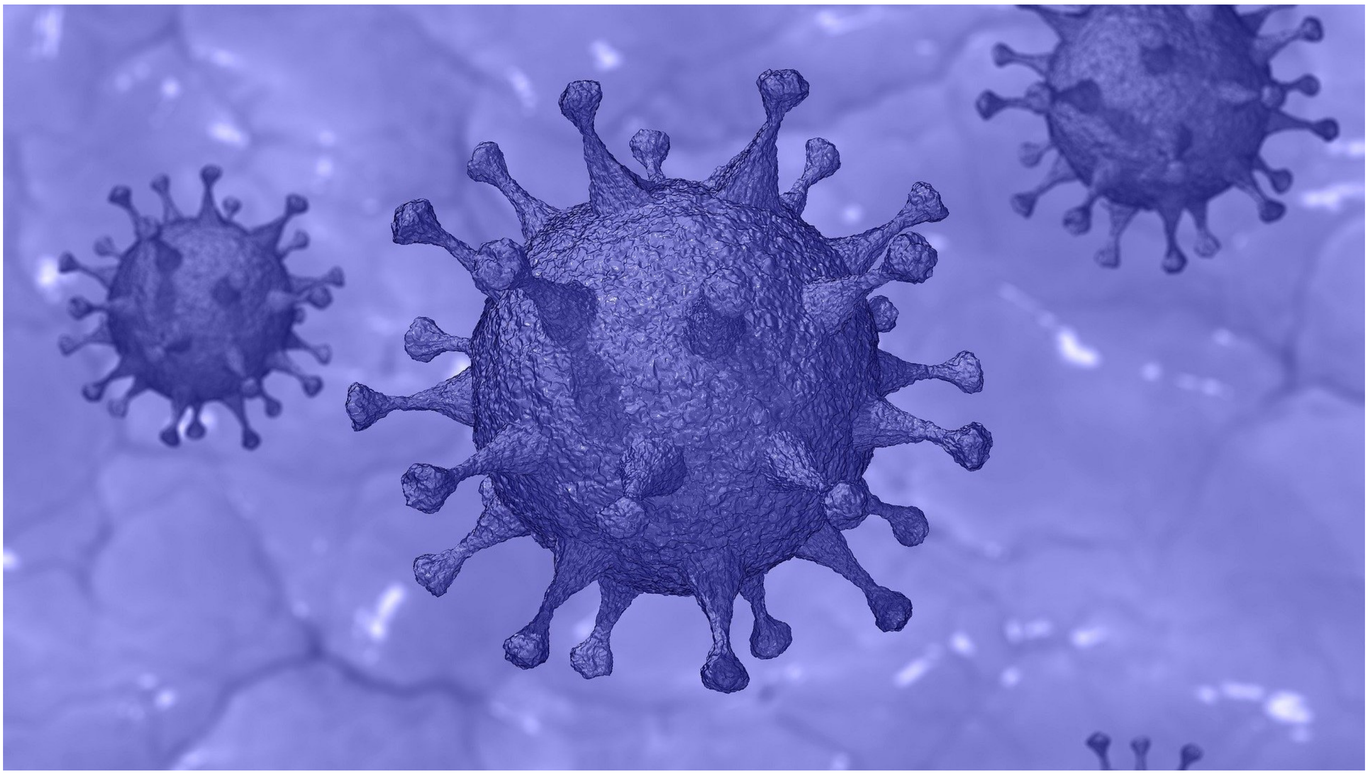

When can COVID-19 be Declared Eliminated from NZ? New Modelling Study

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This blog details a recent modelling study we conducted. In it we estimated that it would take between 27 and 33 days of no new detected cases of COVID-19 for there to be a 95% probability of epidemic extinction in NZ (at around current testing levels). For a 99% probability of epidemic extinction, the equivalent time-period was 37 to 44 days. So now the country urgently needs the Ministry of Health to provide an official definition of elimination and to upgrade the data on its website so that the public, the media and researchers can monitor progress towards achieving the goal.

NZ is a rare example of a country to clearly articulate an elimination goal for the SARS-CoV-2 pandemic virus that causes COVID-19.[1] In Australia, such a goal has been discussed as a potential option[2] but it has not been adopted by the central government. There are other island jurisdictions that may also be approaching elimination (eg, Taiwan and Iceland) and there are some small island jurisdictions that have only ever had sporadic cases – but then have gone for weeks with no reported cases, suggesting successful containment and a likely return to COVID-19 free status (as Trinidad and Tobago have just declared).

