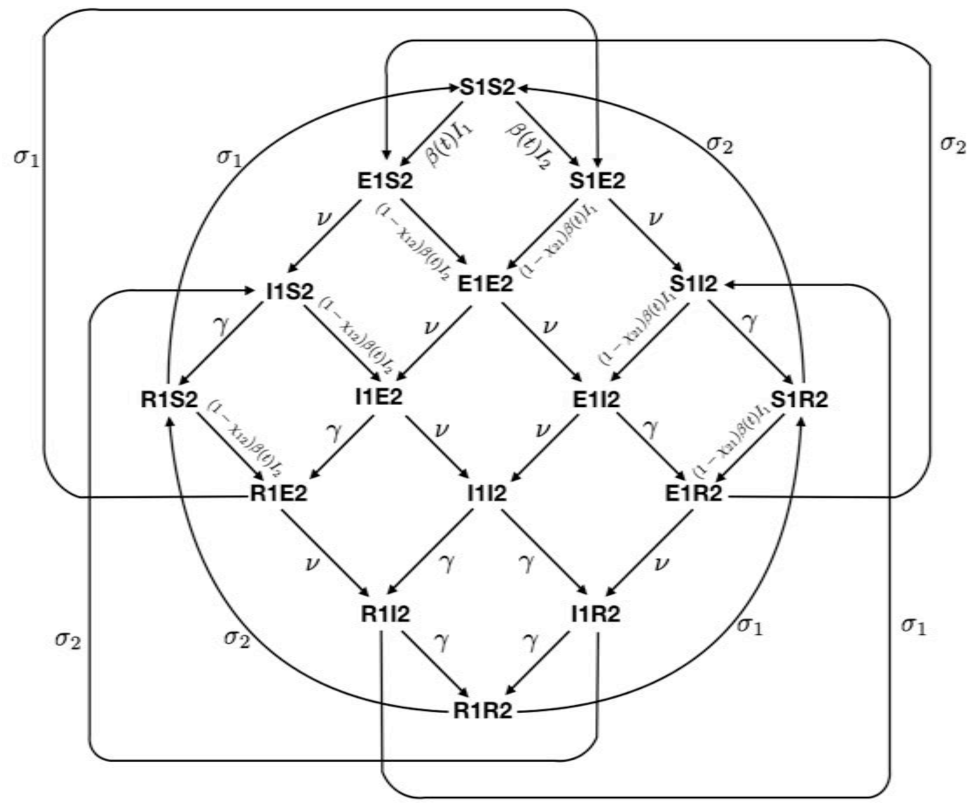


Blue = effect of CoVHKU1, **gold** = effect of CoVOC43, **red** = seasonal forcing

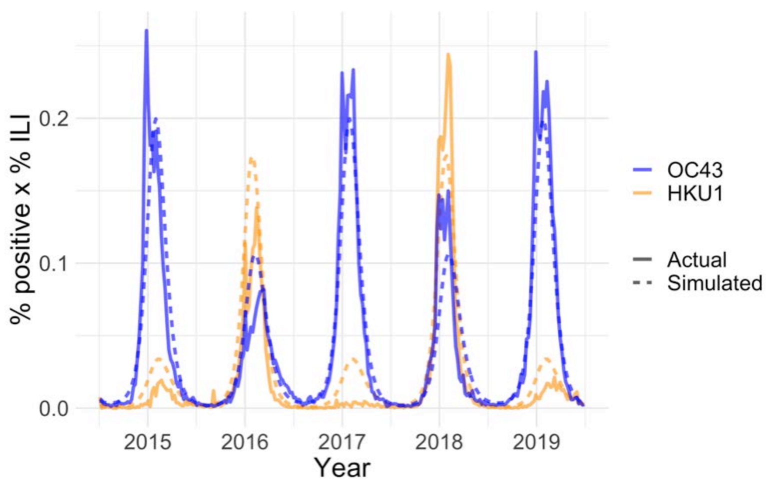
We built an SEIR model to describe current transmission dynamics and project future scenarios

