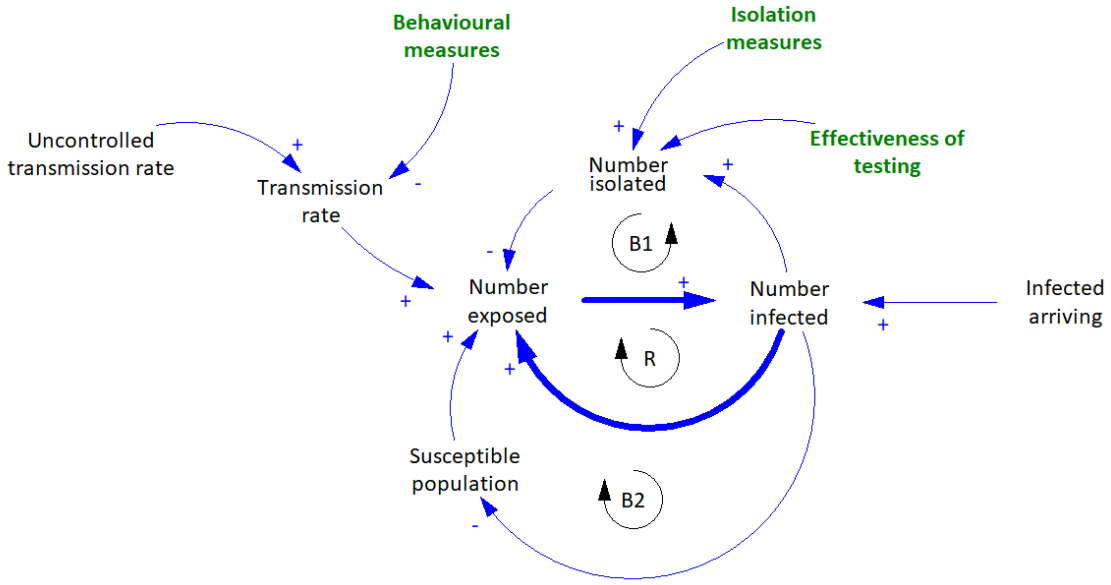
## Corona virus in Australia

In order to respond appropriately to the covid19 epidemic it is important to understand the dynamics of such outbreaks. Systems scientists all over the world are using models to try to understand these dynamics. This note is based on a generic model produced by Tom Fiddaman of Ventana Systems[1], which I have applied to the Australian situation. We are systems modellers, not epidemiologists. We are using the data available, and the information provided by medical experts to explore plausible system behaviour.

One way of demonstrating the dynamics is via a causal loop diagram, which should be read as follows: an increase in Variable A leads over time to an increase (+ sign) or a decrease (- sign) in Variable B. Where these variables combine to form a "loop", and the net gain in this loop is positive, this represents reinforcing feedback which leads over time to either exponential growth or decline (depicted below with an R symbol). Exponential growth is balanced by other variables in the system (these loops are depicted below with a B symbol).

At the outset of the epidemic the number infected in Australia relates to infected people arriving from overseas (*Infected Arriving*). The number of people exposed to the virus is thereafter a function of the susceptible population (essentially everyone) and the transmission rate of the virus. The uncontrolled transmission rate of this virus is around 3, meaning each infected person is capable of infecting 3 others (while the virus is active in their body). As of 20 March, we have around 900 confirmed cases[2] and the growth has been, and remains, exponential in nature. That means the loop designated below as "R" is dominating the dynamics of the epidemic at present.




Without any action taken to limit exposure to the virus or its transmission rate, the number infected would eventually be most of the susceptible population (represented by Loop B2 in the figure above). If this was to occur the epidemic would sweep quickly through the population and peak around June this year, with new infections dropping thereafter. This would be a disastrous outcome

[1] https://metasd.com/2020/03/community-coronavirus-model-bozeman/
[2] https://www.abc.net.au/news/2020-03-17/coronavirus-cases-data-reveals-how-covid-19-spreads-in-australia/12060704

as the medical system could not possibly cope with the number of patients, even if that number was a small percentage of the total number of infected people.

There are in fact very few policy levers that can be used to invoke the balancing loops and offset the present exponential growth.

