Failures of quarantine systems for preventing COVID-19 outbreaks in Australia and New Zealand

Leah Grout1, Ameera Katar2, Driss Ait Ouakrim3, Jennifer A Summers1, Amanda Kvalsvig1, Michael G Baker1, Tony Blakely2, Nick Wilson1

Abstract

Objectives: To identify COVID-19 quarantine system failures in Australia and New Zealand.

Design, setting, participants: Observational epidemiological study of travellers in managed quarantine in Australia and New Zealand, to 15 June 2021.

Main outcome measures: Number of quarantine system failures, and failure with respect to numbers of travellers and SARS-CoV-2-positive travellers.

Results: We identified 22 quarantine system failures in Australia and ten in New Zealand to 15 June 2021. One failure initiated a COVID-19 outbreak that caused more than 800 deaths (the Victorian “second wave”); nine lockdowns were linked with quarantine system failures. The failure risk was estimated to be 5.0 failures per 100 000 travellers passing through quarantine and 6.1 (95% CI, 4.0–8.3) failures per 1000 SARS-CoV-2-positive travellers. The risk per 1000 SARS-CoV-2-positive travellers was higher in New Zealand than Australia (relative risk, 2.0; 95% CI, 1.0–4.2).

Conclusions: Quarantine system failures can be costly in terms of lives and economic impact, including lockdowns. Our findings indicate that infection control in quarantine systems in Australia and New Zealand should be improved, including vaccination of quarantine workers and incoming travellers, or that alternatives to hotel-based quarantine should be developed.

Methods

We defined a quarantine system failure as infection with SARS-CoV-2 of a border or health worker, or of a person in the community with a link to the quarantine and isolation system. This definition included people infected in hospital by someone transferred from a quarantine facility (ie, infected persons for whom the 14-day quarantine process had not ended), but did not include virus transmission between returned persons within quarantine facilities.

During 6 January – 23 June 2021, we searched government websites in both countries, including state-specific websites in Australia, to identify outbreaks and border control failures associated with quarantine systems. When an outbreak source was uncertain (eg, the Auckland outbreak in August 2020), we used the best available information to determine whether it was a quarantine failure. Decisions to label an incident a quarantine system failure were confirmed by all authors.

We calculated failure risk (with 95% confidence intervals [CIs]) per 100 000 travellers who passed through quarantine facilities during 1 April 2020 (Australia) or 17 June 2020 (New Zealand) – 15 June 2021; we also calculated the risk per 1000 SARS-CoV-2-positive people who passed through these facilities. The 95% CIs were calculated as (1.96 ∗ √n)(P / d), where n = number of hotel quarantine failures, P = population size for rate (100 000 or 1000), and d = denominator, which is the number of people who passed through quarantine facilities during the 15-week period.

New Zealand and some Australian states have repeatedly eliminated community transmission of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The two countries have primarily used hotel-based quarantine for citizens returning from overseas, requiring 14 days of quarantine, as well as polymerase chain reaction (PCR)-based virus testing and mask use in shared spaces, such as common exercise areas (in New Zealand, but not in most Australian states).

Adapting hotels for quarantine purposes exploits a resource otherwise underused during the coronavirus disease 2019 (COVID-19) pandemic, given the decline in international travel. However, the major disadvantage of hotel-based quarantine is that shared spaces and inappropriate ventilation probably render it less effective than purpose-built facilities. Moreover, the consequences of escape of the virus from quarantine (eg, via infected facility workers) may be more severe, given the higher population density in the urban areas where the hotels are located.

On 13 June 2021, the rolling 7-day mean number of administered COVID-19 vaccine doses was 0.46 per 100 people in Australia and 0.31 per 100 people in New Zealand. However, as two doses of the vaccines used are required, these numbers do not indicate the number of people who are fully vaccinated. Most border workers in Australia and New Zealand have been fully vaccinated; in New Zealand, more than 56 000 doses had been administered to border workers by 28 March 2021. All hotel quarantine workers in Victoria who have face-to-face contact with returned travellers had received first vaccine doses by the first week of April 2021.

In view of the limitations of hotel quarantine, we estimated the failure risk of quarantine systems in New Zealand and Australia with respect to the spread of COVID-19 into the community.
We identified 22 quarantine system failures in Australia, in one instance initiating an outbreak that caused more than 800 deaths (the Victorian “second wave”); eight lockdowns were linked with quarantine system failures. We identified ten quarantine system failures in New Zealand; one initiated an outbreak that caused three deaths and a lockdown (Box 1; online Supporting Information).

For Australia and New Zealand combined, there were 5.0 failures per 100 000 travellers in quarantine (one per 20 156 travellers) and 6.1 failures per 1000 SARS-CoV-2-positive travellers in quarantine (one per 163 infections) (Box 1). This equates to 4.0–17 failures per 1000 SARS-CoV-2-positive travellers in New Zealand than in Australia could reflect lower quality quarantine measures, but perhaps also greater detection of infections among border workers by testing over a longer period.

