Why time varying reproductive number (Reff) is no longer a useful indicator for COVID-19 policy setting in Australia

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In the early stages of the COVID-19 pandemic in Australia, time varying reproductive numbers (Reff) were a useful tool to gauge progress in containing the disease. Such numbers have been calculated by the Doherty Institute for the Australian Department of Health[1] (see Appendix 1) and, using a similar but different method, by the author[2]. Now that COVID-19 new case numbers are very low in Australia, Reff is no longer a useful number to determine COVID-19 policy, especially regarding easing lockdown restrictions. This is important as the Reff numbers, with reduced impact of imported cases, are being used by some to suggest that there is less room to move in staying under a Reff of 1 than might previously have been thought when using Reff numbers including imports. Some of the graphs in Appendix 1 seem to support such an argument. Here is why this is wrong:

The first point to note is the large statistical uncertainty represented by the increased shading as the case numbers get less. For example, for South Australia, which has had hardly any new cases for a few days, the 90% credible interval stretches up to over 3 and the 50% credible interval to above 1. This is not warning that SA is in danger of losing control, it is a warning that the statistical method is not much use with such low case numbers.

So let's look at the problem another way. Suppose we have perfect knowledge of cases. That is we know everyone who is infected, when they got infected and by whom and we know this throughout the pandemic. We can now calculate Reff exactly. To see this (at a conceptual level), suppose that in some State there are 5 new infections reported today (and we know that's all of them). We also know who infected them and when. For simplicity, let's assume that they were all infected 5 days ago by 5 different people. Let's further suppose that 5 days ago in that state there were a total of 10 infected people and the only people that they passed the infection onto were the 5 reported today. Then Reff = 5/10 = 0.5.

Now suppose we still have perfect knowledge except for one thing, namely the number of asymptomatic infected persons. In the example above, let's assume that there were 10 of these in addition to the 10 we know about. Let's suppose that the asymptomatic persons infect no one. Then Reff = 5/20 = 0.25, which looks even better.

Now let's go back to perfect knowledge and take another variation of our first example. Suppose that one of our 10 known infected persons goes into an institution and say infects 10 people. This is like the recent psychiatric facility outbreak in Melbourne. So now we have 15 new infections for the 10 initial cases and Reff = 15/10 = 1.5. We've been taught that Reff over 1 is bad news.

But which is worse, the example with Reff = 0.25 or the one with Reff = 1.5 ? Clearly the case with Reff = 0.25 is worse as we have 10 unknown asymptomatic carriers out there and while they might

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1 https://www.doherty.edu.au/uploads/content_doc/COVID_19_early_epidemic_analysis_Doherty.pdf