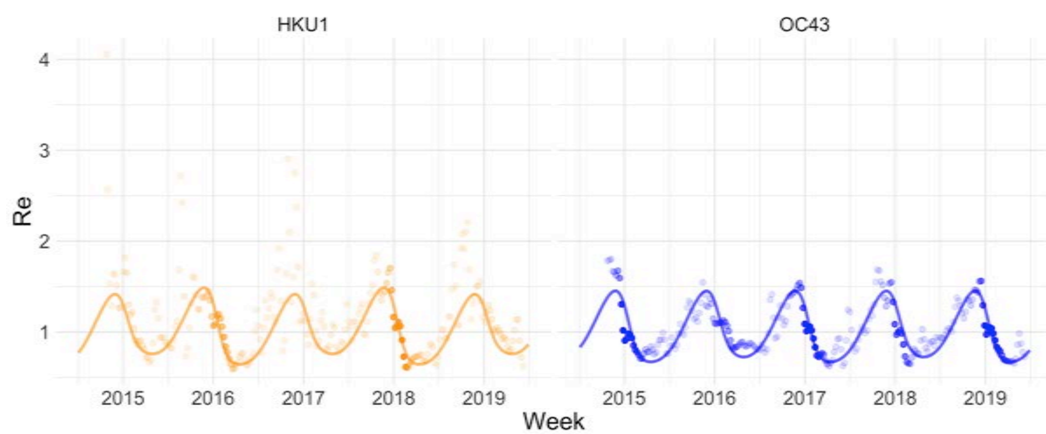
Assumptions:

- Strains have same incubation and infectious periods
- Co-infection doesn't lead to any differences in disease progression