Isolation of infected people (Loop B1)

By isolating infected people, the number of people exposed to the virus is obviously reduced. This is why the authorities are taking strict measures to identify and isolate known infectees and the head of WHO is saying "test, test, test". As overseas arrivals are the initial source of the virus, it is essential that they are tested first, infectees identified and isolated. I think we can be confident that most people that are tested positive will be effectively isolated for the duration of their infection. It would be ideal if everyone could be tested but that is simply not possible. As the infection starts to spread through the population the effectiveness of testing and isolation is further complicated by the fact that many people who have the virus will either be asymptomatic or have mild symptoms, particularly the young[3], meaning they may not be tested at all. It is therefore not possible for isolation to be a perfect remedy. While necessary, it is an insufficient measure.

Behavioural measures

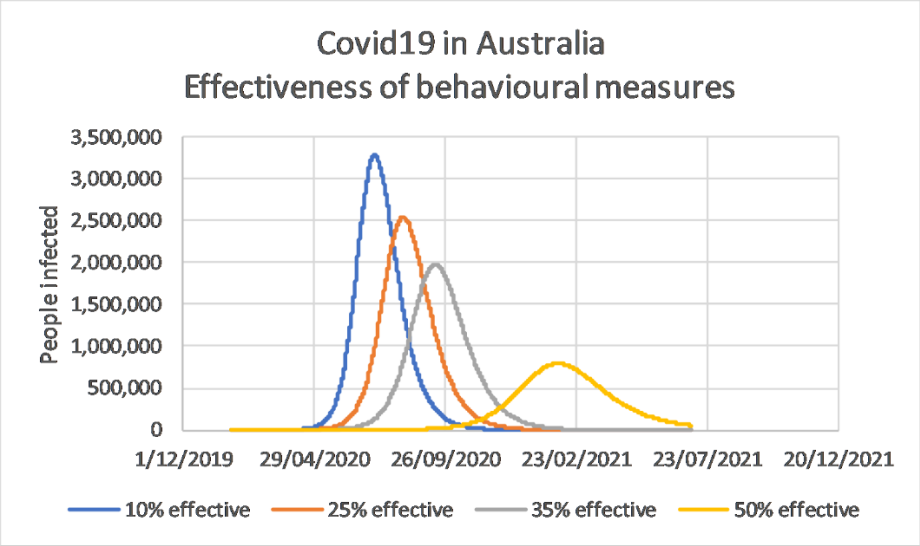
The only other way the number of people exposed can be limited is by reducing the transmission rate through the behavioural measures that by now, we have heard many times, i.e. social distancing (reducing the number of people infectees come into contact with), disinfection of surfaces and hand washing. As we are being told by the medical experts:

*"As individuals, we must all reduce the number of different people we come into contact with on a daily basis, and be prepared to do so for a prolonged period of time.*

*By avoiding these interactions, people who are most at risk from the new coronavirus could halve their risk of infection. By changing our behaviour now, and sustaining these changes throughout the outbreak, we can significantly reduce our own risk of infection, and the risk to others, and by doing so help protect those most vulnerable."*

We can use mathematical models to understand the impact of the measures set out above. I have configured Tom Fiddaman's model to approximately calibrate to the existing Australian data, on the assumption that total infections are double those presently reported. As noted above, isolation in this case cannot be totally effective. In my model I have assumed it is around 25% effective, i.e. 25% of all people infected are isolated for the duration of the infection on an ongoing basis. The graphs below identify the relative impact of behavioural measures in reducing the number of infections in conjunction with that assumption. It is assumed that these measures started in early March and take full effect in one month or so.

[3] https://pediatrics.aappublications.org/content/pediatrics/early/2020/03/16/peds.2020-0702.full.pdf




There are important caveats in interpretation of this graph, as it is based on:

- a very simplified model of a very complex epidemic; and
- calibration to very few imperfect data points at the very beginning of the virus spread.

Its main purpose is to identify the basic system behaviour. Both the magnitude of the numbers and their timing are not (and cannot be) accurate, and should not be not be quoted as being so. These are not predictions of the epidemic.

Nevertheless, it can be seen that effective behavioural measures can have dramatic impact on the number of infections, and also spread those infections over a much longer period, giving the medical system time to respond and cope, thus reducing the number of people suffering serious symptoms or dying. The flip side of this is however an extended infection period. I admit that at this moment it is hard to see that these measures can be maintained for that length of time, given the social and economic consequences.

It is also the case that the scenario set out above will leave millions of Australians still susceptible to the virus, meaning that unless it is completely eliminated from the population (extremely unlikely), there remains a serious future risk. This is where a vaccine becomes critical. The experts think it will likely take 12-18 months for a vaccine to be available. So again, it becomes essential to minimise infections until then. As difficult as isolating ourselves will be in the coming months, it is essential that all of us do everything we can to avoid new infections.

I will be updating my model as new data becomes available.

Bill Grace
21 March 2020