

Estimated impact of testing quarantined contacts at different points in time

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Aim:

To assess the possible impact of testing quarantined contacts at different points in time.

Background and methods

- We used our model, based on the BBC Pandemic contact survey, previously reviewed by SPI-M and SAGE (Kucharski et al, MedRxiv, 2020).
- We assume a 5 day incubation period, 2 day pre-symptomatic infectious period and a 3 day post-symptomatic infectious period, corresponding to 5.5 serial interval, with 60% of cases eventually symptomatic, and relative transmission from asymptomatic infections 50% that of symptomatic.
- We assumed an optimistic baseline scenario in which 90% of people with symptoms would get tested, and 90% of contacts would adhere to quarantine if infected. Delay from onset-to-isolation of index case based on delay from onset-to-confirmation in Singapore, minus one day (Appendix Figure). We assumed 53% app coverage.
- We assume it takes 2 days to trace non-household contacts manually, and app-based tracing can notify contacts instantly. We assume that contacts are quarantined immediately, before being tested, for 2 weeks. We assume it takes 2 days to return test results and contacts are released if test is negative. The probability of testing positive given infection relative to point of infection is given in Appendix Table.
- We assumed background risk of non-COVID symptom onset of 0.1% per day in our baseline scenario (see Appendix for details).
- In the absence of control measures, $R=2.7$.

Conclusions

- If contacts are tested immediately upon quarantine and released if negative, the relative effectiveness of measures will be lower than if contacts are tested after a few days, which reduces the probability a false-negative leaves quarantine. The relative effect is amplified if sensitivity of the test is lower.
- Large numbers of individuals are likely to be asked to quarantine, particularly if there is a delay to test-and-release of contacts and high rate of background COVID-like symptoms.

Table 1: Estimated reduction in effective reproduction number for given delays from quarantine of contact to sample collection, assuming optimistic scenario.

Scenario	Test immediately	Test 3 days after quarantine	Test 6 days after quarantine	No test
Self-isolation only	26%	26%	26%	26%
SI + household quarantine	31%	31%	31%	31%
SI + HQ + tracing of acquaintances	50%	56%	57%	57%
SI + HQ + tracing of all contacts	55%	61%	63%	63%
SI + HQ + app-based tracing	31%	38%	44%	44%

Table 2a: Estimated number of tests performed, relative to 1000 symptomatic COVID cases each day, and optimistic scenario. We do not show tests performed on non-COVID cases.

Scenario	Without testing of contacts	Mean contacts tested
SI + HQ + tracing of acquaintances	1000	38000
SI + HQ + tracing of all contacts	1000	45000
SI + HQ + app-based tracing	1000	17000

Table 2b: Estimated number of contacts of COVID cases not yet released from isolation/quarantine on a given day, relative to 1000 symptomatic COVID cases each day, under optimistic scenario. We assume 2 day turnaround of test results. (Note that totals included detected and isolated infected contacts, so are not a simple multiple of the number of contacts per case)

Scenario	Collect sample immediately	Collect sample 3 days after quarantine	Collect sample 6 days after quarantine	No test
SI + HQ + tracing of acquaintances	120000	210000	310000	510000
SI + HQ + tracing of all contacts	130000	250000	360000	600000
SI + HQ + app-based tracing	61000	96000	130000	210000

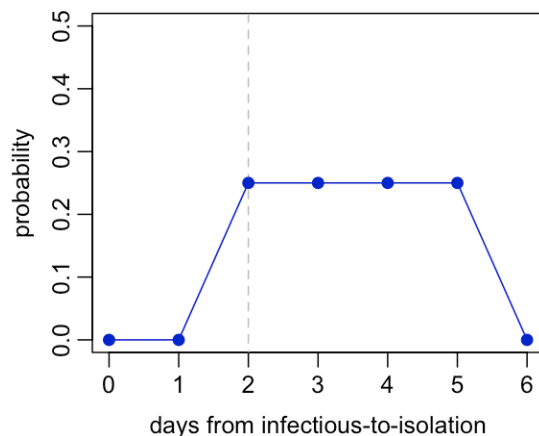
Table 3: Estimated number of people not yet released from quarantine on a given day (contacts of COVID and non-COVID cases), assuming 1000 COVID symptomatic cases per day, and optimistic scenario. Note we do not consider clustering of contacts, so in reality values may be lower.

Scenario	Collect sample immediately	Collect sample 3 days after quarantine	Collect sample 6 days after quarantine	No test
SI + HQ + tracing of acquaintances	2840000	2930000	3030000	3230000
SI + HQ + tracing of all contacts	3350000	3470000	3580000	3820000
SI + HQ + app-based tracing	1233000	1268000	1302000	1382000

Table 4: Estimated reduction in effective reproduction number for given delays from quarantine of contact to sample collection, assuming pessimistic assumptions about test sensitivity.

Scenario	Test immediately	Test 3 days after quarantine	Test 6 days after quarantine	No test
Self-isolation only	16%	16%	16%	16%
SI + household quarantine	19%	19%	19%	19%
SI + HQ + tracing of acquaintances	28%	33%	34%	34%
SI + HQ + tracing of all contacts	30%	37%	38%	39%
SI + HQ + app-based tracing	18%	23%	25%	27%

Appendix Figure: Distribution of time from infectiousness-to-isolation in index case, assuming a 2 day pre-symptomatic infectious period. Mean delay from onset-to-isolation is 1.5 days.



Appendix Table: assumed ability to detect virus on each day post infection.

Day	Optimistic view of ability to detect replication	Pessimistic View
D0 (Day of infection)	5%	0%
D1	20%	5%
D2	50%	20%
D3 (Day of infectiousness)	70%	40%
D4	90%	50%
D5 (Day of onset)	100%	60%

Appendix: background infection risk

We based background risk on the general rates of acute respiratory illness (ARI) from the Tecumseh community survey (1), and the Flu Watch cohort study (2). In Tecumseh, the study found ARI attack rate between 2-3 per person-year. In Flu Watch, the study found around roughly 0.004 ARI per-person day during flu seasons (average any respiratory illness per person weeks from Table S1). To identify a bounding estimate of the Tecumseh findings, we assumed a winter (4 months) / non-winter (8 months) attack pattern of 2 to 1. For an average of 3 ARI incidents a year, 1 during 8 months corresponds to 0.004 probability of attack per day during non-winter. Assuming the same winter / non-winter attack pattern, the Flu Watch findings would indicate roughly half that probability per day.

1. Monto AS, Ullman BM. Acute Respiratory Illness in an American Community. *Jama*. 1974;227(2).
2. Hayward AC, Fragaszy EB, Bermingham A, Wang L, Copas A, Edmunds WJ, et al. Comparative community burden and severity of seasonal and pandemic influenza: results of the Flu Watch cohort study. *The Lancet Respiratory Medicine*. 2014;2(6):445-54.