

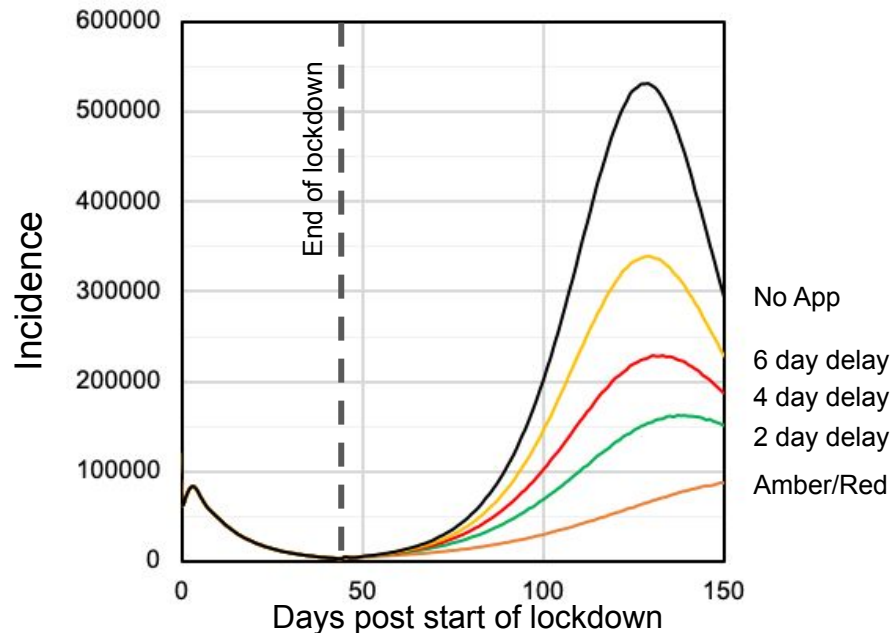
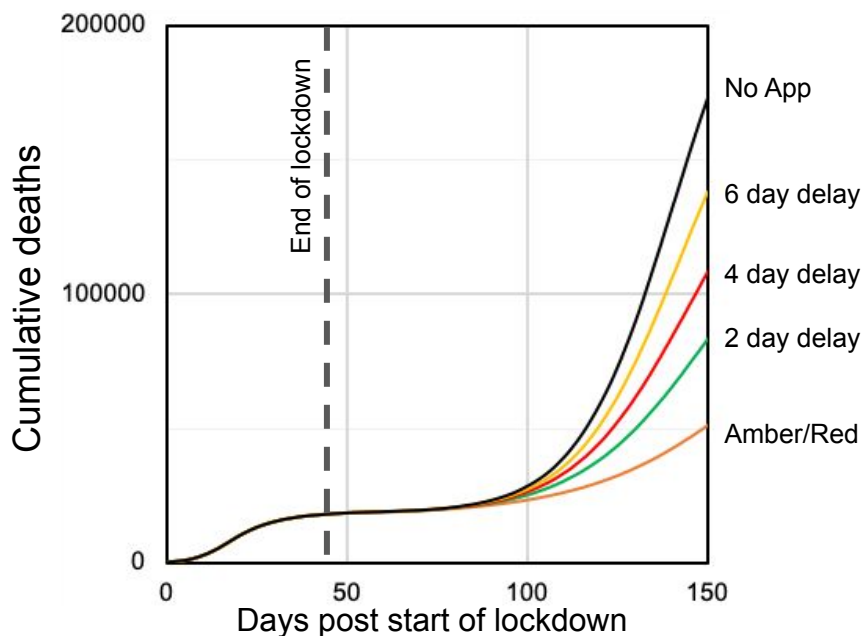
# Digital contact tracing: advice and simulations

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# Context

- A multidisciplinary team including maths, simulation, clinical science, lab & ethics
- Formulated early mathematical model of contact tracing (CT) of COVID-19, and found that due to extensive pre-symptomatic transmission, CT needed to be very fast.
- Digital contact tracing solves this problem of speed.
- Many papers now confirm both findings: presymptomatic transmission, and feasibility of digital contact tracing.
- Since then we have advised several health authorities developing contact tracing apps.
- Developed an open-source agent based simulation: OpenABM-Covid.
- OpenABM-Covid acquires the network-memory needed to model contact tracing, which is not a feature of many other models of infectious disease transmission.