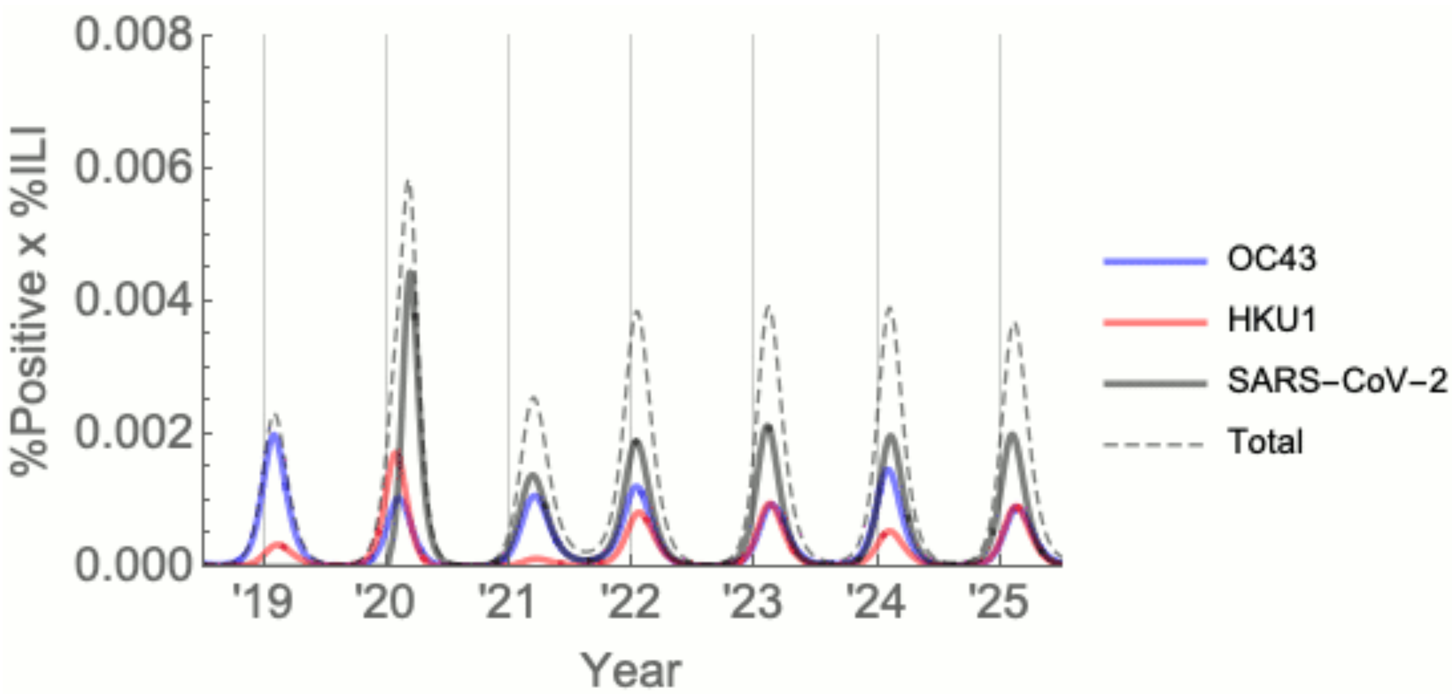


Model provided good fit to observed incidence proxy and effective reproduction numbers



