The health system response to COVID-19 will continue long after we reach 80% vaccination coverage

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Competing Interest:
Mark Hanly receives funding from the National Health and Medical Research Council (NHMRC) and the Sydney Partnership for Health, Education, Research and Enterprise (SPHERE).

Raina MacIntyre receives funding from NHMRC Principal Research Fellowship, grant number 1137582 and MRFF.

Louisa Jorm receives grant funding from the National Health and Medical Research Council (NHMRC), Medical Research Futures Fund (MRFF) and Australian Research Data Commons (ARDC). She receives funding from the Australian Government Department of Health as part of a consortium that has been commissioned to undertake an independent evaluation of the Commonwealth Health Care Homes program.

Oisin Fitzgerald receives funding from the Sydney Partnership for Health, Education, Research and Enterprise (SPHERE).

Timothy Churches receives funding from the Sydney Partnership for Health, Education, Research and Enterprise (SPHERE), Australian Research Data Commons (ARDC) and the Ingham Institute for Applied Medical Research

Disclosure Statement:
Raina MacIntyre has been on an advisory board for COVID-19 vaccine for Seqirus and consulted or done speaking engagements on COVID-19 vaccines for Janssen and Astra Zeneca

Research Funding:
This research was supported by the generous assistance of Ian Sharp, philanthropic supporter of UNSW research, and by a research seed grant provided by the Sydney Partnership for Health, Education, Research and Enterprise (SPHERE) Infectious diseases, Immunity and Inflammation (Triple-I) Clinical Academic Group.

The funding sources had no role in the planning, writing or publication of the work.

Under Australia's current plan to transition the national COVID response, international border restrictions will be relaxed once 70% of eligible adults of are vaccinated, with further easing once 80% coverage is achieved. Our modelling results highlight the continued potential for disruptive outbreaks if international borders reopen while highly transmissible strains are circulating. We comment on implications for the Australian health system.

Following international border closures in March 2020, overseas arrivals into Australia dropped from over 1 million incoming passengers in December 2019 to record lows of fewer than 6,000 arrivals in March 2020. While critical in limiting the spread of the coronavirus into Australia at the outset of the pandemic,[1] the social and economic cost of international border closures has had a profound impact on multiple sectors, including tourism, retail and tertiary education.[2] Population vaccination against COVID-19 is seen as key to reopening borders and nearly 14 million COVID-19 vaccine doses have been administered as of August 7 2021, with 44% of the adult population having received one dose and 22% having received two doses. Estimates suggest that over 80% total population coverage can be achieved by January 2022, although lags in supply, high levels of vaccine hesitancy or delay in including children 12 and over could slow the rollout until mid-2022 or later.[3]

To better understand the implications of reopening the border, we modelled potential disease trajectories in the Australian population using an age-structured epidemic model that accounts for vaccination rollout and new arrivals into the population from November 2021. Our modelling scenarios assumed a starting point of no circulating virus in the community and varied three factors in a $2 \times 2 \times 2$ factorial design: speed of vaccine rollout, scale of border opening and transmissibility in the absence of interventions (Box 1). Our vaccine rollout projections accounted for available doses and hesitancy and predicted two-dose vaccine coverage among eligible adults (16+) of 92% and 56% by November 2021 in the fast and slow rollout scenarios respectively. International arrivals were set at 2,500 or 13,000 daily passengers corresponding to approximately 10% or 50% of average daily arrivals in 2019 (daily arrivals averaged 3,450 in June 2021[4]). Transmissibility in the absence of interventions was set at $R_0 = 2.5$ and $R_0 = 7.0$, approximating the ancestral virus and Delta variant respectively.