2 http://www.kintan.com/COVID19.html

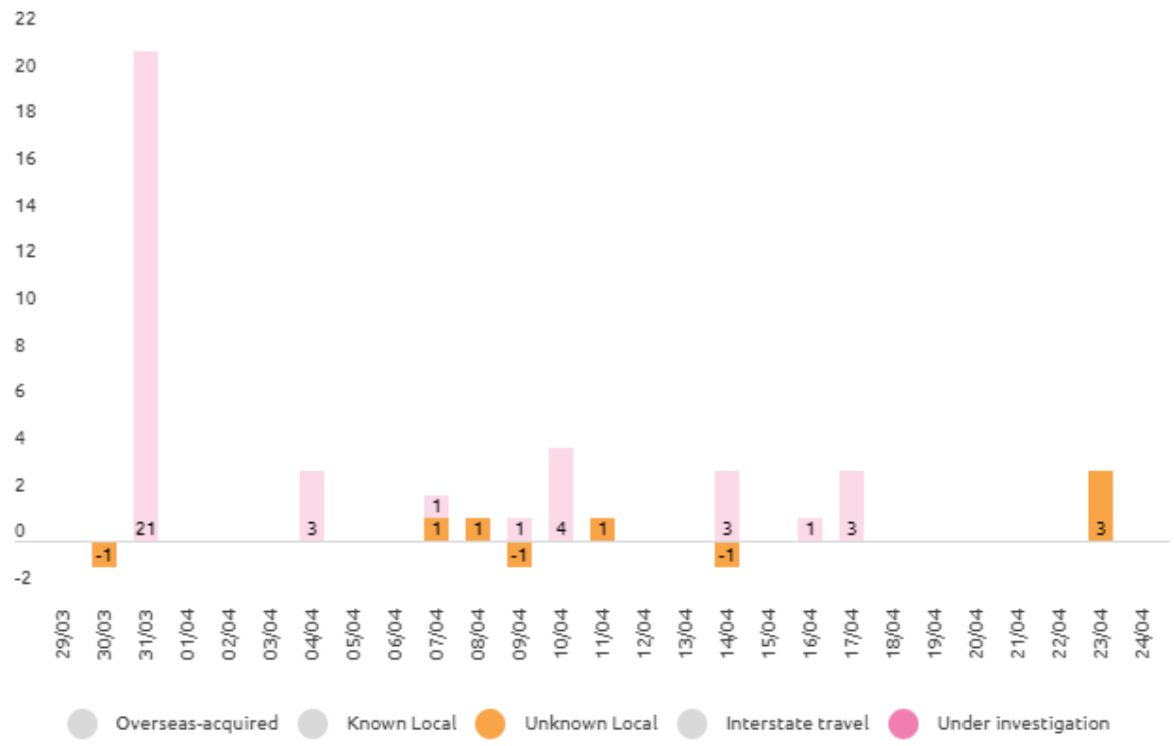
be safe in lockdown, once out in the community, they could wreak havoc. In the case where Reff = 1.5 we know the carrier and he/she and all the cases in the institution can be quarantined.

This problem is noted in the Doherty Paper[1]: "While the symptomatic case detection rate is estimated to be very high in Australia (between 77 and 100% [29]), one largely unknown factor at present is the number of asymptomatic, mild and undiagnosed infections. Even if this number is not? high, the Australian population would still be largely susceptible to infection. Accordingly, complete relaxation of the measures currently in place would see a rapid resurgence in epidemic activity."

To summarise the conclusion from above. For low case numbers, Reff is not a very effective tool to determine relaxation measures given both statistical vagaries and the possibility that the number of asymptomatic cases could be significant. Once these asymptomatic cases are allowed out into the community, the infection process could restart. So what is the solution?

There is one indicator of risk that we have which is possibly more useful than Reff in this context. That is the number of cases of unknown origin. This includes cases that result from infection via an unknown, asymptomatic carrier.

For example, the graph below[3] shows the number of daily new cases of unknown origin and under investigation in South Australia.



The number of unknown-origin cases is very low and this is probably a better tool for assessing risk in SA than the Reff graph discussed above. The very low numbers of unknown-origin cases is a testament to the tracing and tracking efforts that have been put in place in Australia.

As well as tracing and tracking, the other important measure of risk comes from testing of asymptomatic and low-symptom persons and the percentage of positive test results found. The

[3] https://www.covid19data.com.au/

latter has only just started generally in Australia. Given the expected low number of asymptomatic carriers, the number of tests that will need to be conducted to obtain statistically significant results will be large.