Measures have been undertaken that may reduce the risk, including the vaccination of quarantine workers. In New Zealand, the vaccination of border workers with the Pfizer–BioNTech vaccine began in February 2021, and by 11 June it was reported that all managed isolation and quarantine workers had been fully vaccinated. However, more than 1600 other frontline border

| Jurisdiction                   | Failures | Travellers | SARS-CoV-2-positive travellers | Per 100 000 travellers passing through quarantine | Per 1000 SARS-CoV-2-positive travellers |
|-------------------------------|----------|------------|--------------------------------|-----------------------------------------------|----------------------------------------|
| New Zealand and Australia     | 32       | 644 982    | 5206                           | 5.0 (3.2–6.7)                                 | 6.1 (4.0–8.3)                          |
| New Zealand (17 June 2020 – 15 June 2021) | 10       | 145 759    | 955†                           | 6.9 (2.6–11)                                  | 10 (4.0–17)                            |
| Australia (1 April 2020 – 15 June 2021) | 22       | 499 223    | 4251                           | 4.4 (2.6–6.2)                                 | 5.2 (3.0–7.3)                          |
| Australian Capital Territory  | 0        | 988        | 26                             | —                                             | —                                      |
| Queensland                    | 3†       | 111 805    | 724                            | 2.7                                           | 4.1                                    |
| New South Wales               | 9        | 218 457    | 1907                           | 4.1                                           | 4.7                                    |
| Northern Territory            | 0        | 16 378     | 153                            | —                                             | —                                      |
| South Australia               | 2        | 20 524     | 351                            | 9.7                                           | 5.7                                    |
| Tasmania                      | 0        | 1287       | 21                             | —                                             | —                                      |
| Victoria                      | 5        | 83 904     | 550                            | 6.0                                           | 9.1                                    |
| Western Australia             | 3        | 45 880     | 519                            | 6.5                                           | 5.8                                    |

CI = confidence interval. † Numbers at state/territory level were too small for calculation of meaningful 95% CIs. 1 Includes nine SARS-CoV-2-positive people without overseas travel history. 2 Includes two at a hospital during the quarantine process. 3 Includes one non-hotel facility (former workers’ camp). 4 Flights to Victoria were suspended during 14 February – 25 March 2021 following a quarantine failure linked with use of a nebuliser in a quarantine facility, leading to 22 infections (the “Holiday Inn cluster”). Flights to Victoria were also suspended during 2 July – 6 December 2020 (the “second wave”).
## 2 Policy and operational options for reducing the risk of SARS-CoV-2 transmission by travellers to Australia and New Zealand, with proposed prioritisation

| Policy option | Description | Priority |
|---------------|-------------|----------|
| 1. Cap or suspend travel from countries with high infection rates | The Australian and New Zealand governments have the legal powers to reduce the numbers of incoming travellers by restricting the rights of their citizens to return from countries very high incidence rates on public health grounds. | Top priority |
| 2. Pre-departure testing, with or without quarantine | Expand existing requirements for pre-departure testing to further source countries. Pre-departure testing could include both polymerase chain reaction (PCR) testing within 72 hours of departure and rapid testing immediately before departure, to identify infected persons who start shedding virus in the 72 hours preceding departure. Such arrangements are considered legally acceptable. Pre-departure quarantine (for one week) would provide additional assurance, preferably in an airport hotel in a transport hub where New Zealand and Australian officials are permitted to check quality of self-quarantine as strictly as possible during the week before travel. | Top priority |
| 3. Pre-departure vaccination | Make travel contingent on providing evidence of full vaccination. This measure assumes that vaccination at least partially reduces the risk of transmission. | Uncertain |
| 4. Use passenger booking systems to reduce infection risk | Require passengers to declare pre-departure COVID-19 precautions when booking quarantine facility accommodation prior to travel. A booking system is operating in New Zealand and could be adopted in Australia. | High priority |
| 5. Increase in-flight precautions | Explore means for reducing risk of in-flight infection, as documented on a flight to New Zealand. by more stringent enforcement of mask wearing in airports and during flights, and the use of higher efficacy masks (although fit can be critical to the level of protection) or double masking. The United States Centers for Disease Control found that a medical procedure mask blocked 56.1%, a cloth mask 51.4% of particles ejected by a simulated cough dummy; a cloth mask over a medical procedure mask (double masking) blocked 85.4% of particles. Double masking of the dummy reduced the cumulative exposure of an unmasked receiver dummy by 82.2%; if the source was unmasked and the receiver fitted with a double mask, cumulative exposure was reduced by 83.0%. When both source and receiver were double masked, the cumulative exposure of the receiver was reduced by 96.4%. A laboratory study (in people) that compared the fitted filtration efficiency (FFE) of commonly available masks worn singly, doubled, or in combination found that adding a second medical procedure mask improved mean FFE from 55% to 66%, and wearing a procedure mask under a cloth face covering improved overall FFE from 66% to 81%, probably by reducing leakage between mask and skin. These findings may not fully reflect real world double masking, but suggest that it may reduce both the risk from infected people and the exposure of uninfected persons. Minimising talking during eating and drinking, and improved ventilation and spacing during flights might also be worthwhile. | High priority |
| 6. Reduce infection risk in airports and transit hubs | Minimise the risk of cross-infection at departure airports and transit hubs by enforcing physical distancing and mask use. | Medium priority |
| 7. Improve local transport | Ensure sufficient physical distancing of travellers on arrival and in transit to quarantine (eg, reduced shuttle capacity); higher efficacy masks or double masking could be required. | Medium priority |
| 8. Shift to discrete quarantine units | Shift some or all quarantine facilities to rural military bases or camps where discrete units (eg, mobile homes or caravans) could be spatially separated, allowing natural ventilation and eliminating shared indoor spaces. The Howard Springs facility, a converted workers’ camp in the Northern Territory, is a successful model. If spaces were limited, these facilities could be used for travellers from the highest risk countries. | High priority |
| 9. Restrict hotel quarantine in large cities to travellers at low risk of being infected | Reserve large city hotel quarantine for lowest risk category travellers, and send those in higher risk categories to hotels in smaller cities. Airport access and the risk associated with additional travelling need to be considered. | High priority |
| 10. Expand PCR testing of saliva of facility workers and travellers | Expand daily PCR testing of saliva from facility workers to all facilities in both countries. This could also be considered for all travellers, possibly in combination with current testing regimens. In light of the greater transmissibility of new SARS-CoV-2 variants, testing all workers in border-associated occupations (including catering and laundry service staff) at least twice per week should be considered. Documentation of negative test results should replace self-report systems as an occupational requirement for all border workers. | High priority |
| 11. Require vaccination of quarantine staff | Vaccinating all frontline quarantine workers would be particularly valuable should it prove to reduce transmission. | April 2021: nearing completion in some jurisdictions |

