

Supplemental materials

Model Assumptions

CoTECT assumes all tests hold the best sensitivity and specificity, which described false-positive and true-negative as a small probability event. When a small probability event happened, people exposed to the virus did not change to a tested and quarantined status in an expected period. Yet, this possibility is more than zero during the simulation. If the test sensitivity and specificity drop down, we can prolong the expected waiting time to test and self-quarantine in CoTECT. However, the test model(T) is a self-quarantine status that prevents 100% of infections from the confirmed cases, which is relied on a strong assumption. Furthermore, since the model was built based on a Bernoulli distribution, it is plausible that some infected people skipped from self-quarantine get self-recovery instead (Table S1, S2).

Table S1. Setting of transmission rates for CoTECT

	Transmission rate	Parameter definition	Assumed rate	References
Sampled	E-->T	Rate per day at which exposed (E) individuals test positive and enter quarantine status (T)	1/18 (1/15-1/23)	^{1 2 3}
	I-->T	Rate per day at which infected (I) cases test positive and enter quarantine status (T)	1/12 (1/9-1/17)	^{1 2 3}
	Is-->T	Rate per day at which symptomatic infected (Is) cases test positive and enter quarantine status (T)	1/7 (1/4,1/6,1/8,1/10,1/12)	¹
Fixed	I-->Is	Rate per day at which infected (I) cases become symptomatic (Is) cases	1/5	¹
Fixed	E-->I	Rate per day at which an exposed (E) individual become infected (I) cases	1/6.4	⁴
	I-->R	Rate per day at which infected cases with mild or no symptoms (I) recover and are immunized (R)	1/14	^{1 2}

	Is-->R	Rate per day at which infected cases with severe symptoms (Is) recover and are immunized (R)	1/21	^{1 5}
	T-->R	Rate per day at which quarantined, test-positive (T) cases recover and are immunized (R)	1/17	Assumed
	Is-->F	Death rate per day of infected cases with severe symptoms (Is)	0.002	²
	T-->F	Death rate per day of test-positive (T) cases	0.001	^{2 3 6 7}

Table S2. Parameter setting for CoTECT network framework

Parameter	Definition	Value	Reference
Density	Density of whole social network.	1.3	Adjusted according to reported R0 (corresponding with infection probability and contact times)
Concurrent	Number of nodes (individuals) which contact many other nodes at a given day	0%-3%	Assumed
Isolation	Number of nodes (individuals) who does not make any contact with others at a given day	0%-3%	Assumed
Infection probability for symptomatic patient (I)	Probability of an infected individual passes the COVID-19 to another one based on an existed edge between them	30%	Adjusted according to reported R0
Infection probability for asymptomatic patient (E)	Probability of an exposed but asymptomatic individual passes the COVID-19 to another one based on a existed edge between them	20%	Adjusted according to reported R0
Contact times between I	Average contact times between two	3	Adjusted according to reported R0

	connected individuals (one is infected) in a given day		
Contact times between E	Average contact times between two connected individuals (one is exposed) in a given day	3	Adjusted according to reported R0

