On the use of LFA tests in contact tracing: preliminary findings

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Rationale

We compare two policies for the efficacy of Test, Trace and Isolate (TTI):

1. **Status quo**: isolation of symptomatic individuals for 10 days post symptom onset and quarantine of 14 days for within-household contacts and tracing of contacts with 14 day post last exposure for outside of household contacts.

2. **Daily Lateral Flow Assay (LFA) testing** of all contacts with no quarantine for up to 14 days of negative tests; 10 days self-isolation for contacts testing positive. Contact tracing is initiated on a positive test result.

If contacts of a confirmed case do not quarantine and instead test regularly, there is a risk that they will transmit infection if their infection is not picked up by testing. On the other hand, the current system of only testing contacts who become symptomatic will miss contacts who are asymptomatic or do not report symptoms; thus the risk might be offset in gains via identifying more index cases for tracing. We use a household structured branching process model of infection and contact tracing to investigate.

Main points

- Daily LFA testing of traced contacts may offer an improvement over the current contact tracing strategy.

- **These are preliminary results. A full sensitivity analysis has not been completed and many of the parameters have significant uncertainty.** In particular, we were not able to have uncertainty in the test sensitivity curves.

- To make the strategies comparable for this analysis, we model uptake and adherence to self-isolation and quarantine (status quo policy) and daily LFA testing of 100%. This is not a realistic assumption in practice.

<u>Assumptions about the proposed daily LFAT testing of contacts policy:</u>

- If an individual has symptoms, and is not being LFA tested, then they must isolate and request a PCR test.
- When an individual tests positive (through either LFA or PCR), an individual initiates contact tracing for their recent contacts. Their household members begin LFA testing if they haven't already.

- When an individual is traced, they begin LFA testing.
- While an individual is being LFA tested, they do not have to quarantine.
- If an individual in a household where there has already been a confirmed case tests positive on an LFA test, the other individuals in the household only continue to get LFA tested until the time of the earliest recognised household symptom or LFA test plus the duration of LFA testing (14 days).
- If an individual is being LFA tested, then they do not get PCR tested.

Tracing rules for LFA testing of contacts:

Previously, when an individual tested positive through a PCR test, they would list contacts that occurred 2 days prior to symptom onset and 7 days post symptom onset. With the new LFA tests, these criteria do not necessarily make sense. Some individuals will test positive prior to symptom onset, and asymptomatics who do not have a symptom onset will also test positive.

We adopt the following assumed rules for contact tracing:

- If an individual tests positive through a PCR test:
    - Contacts occuring 2 days prior to and 7 days post symptom onset are traced
    - This is the current policy
- If an individual tests positive through a LFA test:
    - Contacts that occurred in the 5 days prior to receiving the positive test result are traced
    - Increasing the number of days prior to receiving the positive test result could be beneficial as this would increase backwards tracing.

Model of test sensitivity:

- We assume that the LFA test sensitivity curve is the same shape as the PCR test sensitivity curve [1l].
- When self administered by self-trained members of the public, LFA tests correctly identified 57.5% (95% CI:52.3-62.6%) of cases that were identified by PCR tests [2]. We rescale the curve so that this relationship holds true at all time points.
- We assume that the test sensitivity curve is the same for asymptomatic infections.

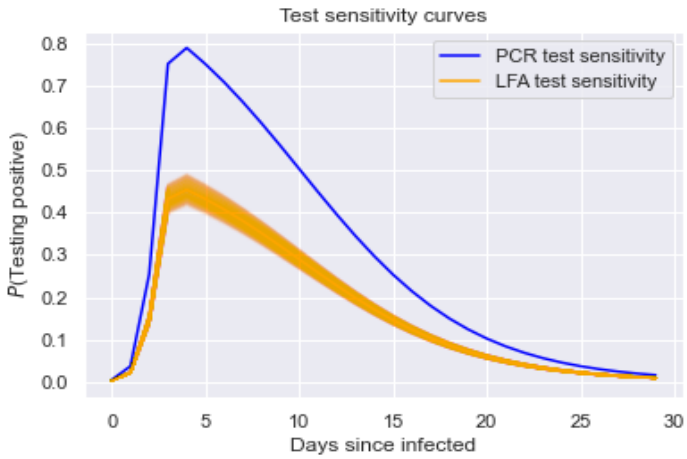

Figure 1: Our assumed test sensitivity probabilities over time since infected.

Results

We simulate the two strategies for 1000 simulations. Contact tracing delays, success probabilities and social distancing were kept constant across all simulations.