Once NZ can declare itself having achieved SARS-CoV-2 elimination status, it can potentially phase out nearly all restrictive disease control measures, while maintaining tight border controls with quarantine for incoming travellers. It could also then explore permitting quarantine-free travel with other COVID-19 free nations, as envisaged by the Prime Ministers of Australia and NZ in terms of a trans-Tasman "bubble".[3] More realistically however, it might be that such quarantine-free travel with NZ first begins with other island jurisdictions that have never had cases of COVID-19 and for whom NZ is the main or only air-traffic transit hub (eg, Samoa, Tonga, Cook Islands, Niue), or which might declare elimination status before Australia (eg, possibly Taiwan).

A very brief description of the model we used is in the Appendix below with the full description of the model and more detailed results published as a pre-print.[4]

What we found: Estimating time to epidemic extinction

This modelling work estimated it would take between 27 and 33 days of no new detected cases for there to be 95% probability of epidemic extinction, assuming effective reproduction numbers (Re) in the range of 0.5 to 1.0, combined with effective case isolation (Table 1, Figure 1). This range was 37 to 44 days (around 5 to 6 weeks) for the 99% probability level.

We also considered various scenarios with lower levels of symptomatic cases of COVID-19 seeking medical attention and lower levels of testing. For example, the time-period was up to 53 to 91 days (second scenario in Table 1, for the 95% level of probability).

Table 1: *Probability level of SARS-CoV-2 elimination by number of days since the last detected case of COVID-19 (starting with 10 infectious cases for each value of Re in the range of: 0.5 to 1.0; using 10,000 simulations per parameter set).*

Base case and scenarios	**50% probability**	**95% probability**
Base case analysis: 39.5% of symptomatic cases seek medical attention in primary care [based on Flutracking data for NZ] and assuming 95% of these people are tested for SARS-CoV-2 (and accounting for PCR test sensitivity)	12 to 15 days	27 to 33 days
Scenario 1: 30% seek medical attention, 60% of them are tested	17 to 24 days	38 to 51 days
Scenario 2: 20% seek medical attention, 30% of them are tested	24 to 42 days	53 to 91 days

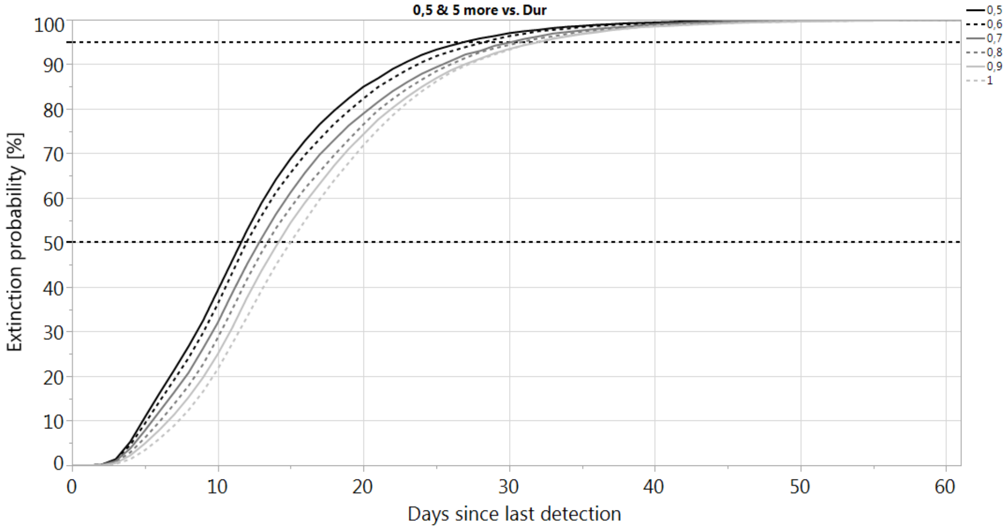

Figure 1: Probability that pandemic virus extinction has occurred according to different Re values. The chart shows extinction probabilities if no new COVID-19 cases have been reported for a given number of days (10,000 simulations starting with 10 infectious cases for each value of Re). The curves from left to right relate to Re = 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, respectively.

Interpreting these results

These results suggest that with an effective surveillance system (high levels of testing symptomatic cases with cough and fever and testing of respiratory cases being hospitalised), it is possible to achieve high assurance that an elimination goal has been achieved in around four to five weeks of no cases being detected (Figure 1). Of course this modelling assumes that Re values have been successfully suppressed (at Re ≤ 1.0) during the critical period – which appears to have happened during the lockdown during Alert Levels 4 and 3 in NZ.[5] [6] Since the move to Alert Level 2, there is probably some on-going suppression of Re due to persisting interventions and behaviour changes (eg, restrictions on event numbers, hand washing and respiratory hygiene, some people still working from home, some mask use and people staying home when unwell).