# Epidemic control is highly sensitive to speed of notification



Initial  $R_0$  of 3

Assuming 20% reduction in non-household contacts after lockdown

**Delay includes: Time taken to report symptoms and order test + (mail order kit deliver/collection time OR time to visit testing centre) + test turnaround time**

# Initiating tracing on symptoms buys precious time

AMBER notifications are not quarantine notifications.

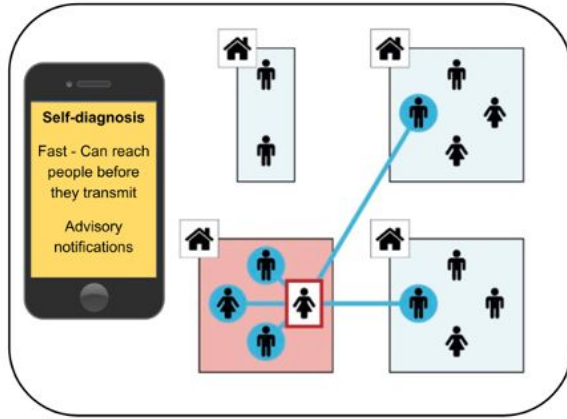
“You’ve come into contact with someone who declares symptoms of COVID-19”

Most AMBER notifications are temporary (time it takes for the index to take a test)...some will turn to RED

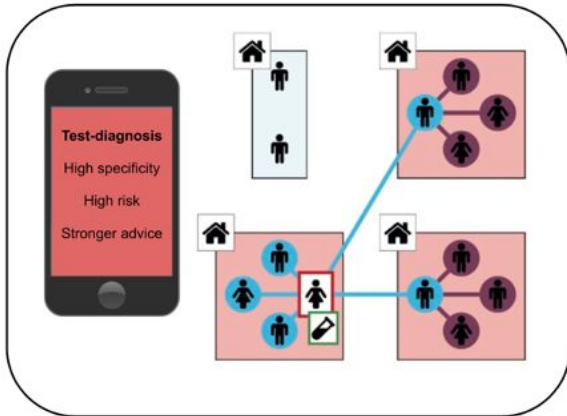
Time to prepare: eg. make arrangements at work

Step-up social-distancing measures – eg. wear a mask

Avoid contact with the elderly and vulnerable

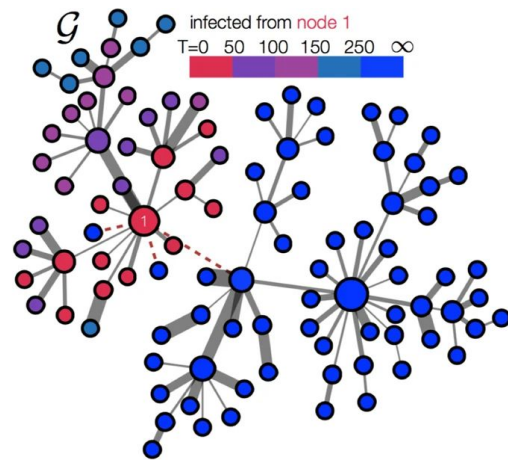


Index tests positive



# The app is useful even at low levels of uptake

1. In clustered social networks, someone who receives a notification that they have come into contact with an infected individual, who quarantines themselves, is at reduced risk of acquiring infection from their immediate social network (no ‘false positives’).
2. If a group of people who contact each other frequently, such as friends, family & colleagues, have high uptake, then they have created a local protection that will prevent sustained chains of transmission in that group.
3. Even at low uptake, the health authority will gain access to number of users asking for and receiving tests, and will be able to detect changes in transmission rates and respond more quickly to local outbreaks.