Scenario 1 - High levels of asymptomatic transmission

We assume that 30% of cases are asymptomatic, and that asymptomatic infections are just as infectious as symptomatic infections.

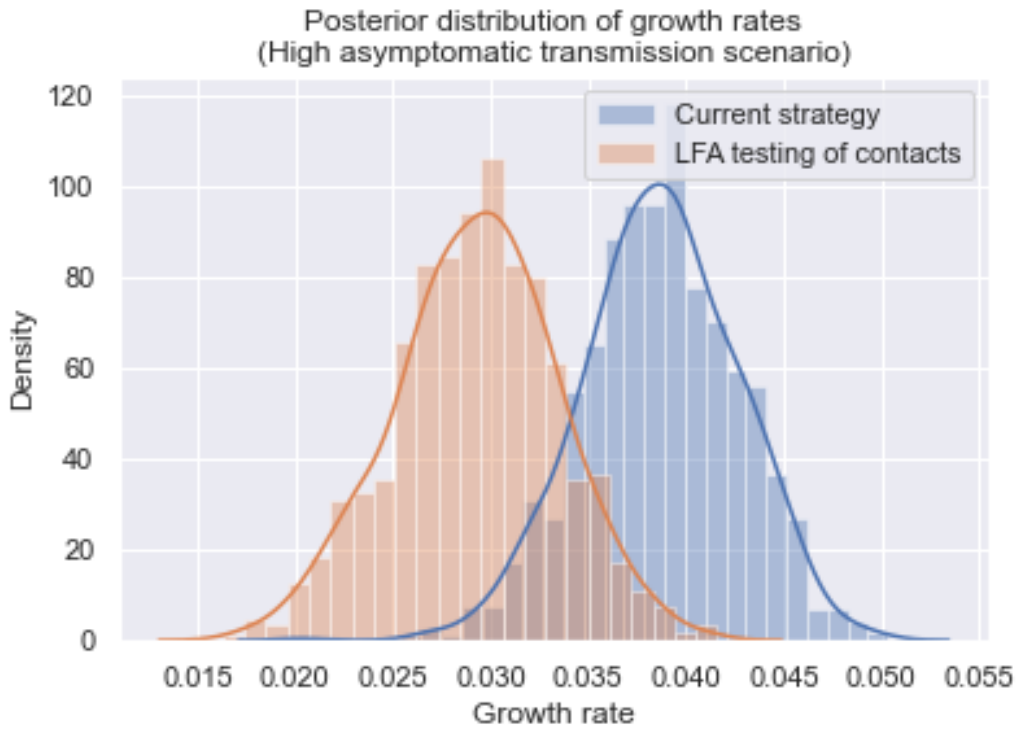

Figure 2: The posterior distribution of growth rates for a scenario with high levels of asymptomatic transmission.

The posterior distributions of growth rates are statistically different (p value < 0.001), and the growth rate was reduced by 0.009 (95% CI: 0.001, 0.018)

Scenario 2 - Low levels of asymptomatic transmission

We assume that 20% of cases are asymptomatic, and that asymptomatic infections are 35% as infectious as symptomatic infections.