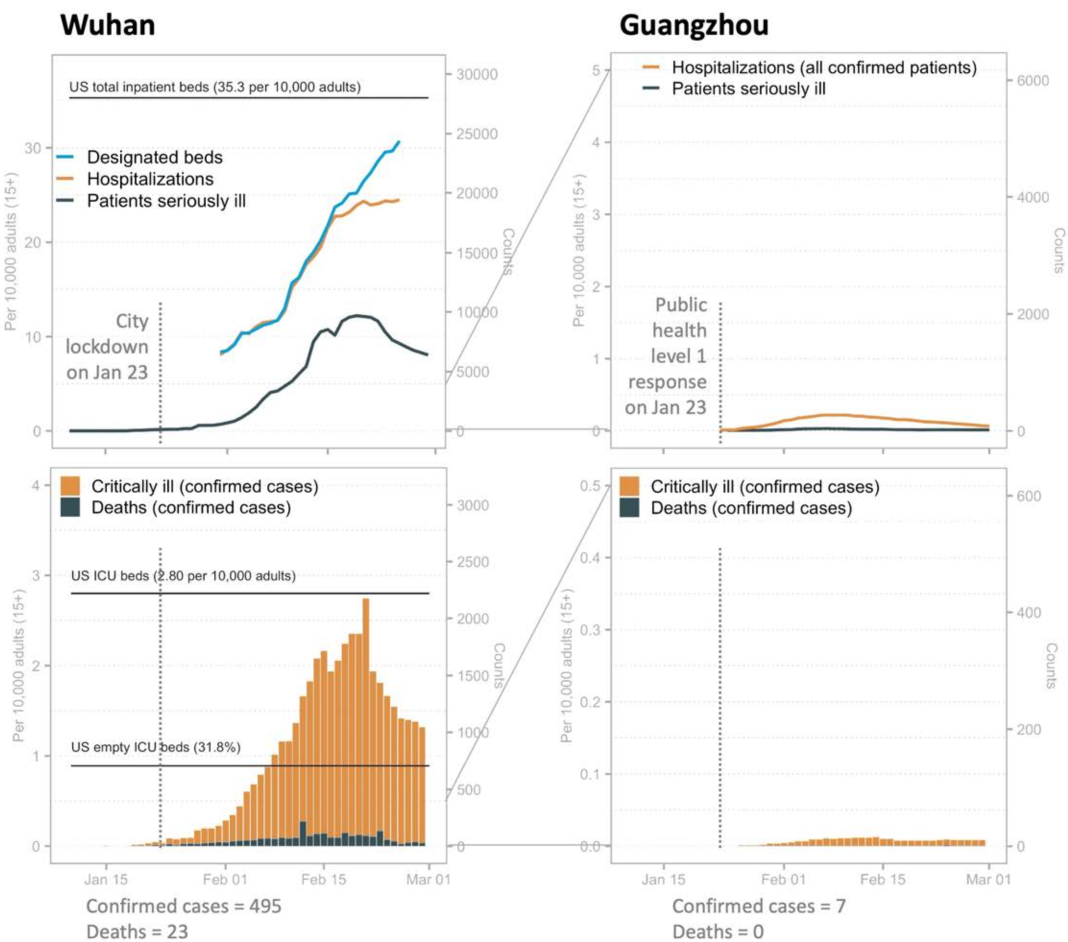


Scenarios: winter *vs.* summer introduction



40 week immunity to SARS-CoV-2
30% cross immunity from SARS-CoV-2 to other betacoronaviruses

Hospital and ICU demand



- Can protect HC with distancing
- 3-4 week delay from closedown to peak ICU demand
- Lingering ICU for weeks

Ruoran Li, Caitlin Rivers, Qi Tan,
Megan Murray, Eric Toner, Marc Lipsitch

Work in progress

- Travel and introductions into Africa
- Scenarios for interventions: starting, stopping
- Ethics of vaccine trials, ethics of vaccine distribution
- More on bed capacity
- Comparing individual quarantine to active monitoring of symptoms for containment
- Diagnostics and serodiagnostics (Mina)

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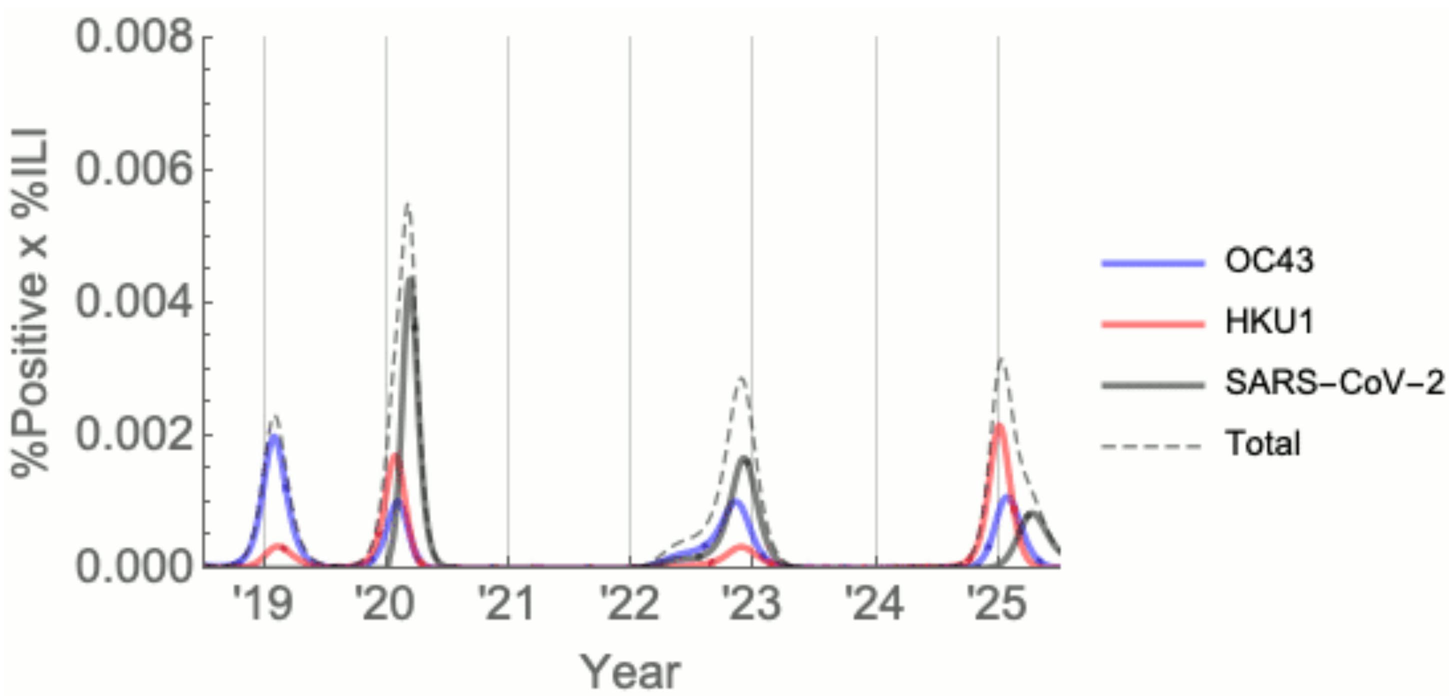
Scenarios: post-pandemic dynamics