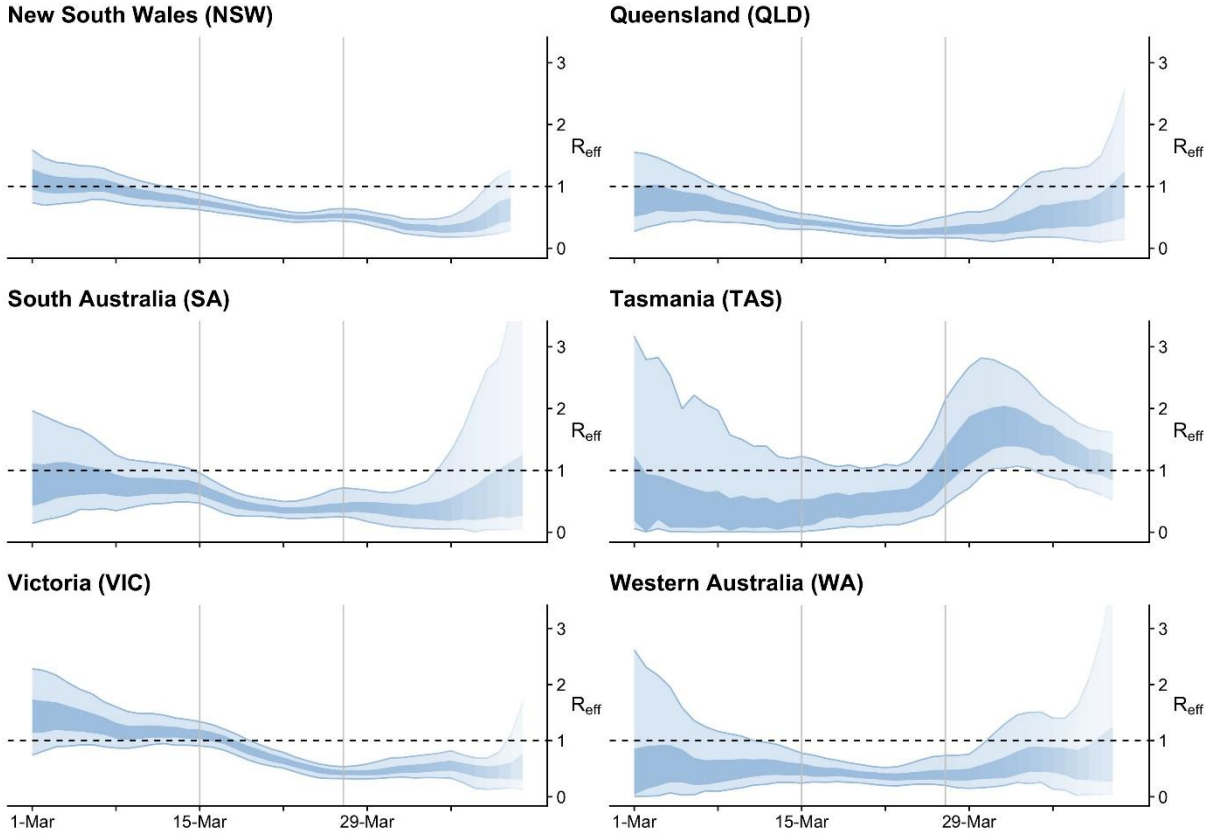
Given the above, how then should Australia reopen for business? The answer is “cleverly”. The purpose of this note is not to opine on details of opening, but one example will suffice. How would you cleverly reopen an office? (Fortunately, the author no longer has management responsibilities for large numbers of people in offices but the thought of being in such a management position during a pandemic is not pleasant.)

In opening the office, it should be assumed that at least one of the team is an infected asymptomatic carrier. You could have the whole team tested but then they can get infected as soon as they leave the office. So, apart from what are now normal social distancing and cleanliness procedures, the procedure of splitting the team in two with the two halves working in different locations (e.g. one half at home), as has been practiced already by some businesses, will need to carry on after opening up. If a member of the half in the office gets sick, then that half gets tested and remains quarantined until a clear test result is obtained. The other half moves into the office.

Finally, as mentioned, tracing and tracking has been an important part of getting Australia to a favourable point, so what about the Government’s tracing app? Despite the author’s hypersensitivity to cyber security risk and fear of government operational risk (e.g. accidentally releasing data to the internet) and sovereign risk (e.g. legislation being amended to allow law enforcement officers access to data for terrorist tracing), it is considered that the reward of controlling subsequent disease outbreaks is worth the risk.

In summary, Reff is not now an especially useful policy setting tool. Other metrics point to Australia being able to cleverly open up now with extensive use of testing and tracing.

Appendix 1 Doherty Institute Reff[4]



[4] https://twitter.com/dj_price10/status/1253566959133749248/photo/1