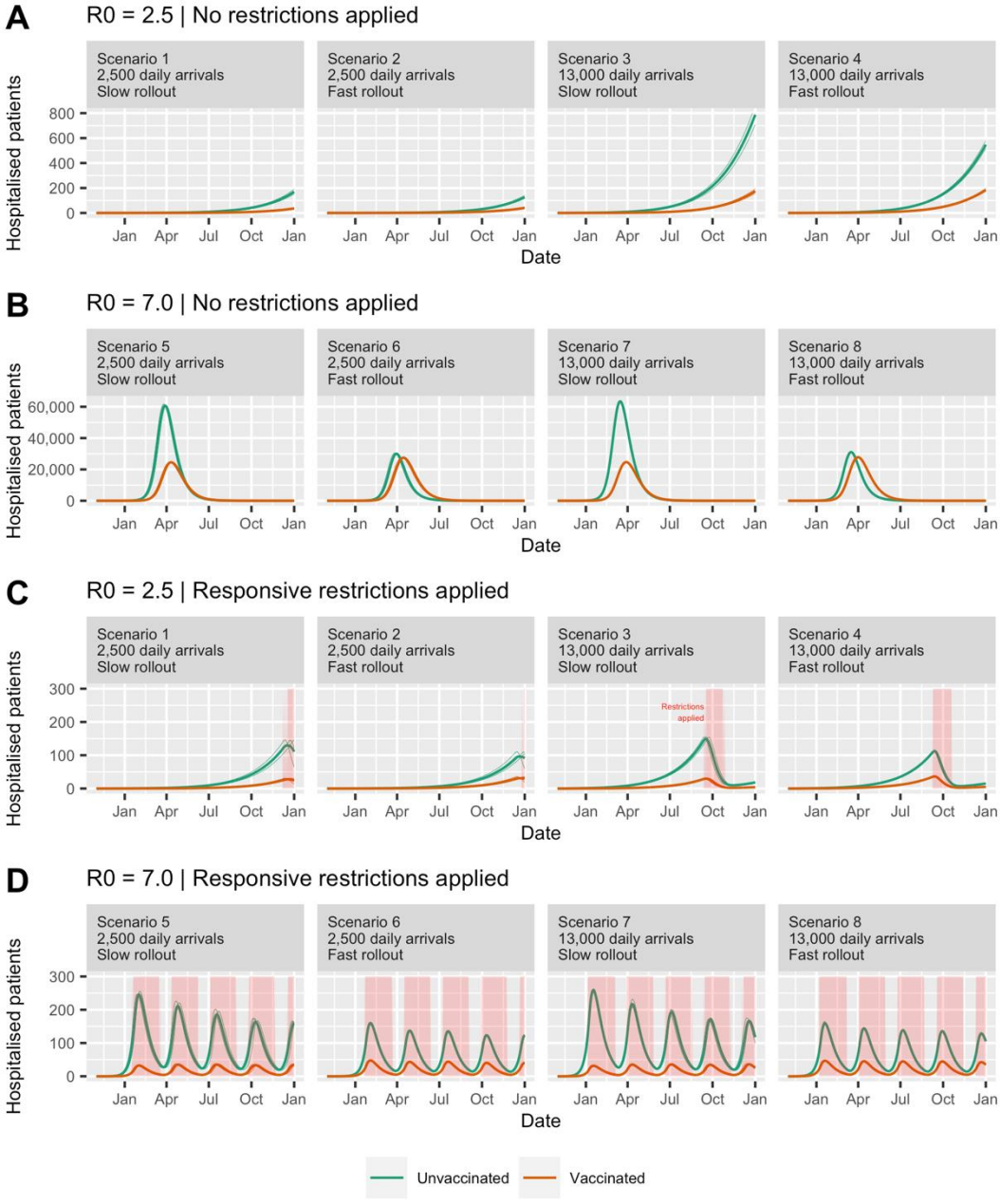
Box 1. Summary of simulation scenarios varying the baseline reproduction number, scale of border opening and speed of vaccine rollout