104 week immunity to SARS-CoV-2
70% cross immunity from SARS-CoV-2 to other betacoronaviruses

Fully agree with broad outlines of Imperial report

- Long-term distancing is only alternative to overwhelming health care system
- Both may occur if our control measures are inadequate
- Neither is attractive

Projecting the transmission dynamics of SARS-CoV-2 through the post-pandemic period

Stephen Kissler[1†], Christine Tedijanto[2†], Edward M. Goldstein[2], Yonatan H. Grad[1], Marc Lipsitch*[2]

[1]Department of Immunology and Infectious Diseases, Harvard T.H. Chan School of Public Health, Boston, MA, USA
[2]Department of Epidemiology, Harvard. T.H. Chan School of Public Health, Boston, MA, USA

* Correspondence to: mlipsitc@hsph.harvard.edu
† denotes equal contribution

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MIDAS Models of Infectious Disease Agent Study

Funded by the National Institutes of Health

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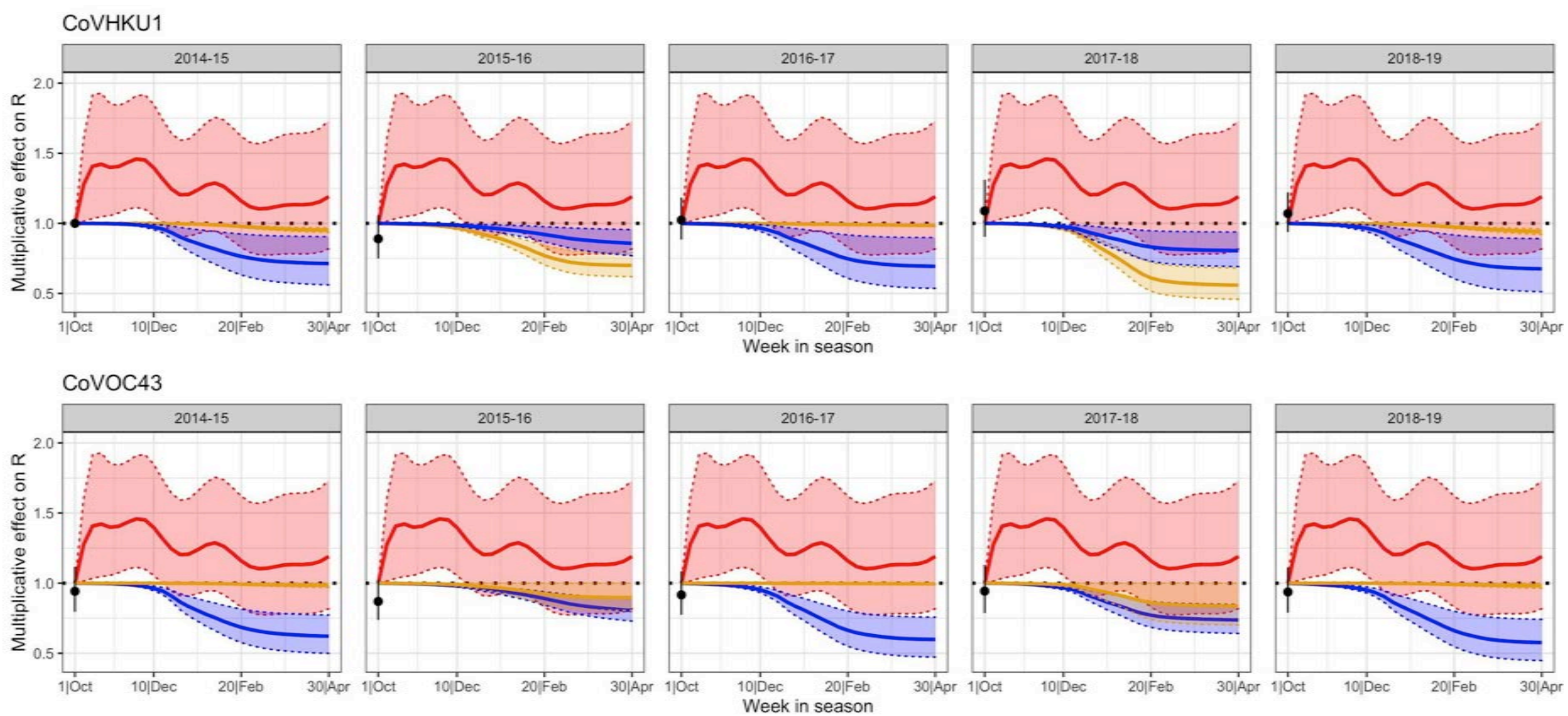
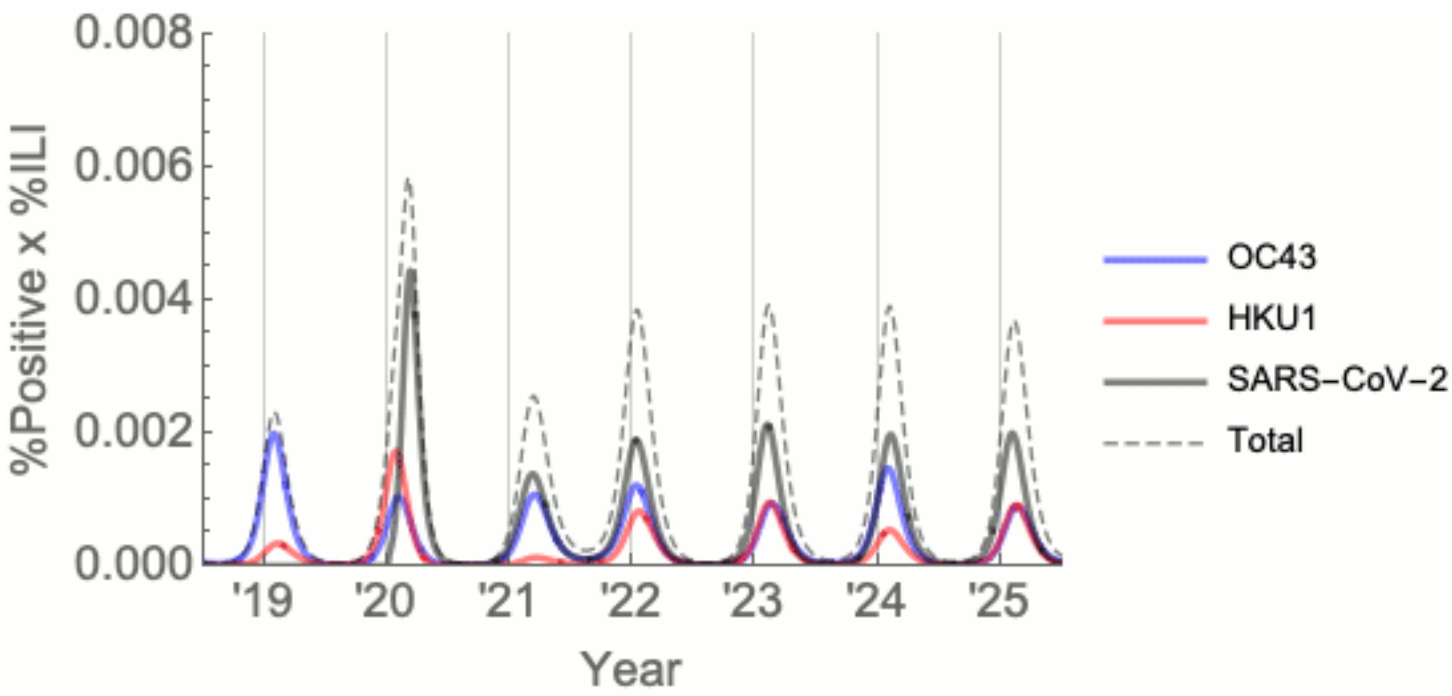