Continues
While vaccination of quarantine workers and other border staff was a priority during the first phase of the national vaccine rollout in Australia, information on how many had been vaccinated was not published. In some states, it was reported in April that all border staff had been required to undergo vaccination in early 2021.19

Full vaccination of frontline border workers may have prevented some quarantine system failures. However, vaccination does not eliminate the risk of transmitting or being infected with SARS-CoV-2, although a moderate degree of protection is likely. For example, vaccine efficacy with respect to symptomatic COVID-19 was 67% more than 14 days after the second Pfizer/BioNTech vaccine dose,20 while a later study reported that clinical vaccine efficacy for preventing symptomatic nucleic acid amplification test (NAAT)-positive infection was 70% for the Alpha variant and 82% for other lineages more than 14 days after the second dose.21 Infection rates were reduced by 70% in people who had received two doses of the Moderna vaccine (asymptomatic and symptomatic cases),22 and by 95% with the Pfizer/BioNTech vaccine (national surveillance data in Israel).23 Studies in other primates suggests that the peak infection was 70% for the Alpha variant and 82% for other lineages more than 14 days after the second dose.21 Infection rates were reduced by 70% in people who had received two doses of the Moderna vaccine (asymptomatic and symptomatic cases),22 and by 95% with the Pfizer/BioNTech vaccine (national surveillance data in Israel).23 Studies in other primates suggests that the peak

Increased testing of quarantine workers25 will identify some quarantine failures before they lead to community outbreaks. Other improvements in quarantine systems include better security, requiring mask wearing inside quarantine facilities, reducing access to shared spaces, and improving personal protective equipment (PPE) use by workers.26,27

Better or purpose-built quarantine facilities in rural locations would both avoid the greater risk of close community contacts associated with central business district hotels and that of within-building spread by inappropriate ventilation systems. There have been no quarantine failures at the Howard Springs facility near Darwin, a success that was cited in the June 2021 announcement of the construction of a purpose-built quarantine facility in Victoria.28 Other infection prevention and control measures, including PPE, will remain important in all quarantine facilities.

The most direct way to substantially reduce the risk of SARS-CoV-2 escaping quarantine is to reduce the number of arriving travellers from areas with high infection levels, as New Zealand and Australia did temporarily for travel from India and other high risk countries in April 2021.25 Beyond this measure, a range of other improvements in arrangements and processes could be considered (Box 2).

**Limitations**

The cause of some COVID-19 outbreaks was uncertain (eg, Auckland, August 2020) and there was imprecision in traveller numbers for Australia, as some people moved between states on domestic flights, and this was not captured in the data we analysed. Additionally, COVID-19 case numbers are often provisional because of reclassifications of false positive results and duplications. We did not assess change in quarantine system failures over time because of the relatively small number of failure events. The risk of system failures is probably highly dynamic as traveller volumes, infection rates, and quarantine processes change, and as vaccination rates for border workers and in the community increase. The number of deaths per failure was almost entirely attributable to the second wave in Victoria, and therefore should not be extrapolated to future failures.

**Conclusions**

We identified 32 COVID-19 quarantine failures in Australia and New Zealand to 15 June 2021. Quarantine system failures can be costly in terms of lives and economic impact. Hotel-based quarantine needs to be improved or alternative approaches developed.

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