MATHEMATICAL MODELLING FOR SOUTH AUSTRALIA TO INFORM THE COVID READY PLAN

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EXECUTIVE SUMMARY

When the South Australian borders open at a level of 80% vaccination of those over 16 years, maintaining current Public Health and Social Measures (PHSM, i.e. activity restrictions) along with the testing and contact tracing capacity in South Australia will allow us to remain within the state's hospital ward and ICU capacity.

Relaxing restrictions from current PHSM poses a risk to being able to manage the hospital ward and ICU demand from COVID-19 infections generated in the community, with a moderate chance of approximately 15–22% of exceeding ICU capacity if current PHSM remain in place but the mandatory requirement for facemasks is removed. Furthermore, there is a high chance of approximately 79–89% of exceeding ward capacity and 81–92% of exceeding ICU capacity if Vaccine Certificates (to allow higher-risk activities by fully vaccinated individuals) with partial compliance of this new system are introduced at the 80% vaccination threshold.

Mathematical models are characterised by uncertainty. The amount of uncertainty depends on our ability to accurately measure the inputs for the model. Predicting human behaviour is inherently difficult, which explains some of this uncertainty. Mathematical models need to be taken in this context and be used along with other factors in determining public health response to preventing disease outbreaks. Modelling remains an extremely useful tool to be able to inform planning and decision making especially in an environment with no precedence.

OVERVIEW OF THE MODELLING

SA Health, with the assistance of SAHMRI, commissioned mathematical modelling specific to South Australia to inform decision making about COVID-19 as population vaccination rates reach 80% in line with Phase B of the National Plan.

The Doherty Institute, which has been undertaking modelling for the Commonwealth Government throughout the entirety of the pandemic, used models of COVID-19 infection and vaccination to define a target level of vaccine coverage for transition to Phase B of the National Plan. This national model was based on the consideration of a range of factors associated with COVID-19 transmission, severity and vaccine effectiveness for the Delta variant but was not specific for jurisdictions. It provides a model based on the assumption of a single national epidemic. The Doherty network continues to provide modelling that informs national approaches to testing, contact tracing, isolation, quarantine and other aspects of disease control.

The team undertaking the South Australian modelling are specialist academics from the University of Adelaide who are part of the broader Doherty network. The South Australian COVID modelling is therefore similar to and informed by work done at the national level.

Mathematical models have inputs and outputs and the outcome of different scenarios can be considered by changing these inputs. The inputs reflect the public health interventions available to us which can be summarised as:

1. Vaccination – starting at 80% and assuming a steady increase
2. Public health and social measures (PHSM) – including personal hygiene behaviours, density requirements and caps on numbers, mask wearing and COVID management plans.
3. Testing, tracing, isolation and quarantine (TTIQ) – this includes testing for COVID, contact tracing of cases, isolating cases and requirements to quarantine close contacts. The use of QR check-in information will remain critical.

The South Australian modelling also uses state-specific data. This includes:

- adjusting for the older population in South Australia
- adjusting for differences in vaccination rates across age groups along with state specific vaccination forecasts
- the South Australian estimate of transmission potential, reflecting the impact of PHSMs.

The model does not adjust for geographic differences in vaccination rates within the state. The model has been based on seeding of cases into South Australia at a hypothetical rate of 20 infectious cases per day for 30 days, noting that not all of these cases will be detected by testing. This rate of seeding is considered reasonable given the predicted number of people entering South Australia from the states where there are high rates of community transmission. All scenarios modelled assume that South Australia will be opening its borders to fully vaccinated people only. The model does not account for waning immunity over time, nor booster vaccine doses. The model assumes that the public health and social measures in place at the beginning of border opening remain in place for a 300-day period. This number of days is used in the model because it is important to map out the whole hypothetical scenario for the length of time predicted by the modelling. This allows the most accurate assessment of all likely outputs.

Test trace isolate quarantine (TTIQ)

The modelling has used our best estimate of the TTIQ capacity in South Australia. Up until now South Australia has used an 'optimal' contact tracing system. However, as case numbers increase, contact tracers will rely more on SMS messaging and the prioritisation of contacting cases will become critical as the system is no longer able to contact everyone so quickly. This is necessary to cope with the case numbers and we will move to 'partial' TTIQ. The point at which this changes has important implications on the transmission of the virus. The actual point for transition to partial TTIQ is untested and therefore unknown. The model involves the best estimate of realistic TTIQ for South Australia and is called 'mixed' TTIQ.