Blue = effect of CoVHKU1, **gold** = effect of CoVOC43, **red** = seasonal forcing

In uncontrolled epidemics, timing of introduction matters a lot



40 week immunity to SARS-CoV-2
30% cross immunity from SARS-CoV-2 to other betacoronaviruses

Scenarios for interventions

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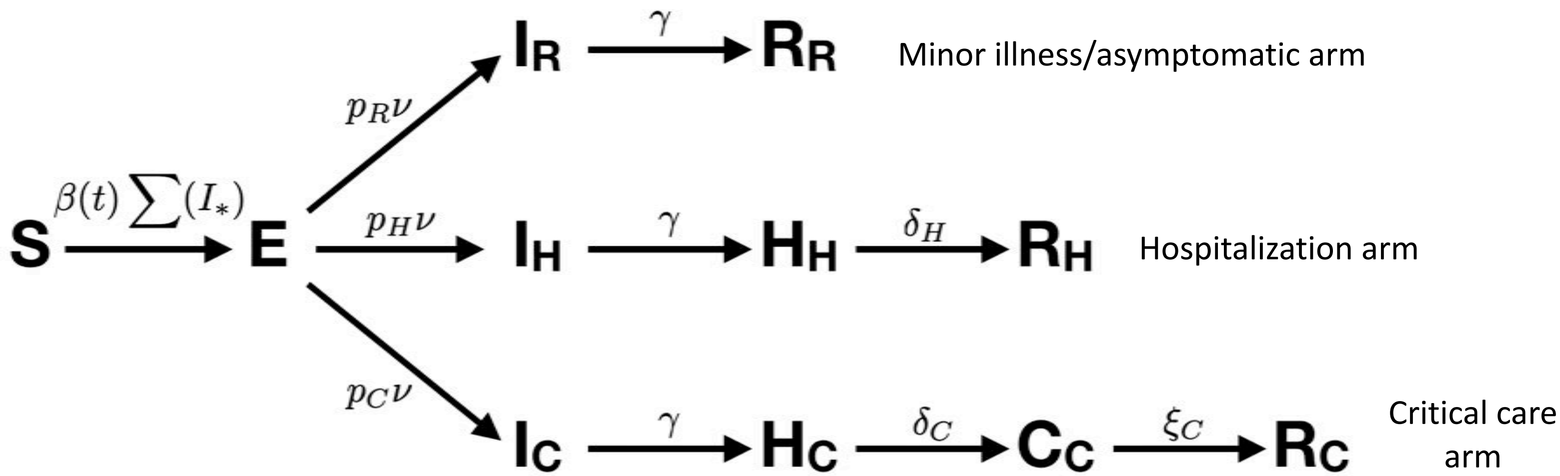
Center for Communicable Disease Dynamics

MIDAS Models of Infectious Disease Agent Study

Funded by the National Institutes of Health

Model (with Imperial parameters)



Model (with Imperial parameters, +/- seasonality