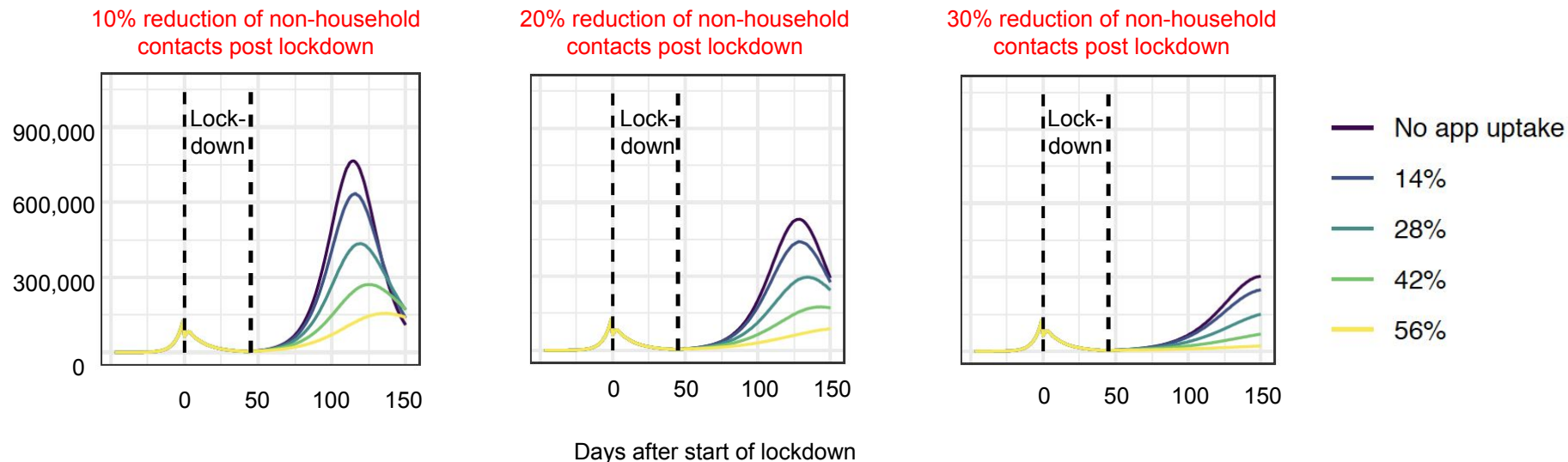
*OpenABM-Covid simulates spread on small world networks*

*Example network visualisation from  
Tolic et al Scientific Reports 2018*

# The app reduces cases and deaths at all levels of uptake

## The app achieves epidemic control at 56% of uptake

Daily new cases



Initial  $R_0$  of 3

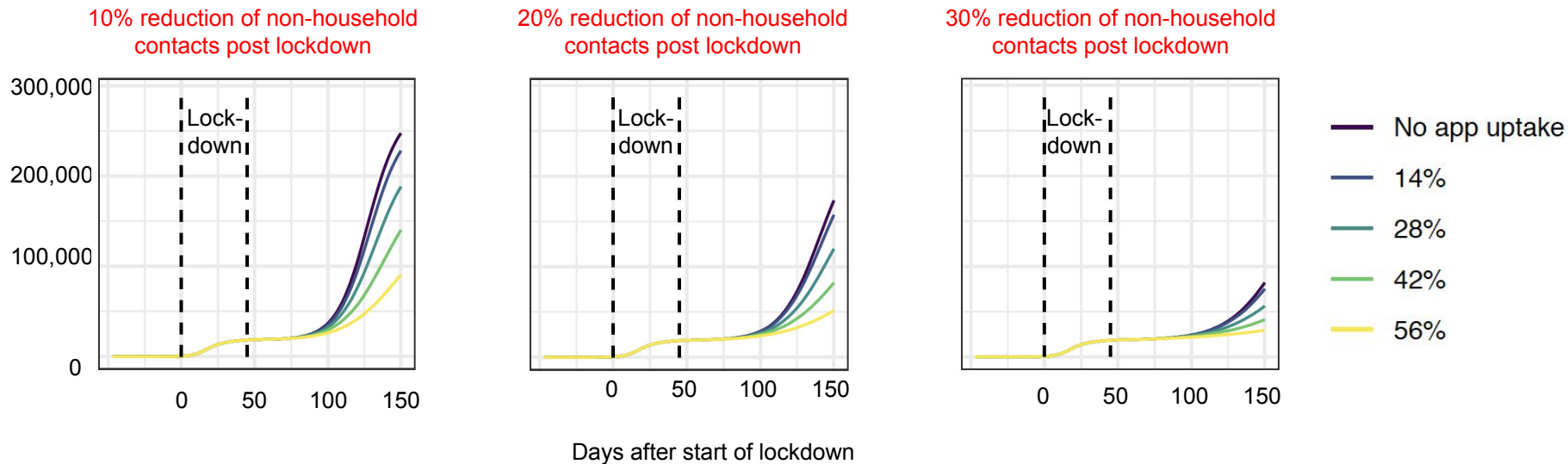
Lockdown of 45 days

Amber/red notifications (trace first, release on test)