Transmission Potential (TP)

TP refers to the average number of new people a positive COVID case infects. The TP is calculated by taking into account current PHSM. It reflects the impact of a set of interventions by measurements of social mobility (using for example Google mobility data), and a weekly national survey to assess self-reported compliance with COVID safe behaviours. TP involves uncertainty and the model includes best estimate of TP for South Australia. The TP for South Australia has been measured every week over the pandemic and closely follows changes in our local restrictions.

Latest data from the scientific literature

The modelling incorporates the most up to date scientific information about COVID-19 transmission (specific to the Delta variant) and impact of the disease. In addition, the modelling uses the most recent scientific information about the effectiveness of vaccination in terms of stopping people getting infected, onward transmission to others, asymptomatic and symptomatic infection, severe illness, hospitalisation and death.

Outputs

Based on the above inputs, the model produces outputs. These outputs predict, the likelihood of an outbreak occurring, the likely timing of this and the likely size of the wave. If an outbreak wave occurs the modelling will also estimate the:

- daily number of cases,
- daily hospital admissions and total hospital ward capacity requirements,
- ICU beds needed; and
- number of deaths from COVID.

These outputs can then be **compared against South Australia's health system capacity**, notably the number of ward beds and ICU beds.

Modelling is an iterative process and three scenarios are the focus of this report:

1. Opening borders at 80% vaccination rate in South Australia and maintaining current PHSM.
2. Opening borders at 80% vaccination rate in South Australia and maintaining current PHSM, but removing mask wearing requirements.
3. Opening borders at 80% vaccination rate in South Australia and maintaining current PHSM including masks, but allowing higher risk activities for double-vaccinated people (using vaccine passports and assuming 75% compliance).

KEY FINDINGS:

Scenario 1: Maintaining current PHSM (i.e., Current Restrictions)

- Under this scenario, the model suggests that South Australia will be able to manage the ward and ICU demand from COVID-19 infections generated in the community.
- The chance of an outbreak – that is averaging more than 100 cases per day over any three-day period – is estimated to be 27%.
- In the event of an outbreak, this scenario is estimated to be manageable with respect to hospital capacity:
    - Peak Ward Occupancy – 36 beds (range 21, 78)[1] and extremely small chance of demand exceeding 200 ward beds
    - Peak ICU Occupancy – 9 beds (range 5, 19) and extremely small chance of demand exceeding 30 ICU beds; and
    - Total Deaths (over the 300 days) – 13 individuals (range 4, 51).
    - Peak Ward Occupancy and Peak ICU Occupancy for those aged 0-11:
        - Peak Ward Occupancy (0–11 years) – 7 beds (range 2, 21)
        - Peak ICU Occupancy (0–11 years) – 1 beds (range 0, 5).

Scenario 2: Relaxing restrictions from current PHSM - by removing mask mandates in general settings but keeping all other public health restrictions in place

- The chance of an outbreak is estimated to be 64%.
- In the event of an outbreak, this scenario is estimated to present risks to being able to manage cases in particular with respect to ICU capacity:
    - Peak Ward Occupancy – 70 beds (range 23, 203) – and a 3% chance of demand exceeding 200 Ward beds
    - Peak ICU Occupancy – 18 beds (range 6, 47) – and a 20% chance of demand exceeding 30 ICU beds and
    - Total deaths (over the 300 days) – 55 individuals (range 6, 186).

Scenario 3: Relaxing restrictions from current PHSM – by introducing the use of Vaccine Certificates (with 75% compliance to this requirement) allowing higher-risk activities by fully-vaccinated individuals

- The chance of an outbreak is estimated to be 84%.
- In the likely event of an outbreak, this scenario is estimated to present risks to being able to manage cases, in particular with respect to ward and ICU capacity:
    - Peak Ward Occupancy – 351 beds (range: 24, 585)– and an 85% chance of demand exceeding 200 Ward beds
    - Peak ICU Occupancy – 72 beds (range: 6, 119) – and an 87% chance of demand exceeding 30 ICU beds
    - Total Deaths – 315 individuals (range: 8, 424)

[1] median (95% confidence interval)