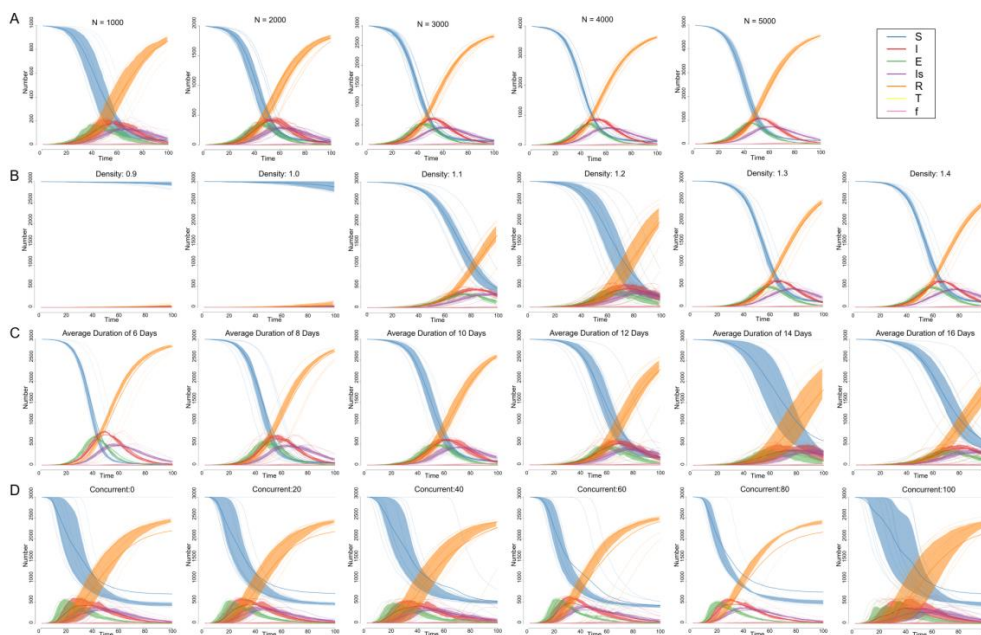


Figure S1: Sensitivity analyses for baseline models of different (A) population sizes (N=1000, 2000, 3000, 4000, and 5000), (B) densities (0.9, 1.0, ..., 1.4), (C) average duration (6 days, 8 days, ..., 16 days), and (D) concurrent nodes (0, 20, ..., 100). Curves for each compartment in each model are shown in the graphs and demonstrate similar proportions of people in each compartment in the whole population for different population sizes.

Table S3: Sensitivity analyses for baseline models of different population sizes, densities, average duration, and concurrent nodes.

Parameters	Values	Total infections	Peak daily infections	Proportion of total infections in whole population	Cumulative deaths of unconfirmed cases
Population size	1000	883.2	290.9	88.3%	12.1
	2000	1826.2	668.5	91.3%	27.4
	3000	2769.8	1035	92.3%	39.3

	4000	3676	1378.4	91.9%	52.7
	5000	4606.9	1716.8	92.1%	60.8
Density	0.9	42.5	2.5	1.42%	0.2
	1.0	66.4	4.4	2.21%	0.8
	1.1	1754.6	61	58.49%	25
	1.2	2053.8	61.7	68.46%	26.1
	1.3	2510.2	99.9	83.67%	31.5
	1.4	2747.6	106.8	91.59%	37.5
Average duration (Days)	6	2864.4	130	95.48%	40.3
	8	2741.3	102.4	91.38%	38.3
	10	2627.7	93.4	87.59%	38.7
	12	2310.4	73.8	77.01%	32.8
	14	1823.8	52.2	60.79%	24.5
	16	1755.3	59.4	58.51%	22.1
Concurrent nodes	0	2229.3	77.1	74.31%	30.1
	20	2210.4	86.7	73.68%	33.8
	40	2302.2	67.7	76.74%	30.8
	60	2444.8	93.2	81.49%	31.6
	80	2189.8	92.9	72.99%	29.6
	100	2167.6	69.5	72.25%	27.5

Estimation of IsT rate based on real-world data

According to the public information about the epidemic investigation, we calculated the average time from onset to reporting of the first 23 symptomatic cases in the second-wave outbreak of Covid-19 to be 2.7 days (Table S4), with case data displayed in Table S5. 2.7 days is shorter than four days we set in scenario-1, therefore, it is realistic and feasible to set the window period of the best scenario as four days. According to another cohort study in Beijing⁸, China, the median time interval from illness onset to laboratory confirmation is seven days (4.7–10.2), so a four day window period is rational (Table S4, S5).

Table S4. Testing efficiency for the second-wave outbreak in Beijing, China

Average time from onset to reporting (first 37 cases)	Percentage of cases confirmed by contact tracing (first 37 cases)	Tests for traced contacts (first ten days)	Daily testing capacity within one month	Test efficiency for cases with fever	Test efficiency for other patients	Test efficiency for other patients	Test efficiency for normal test application	Total confirmed cases	Percentage of cases confirmed by targeted screening tests
2.7 days	68%	2342 thousand	90 to 100 thousand	6h	12h	6h	24h	335	52%

Table S5. Average time from onset to reporting, and means of reporting of first 37 cases for the second-wave outbreak in Beijing, China⁸

Number of cases	Symptom	Days from onset to reporting	Means of reporting
1	fever	0	initiative
2	fever	4	initiative
3	fever	5	initiative
4	fever	4	initiative
5	fever	1	initiative
6	fever	5	initiative
7	fever	2	initiative
8	no	NA	tracing
9	no	NA	tracing
10	muscle soreness	3	tracing
11	sore throat	2	tracing
12	fever	0	initiative
13	headache	8	tracing
14	no	NA	tracing
15	no	NA	tracing
16	sore throat	1	tracing
17	fever	4	tracing
18	fever	0	initiative
19	cough	1	tracing
20	sneeze	2	tracing
21	fever	2	tracing
22	sneeze	8	tracing
23	headache	1	tracing
24	no	NA	tracing
25	fever	1	initiative
26	fever	4	initiative
27	fever	2	tracing
28	no	NA	tracing

29	dry throat	2	tracing
30	no	NA	tracing
31	no	NA	tracing
32	no	NA	tracing
33	no	NA	tracing
34	no	NA	tracing
35	no	NA	tracing
36	no	NA	tracing
37	no	NA	initiative
Average		2.7	

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