The time period for no new cases we have identified of four to five weeks is similar to a provisional “28 days since the onset date of the last known infection” that has been suggested for NZ previously.[7] This is also the span of two maximal incubation periods (14 days, which is being used for determining the length of quarantine for incoming travellers in NZ). Furthermore, the Ministry of Health defines a cluster of COVID-19 cases as “closed” when there have been no new cases for two [maximal] incubation periods (i.e. 28 days) from the date when all cases complete isolation”. The same interval is the WHO definition of the end of an Ebola outbreak.

A 28-day period for elimination has also been proposed for the Australian setting.[2] Nevertheless, it is possible that the 99% level of probability provides a safety margin that might be preferable (ie, the 37 to 44 day period we have estimated).

So when might the clock start ticking for reaching a defined

elimination point in NZ?

It is now becoming urgent that the Ministry of Health publish a definition of the elimination of SARS-CoV-2 for NZ. As some of us have argued previously,[7] this should be a science-based definition that defines a minimal level of high quality surveillance occurring, and ideally should be done in conjunction with Australian health authorities. But the Ministry also needs to provide critical information on its website (as stated previously[8]), and in the elimination context this needs to be:

- What was the date of the last newly notified case from SARS-CoV-2 transmission within NZ (ie, not an infected incoming traveller put into supervised isolation whose data needs to be clearly differentiated on the Ministry's website and who is not relevant to the elimination goal)?
- What was the last estimated date* that this last notified case was still infectious while out in the community; the date* they went into isolation; the date* they were reported as having become non-infectious (based on testing while in isolation); and the date* they were released from isolation. Further details could also help with interpretation as it could be a person tests positive at the end of a period of being isolated but this may reflect residual viral RNA fragments in their body when they are no longer considered to be infectious.

*All these asterisked dates could be plausible options for when "to start the clock" for a 28 day (or whatever) period before SARS-CoV-2 elimination can be declared by the Ministry of Health for NZ.

Conclusions

In the context of a high level of testing, a period of around one month of no new notified cases of COVID-19 would give 95% certainty that elimination of SARS-CoV-2 transmission had been achieved in NZ. But the country urgently needs the Ministry of Health to provide an official definition of elimination and to upgrade the data on its website so that the public, the media and researchers can monitor progress towards achieving this important goal.

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Appendix: Brief description of the model we used

To run "time to elimination" analyses for NZ, we used a stochastic SEIR type model, specifically a stochastic version of CovidSIM which was developed specifically for COVID-19 (http://covidsim.eu; version 1.1). Work has been published from previous versions of this model,[9 10] and a similar simulation approach was taken previously for a poliomyelitis elimination study.[11] The stochastic model was built in Pascal and 10,000 simulations were run for each set of parameter values.

The parameters were based on available publications and best estimates used in the published modelling work on COVID-19 (as known to us on 13 May 2020). Key components were: a starting position of 10 infected cases, the assumption of effective border control with no new imported cases, 80% of infected COVID-19 cases being symptomatic, 39.5% of cases seeking medical consultation in primary care settings, and 4% of symptomatic cases being hospitalised (see the full article:[4]). The level of testing of symptomatic cases in primary care and for respiratory cases being tested when hospitalised (both at 95% coverage with test sensitivity of 89%[12]), was as per a fairly optimal surveillance system conducting 7,800 tests per million people per week (slightly less than the level in NZ as per mid-May 2020 at 8,190 tests per million people per week[13]). Identified cases were transferred to supervised isolation which was assumed to be 95% effective. We considered different levels of transmission with the effective reproduction number (Re) of SARS-CoV-2 to be 0.5, 0.6, 0.7, 0.8, 0.9, and 1.0 (with extinction still occurring in the last case [Re = 1.0] due to accumulation of immune individuals after infection).

In each stochastic simulation, the delay since the last detected cases was stored on a daily basis together with the information as to whether infection was still ongoing or was extinguished. The probability that extinction had occurred if no cases have been reported for a given number of days was calculated by dividing the number of such delays during extinction by the total number of such delays (ie, with ongoing transmission or with extinction). Other scenarios considered the impact of higher starting numbers of infected cases, and lower levels of attendance for medical consultations in primary care and also for the level of testing.

Lead image by Pete Linforth from Pixabay

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