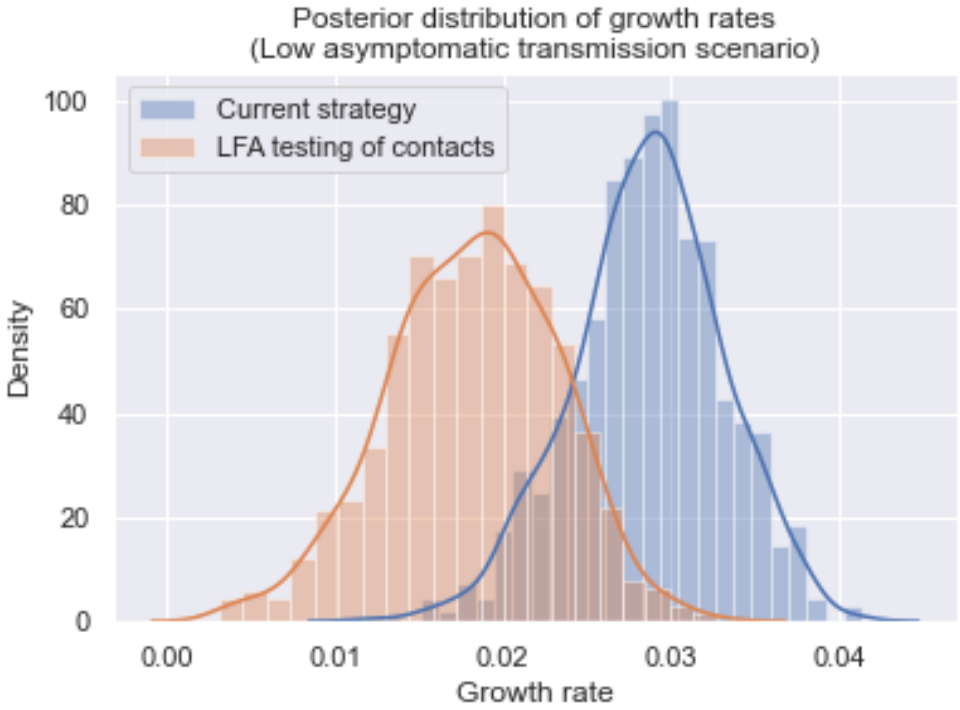

Figure 2: The posterior distribution of growth rates for a scenario with low levels of asymptomatic transmission.

The posterior distributions of growth rates are statistically different (p value < 0.001), and the growth rate was reduced by 0.0104 (95% CI: 0.001, 0.021)

Conclusions

We conclude that LFA testing of traced contacts could offer an improvement over the current contact tracing strategy. In both scenarios, introducing lateral flow testing of contacts reduced the growth rate by approximately 0.01.

This is a preliminary and rapid analysis, and sensitivity analyses have not yet been performed. There are uncertainties in assumptions about infection, testing, uptake and adherence that are not reflected in these findings.

Model of infection and TTI

We model a branching process of infection on individuals (‘nodes’) structured into households, with the contact tracing process modelled as a ‘superinfection’ along the tree generated by the infection branching process [3]. The model increments along discrete time-steps of one day, progressing both the infection transmission and the tracing processes. Each day, nodes make outside and within household contacts parameterised using the Polymod study [4], stratified by household size, distributed as per the UK population in 2018. To reflect changes in behaviour and physical distancing policies, we

scale the proportion of outside-household contacts made. The distribution of secondary cases is modeled as an overdispersed negative binomial distribution. Infection parameters are as Table 1.

We do not model repeat contacts. The model does not reflect any population immunity.

We compare the proposed daily LFA testing of contact policy described above to the status quo policy: untraced symptomatic individuals report their infection after a symptom reporting delay and a given proportion (defined by the infection reporting probability) seek a PCR test. Contact tracing is modelled with a set of testing delays, tracing delays and a tracing success probability informed by literature and statistics reported by TTI over the recent months. Self-isolation of self-reported cases lasts 10 days from symptom onset and contacts of a case quarantine for 14 days either from symptom onset of the first household case for within-household contacts, or 14 days post-infection date, assumed to be last exposure, for contacts of non-household cases.

For each of these scenarios we include higher and lower estimates of the proportion of infections that remain asymptomatic throughout their infection and the relative infectivity of asymptomatic to symptomatic infections [5].

Table 1 Parameter values

Parameter	**Values**
Growth Rate (pre-interventions or contact reductions)	0.22 per day (doubling time around 3 days) [6]
Incubation period	Gamma (shape=3.019, scale=1.6 days) [7]
Generation time	Weibull (mean=5, var=1.9^2 days) [8]
Household Size Distribution	(1: 0.29, 2: 0.35, 3: 0.15, 4: 0.14, 5: 0.05, 6: 0.02)
Household secondary attack rate	25% [9,10]
Overdispersion of secondary cases distribution	0.32
Proportion asymptomatic	Low: 0.2, High: 0.3 [5]
Relative infectivity of asymptomatics	Low: 0.35, As symptomatic: 1 [5]

Number of social contacts per day	Polymod (within and outside household proportions, by household size) [4]
Reduction in global contacts per day due to physical distancing	60%
Onset to isolation and PCR test booking among untraced symptomatic individuals	Gamma (mean = 2.62, sd = 2.38) [6, data from Singapore]
PCR testing delay (test to result and tracing)	Specimen to report delay, Exponential distribution, mean 1.5 days
Contact tracing delay	Exponential distribution mean 1.5 days
Probability of successfully tracing a contact	0.7
Probability that an untraced symptomatic infected individual reports their symptoms and seeks a test	0.5
Probability that individuals take up and adhere to 10 days self-isolation and 14 days quarantine in the status quo policy model.*	1
Probability that individuals take up daily testing if traced as a contact, adhere to the full 14 day testing period if test-negative and list contacts for tracing if test-positive.*	1

*These parameters are not intended to be realistic, but are used for comparability purposes given the lack of data as to uptake and adherence to daily LFA testing. Evidence suggests that leaving the house during isolation is common [11].

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