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### Cumulative deaths

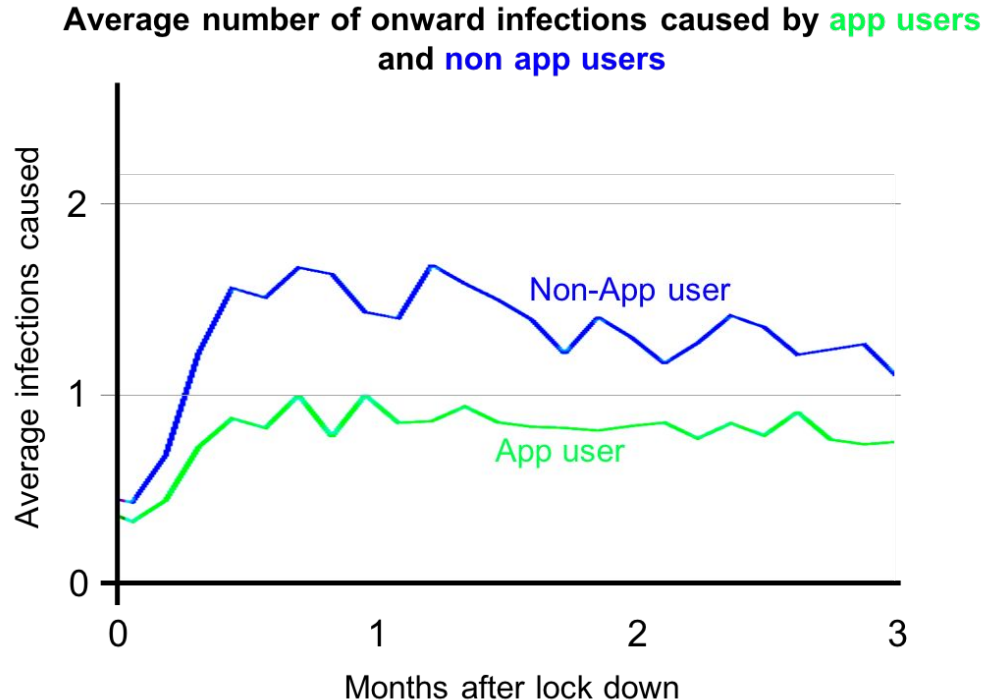


Initial  $R_0$  of 3

Lockdown of 45 days

Amber/red notifications (trace first, release on test)

# App users are predicted to cause one third less infections than non-app users



OpenABM-COVID simulation output. App users are predicted to cause 30% less onward transmissions in their community than non-app users. Based on a simulation of digital contact tracing that issues AMBER warnings to alert people of contact with symptomatic people, and RED warnings to alert people of contact with confirmed cases. Assumes 56% of the population use the app effectively. "Average infections" is defined as the average number of people that are infected by each *contact* of an *index* case. Assumes general population reduces social contacts outside their home by 25% compared to pre-lock down. Assumes the app is 80% effective at detecting transmission events



# Ongoing research questions

- Formulated early mathematical model of contact tracing (CT) of COVID-19, and found that due to extensive pre-symptomatic transmission, CT needed to be very fast.
- Digital contact tracing solves this problem of speed.
- Many papers now confirm both findings: presymptomatic transmission, and feasibility of digital contact tracing.
- Several papers express concern that effect may be limited at low app uptake: if  $U$  is the proportion of app users, then apps detect  $U^2$  contacts. If  $U$  is low, then  $U^2$  is very low.
- In our latest research, we find that this simple intuition is incorrect, for three reasons.