Estimated impact of delay from isolation of symptomatic case to test result and quarantine of contacts

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Aim:
To assess the possible impact of delays from isolation of symptomatic cases to quarantining of contacts.

Background and methods
• We used our model, based on the BBC Pandemic contact survey (previously reviewed by SPI-M and SAGE (Kucharski et al.)).

• 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 80% of people with symptoms would get tested and test positive if infected, and 80% of contacts would test positive and 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 (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 household contacts are quarantined immediately, without being tested.

• In the absence of control measures, R=2.6. We assumed background risk of non-COVID symptom onset of 0.1% per day in our baseline scenario.

• 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.

Table 1: Estimated reduction in effective reproduction number for given delays from isolation of primary case to start of contact tracing, under baseline scenario.

Scenario	No delay	24hr delay	48hr delay	72hr delay
Self-isolation only	18%	18%	18%	18%
SI + household quarantine	22%	22%	20%	20%
SI + HQ + tracing of acquaintances	41%	36%	31%	27%
SI + HQ + tracing of all contacts	43%	40%	33%	28%
SI + HQ + app-based tracing	30%	30%	29%	26%

Table 2: Estimated number quarantined (COVID + non-COVID) per day, and ratio of non-COVID contacts to COVID cases quarantined per day before index case test results, under baseline scenario.

Scenario	Contacts of non-COVID cases quarantined per day	Contacts of COVID cases quarantined per day (1k new COVID cases per day)	Contacts of COVID cases quarantined per day (4k new COVID cases per day)
Self-isolation only	0	0	0
SI + household quarantine	130000	1920	7680
SI + HQ + tracing of acquaintances	1950000	28800	115000
SI + HQ + tracing of all contacts	2280000	33600	134000
SI + HQ + app-based tracing	814000	12000	48000

Table 3: Estimated number of non-COVID contacts not yet released from quarantine on a given day (assuming contacts are quarantined before test result of index case), under baseline scenario.

Scenario	24hr delay to test result of index case	48hr delay to test result of index case	72hr delay to test result of index case
SI + HQ + tracing of acquaintances	1950000	3900000	5850000
SI + HQ + tracing of all contacts	2280000	4560000	6840000
SI + HQ + app-based tracing	814000	1628000	2442000

Table 4: Estimated reduction in effective reproduction number for given delays from isolation of primary case to start of contact tracing, under more pessimistic scenario (50% of infected cases isolate and test positive, 50% infected contacts quarantine and test positive, 0.2% background risk of COVID-symptoms).

Scenario	No delay	24hr delay	48hr delay	72hr delay
Self-isolation only	11%	12%	11%	11%
SI + household quarantine	13%	13%	12%	12%
SI + HQ + tracing of acquaintances	20%	18%	16%	14%
SI + HQ + tracing of all contacts	22%	21%	17%	16%
SI + HQ + app-based tracing	16%	16%	15%	14%

Table 5: Estimated number quarantined (COVID + non-COVID) per day, and ratio of non-COVID contacts to COVID cases quarantined per day before index case test results, under more pessimistic scenario.

Scenario	Contacts of non-COVID cases quarantined per day	Contacts of COVID cases quarantined per day (1k new COVID cases per day)	Contacts of COVID cases quarantined per day (4k new COVID cases per day)
Self-isolation only	0	0	0
SI + household quarantine	170000	1250	5000
SI + HQ + tracing of acquaintances	2440000	18000	72000
SI + HQ + tracing of all contacts	2920000	21500	86000
SI + HQ + app-based tracing	949000	7000	28000

Table 6: Estimated number of non-COVID contacts not yet released from quarantine on a given day (assuming contacts are quarantined before test result of index case), under more pessimistic scenario.

Scenario	24hr delay to test result of index case	48hr delay to test result of index case	72hr delay to test result of index case
SI + HQ + tracing of acquaintances	2440000	4880000	7320000
SI + HQ + tracing of all contacts	2920000	5840000	8760000
SI + HQ + app-based tracing	949000	1898000	2847000

Conclusions

• Under optimistic but plausible assumptions, self-isolation, HH quarantine and contact tracing alone is unlikely to be sufficient to maintain R <1. It is likely substantial social distancing measures will also need to be in place.

• Large numbers of individuals are likely to be asked to quarantine, particularly if high number of non-COVID infections and delay to test results for index case.
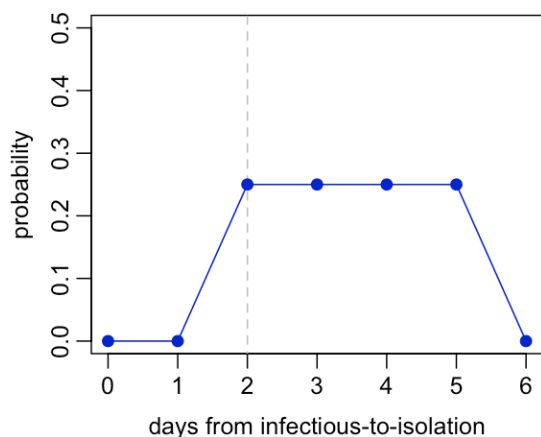
Figure: Distribution of time from infectiousness-to-isolation in index case, assuming a 2 day pre-symptomatic infectious period. Mean delay from onset-to-isolation is 1.5 days.

References

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.