Scenario	Reproduction number in the absence of interventions (R_0)	Scale of border opening (daily arrivals from November 1)	Vaccine rollout speed	Projected vaccine coverage Nov 2021 (16+ / total)	Projected vaccine coverage Mar 2022 (16+ / total)
1	2.5	2,500	Slow	56% / 43%	83% / 65%
2	2.5	2,500	Fast	92% / 71%	97% / 75%
3	2.5	13,000	Slow	56% / 43%	83% / 65%
4	2.5	13,000	Fast	92% / 71%	97% / 75%
5	7.0	2,500	Slow	56% / 43%	83% / 65%
6	7.0	2,500	Fast	92% / 71%	97% / 75%
7	7.0	13,000	Slow	56% / 43%	83% / 65%
8	7.0	13,000	Fast	92% / 71%	97% / 75%

The resulting eight scenarios were modelled from November 2021 to the end of December 2022, with and without responsive restrictions that emulate the net effect of lockdowns, case isolation, contact tracing and quarantine. These restrictions were activated when the total number of currently infected individuals exceeded 10,000 and remained in place until the total number of

currently infected individuals dropped below 2,000 for 14 days. We assumed that the probability of an incoming passenger seeding a new chain of infection was 3.1 per 100,000 based on the estimated failure rate of the Australian hotel quarantine system between 1 April 2020 and 31 January 2021.[5] This may be an under-estimate given recent evidence of airborne spread of the Delta variant, if current hotel quarantine arrangements continue.

Box 2. Estimated prevalence of COVID-19 related hospitalisations (Nov 1 2021 – Dec 31 2022) without responsive restrictions (Panel A) and with responsive restrictions (Panel B)



Notes The shaded red bars in Panels C and D indicate periods where the responsive restrictions were activated.

For model scenarios with transmissibility similar to the ancestral virus (R_0 = 2.5), border openings in the absence of any restrictions resulted in some local transmission, but the prevalence of cases with severe illness leading to hospitalisation did not exceed health system surge capacity (estimated at over 4,000 ICU beds[6], Box 2 Panel A). However, for scenarios based on higher transmissibility (such as the Delta variant) opening the borders at any scale with no restrictions prompted an

overwhelming surge in hospitalisations (Box 2, Panel B). More realistically, surges in cases would necessitate some responsive restrictions, and our models that incorporated such responses showed that repeated cycles of restrictions would be necessary due to the ongoing risk of newly seeded cases from overseas arrivals establishing community chains of transmission, particularly for highly transmissible strains (Box 2, Panel D). Under these contained outbreaks, most severely ill cases were unvaccinated, although 1-2 in 10 hospitalised patients were fully vaccinated.

Under Australia's four-phase roadmap out of the pandemic, international border controls would be relaxed once vaccine coverage among the over 16s reaches 80%, guided by modelling from the Doherty Institute.[7] Similar modelling from the Grattan Institute[8] emphasised a stricter 80% of the total population as a key threshold to see an end to lockdowns in Australia. Although population vaccination is a crucial line of defence, our modelling results underscore that if borders are reopened while highly transmissible variants are circulating globally, large and disruptive outbreaks will still be possible even when total coverage exceeds 80%. These results reinforce that mass-vaccination will not be the final act in the pandemic response, especially now that the ancestral virus has mutated to more transmissible strains. However, given the focus on protecting the health system from being overwhelmed, the efficacy of the available vaccines in preventing serious disease means that the threshold to introduce restrictions is likely to be considerably more lenient than under current policy once high vaccine coverage is achieved. We also recognise that well-matched more efficacious vaccines against variants of concern will become available in the future, which will improve the outcomes of mass vaccination.

Maintenance of high levels of community testing to facilitate the rapid detection and isolation of new cases will be essential in the post-vaccination phase. Ongoing non-pharmaceutical interventions including masks may also be necessary to live with COVID-19. It will also be essential to develop quarantine protocols that minimise the risk of leakage into the community and are scalable to individual's vaccination status and jurisdiction of origin, as well as physical infrastructure to effectively quarantine high-risk passengers who may be infected with highly transmissible virus variants. Health service planning will be required for the significant health care needs of people in quarantine who require emergency department review[9] and the potential for higher hospitalisation rates with emergent variants if borders open at scale with quarantine in place.

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